Pyslet Documentation

Release 0.6.20160201

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Contents

CHAPTER 1

What's New?

As part of moving towards PEP-8 compliance a number of name changes are being made to methods and class attributes with each release. There is a module, pyslet.pep8, which contains a compatibility class for remapping missing class attribute names to their new forms and generating deprecation warnings, run your code with "python -Wd" to force these warnings to appear. As Pyslet makes the transition to Python 3 some of the old names will go away completely.

It is still possible that some previously documented names could now fail (module level functions, function arguments, etc.) but I've tried to include wrappers or aliases so please raise an issue on Github if you discover a bug caused by the renaming. I'll restore any missing old-style names to improve backwards compatibility on request.

Finally, in some cases you are encouraged to derive classes from those defined by Pyslet and to override default method implementations. If you have done this using old-style names you will *have* to update your method names to prevent ambiguity. I have added code to automatically detect most problems and force fatal errors at runtime on construction, the error messages should explain which methods need to be renamed.

1.1 Version Numbering

Pyslet version numbers use the check-in date as their last component so you can always tell if one build is newer than another. At the moment there is only one actively maintained branch of the code: version '0". Changes are reported against the versions released to PyPi. 'XX' at the end of the version indicates changes that have not yet been released to PyPi but have been committed to the master branch (with tests passing).

Not sure which version you are using? Try:

```
from pyslet.info import version
print version
```

1.2 Version 0.6.20160201

Summary of New Features: LTI module rewritten, now suitable for real applications! WSGI-based web-app framework built using Pyslet's DAL MySQL Database connector for Pyslet's DAL SSL, Certificates and HTTP Basic Authentication HTTP Cookies URNs

#3 PEP-8 driven refactoring (ongoing)

Added new method decorators to make supporting renamed and redirected methods easier. Added checks for ambiguous names in classes likely to have been sub-classed by third-party code.

#8 Support for SSL Certificates in HTTP Clients

Fixed certificate support in OData and Atom clients. See blog post for further information on how to use certificates: http://swl10.blogspot.co.uk/2014/11/basic-authentication-ssl-and-pyslets.html

#9 HTTP client retry strategy

Improved HTTP retries with simple Fibonacci-based back-off. Also fixed a bug where, if the first request after a server timed out an idle connection is a POST, the request would fail.

#12 bug when using numeric or named parameters in DB API

The basic bug is fixed and I've also added support for paramstyle 'format'.

#14 content element missing in media-link entries

Fixed. Affected atom xml formatted entities only.

#15 MySQL implementation of Pyslet's DAL (ongoing)

Changes to the core DAL to deal to better support other DB modules. These included added support for LIMIT clauses to speed up paged access to large entity sets. Implementation of a retry strategy when database commands return OperationalError (e.g., MySQL idle timeouts). An updated connection pool manager and an optional pool cleaner method to clean up idle database connections.

#18 Possible bug in parsing AssociationSet names

Added a compatibility mode to odata2.csdl to enable the metadata model to optionally accept hyphen or dash characters in simple identifiers using:

```
import pyslet.odata2.csdl as edm
edm.set_simple_identifier_re(edm.SIMPLE_IDENTIFIER_COMPATIBILITY_RE)
```

#19 OData Function parameter handling

Enabled function parameter passing in OData service operations. Only primitive types are supported but they are now parsed correctly from the query string and coerced to the declared parameter type. Bound functions now receive them as a dictionary of SimpleValue instances.

#20 HTTP Basic Authentication

Fixed an issue with the OData basic authentication support, in some cases the HTTP client was waiting for a 401 when it could have offered the credentials preemptively. See also the following blog article: http://swl10.blogspot.co.uk/2014/11/basic-authentication-ssl-and-pyslets.html

#22 Support for navigation properties in OData expressions

Although the code always contained support in general, the mapping to SQL did not previously support the use of table joins in SQL expressions. This release adds support for joins (but not for nested joins).

#23 A Framework for WSGI-based LTI Applications

Added a new module to make it easier to write WSGI-based applications. Re-factored the existing Basic LTI module to use the new oauthlib and Pyslet's own OData-inspired data access layer.

#24 ESA Sentinel mission compatibility

Added the capability to override the metadata used by an OData server to deal with validation issues in some services. Clients can now also be created from an offline copy of the service root document.

#26 HTTP client eats memory when downloading large unchunked files

Fixed the download buffer which was failing to write out data until an entire chunk (or the entire download) was complete.

#29 https connections fail on POST after remote server hangup

Partial mitigation with an agressive 2s window in which to start sending a follow-up request when pipelining through https. This is a crude solution and the bug remains open for a more robust solution based around use of the Expect header in HTTP/1.1.

#30 HTTP client cleanup thread

Added an optional parameter to the HTTP client constructor that creates a cleanup thread to close down idle connections periodically.

#31 Removed reliance on Host header in wsgi app class

There are a number of ways an application can be attacked using a forged Host header, wsgi now ignores the Host header and uses a new setting for the preferred scheme//host:port.

#32 get_certificate_chain

Implemented a function to create a complete certificate chain. Implemented using pyOpenSSL with a lot of help from this article

#33 Fixed exception: 'NoneType' object has no attribute 'current_thread' on exit

Caused by an overly ambitious __del__ method in SQLEntityContainer.

#34 Fixed missing Edm prefix in OData sample code #35 Fixed missing import in rfc5023 (atom protocol) module #36 Fixed incorrect error messages in OData $filter queries #37 Extended comparison operators in OData to include DateTimeOffset values

All thanks to @ianwj5int for spotting

#38 Python 3 compatibility work

I have started revising modules to support Python 3. This is not yet production ready but it is a small impact on existing modules. I have done my best to maintain compatibility, in practice code should continue to work with no changes required.

The most likely failure mode is that you may find a unicode string in Python 2 where you expected a plain str. This can have a knock-on effect of promoting data to unicode, e.g., through formatting operations. In general the returned types of methods are just being clarified and unicode values are returned only where they may have been returned previously anyway. However, in the case of the URI attributes in the rfc2396 module the types have changed from str to unicode in this release.

This is work in progress but the impact is likely to be minimal at this stage.

#40 & #41 Composite keys and Slug headers

Key hints were not working properly between the OData client and server implementations, and were not working at all when the key was composite. It is now possible to pass the formatted entity key predicate (including the brackets) as a Slug to the OData server and it will attempt to parse it and use that key where allowed by the underlying data layer.

#43 Fixes for Python running on Windows

The only substantive changes required were to the way we check for io failures when IOError is raised and the way we handle URI containing non-ASCII characters. Some of the unit tests were also affected due to issues with timing, including the reduced precision of time.time() on Windows-based systems.

Untracked enhancements:

Added a new module to support HTTP cookies. The HTTP/OData client can now be configured to accept cookies. The default behaviour is to *ignore* them so this won't affect existing applications.

Added a new module to support URN syntax to provide a better implementation of the IMS LTI vocabularies.

Added an optional params dictionary to the OData expression parser to make it *much* easier to parse parameterized OData queries.

Added new methods for creating and executing drop table statements in the DAL.

Reworked sample code for the weather data server, included example driver files for mod_wsgi

Other fixes:

Fixed an issue in the OData client that caused basic key lookup in filtered entity collections to use both a key predicate and a $filter query option. This was causing the filter to be ignored, now the key predicate will be added to the filter rather than the path segment.

Fixed the OData DateTime parser to accept (and discard) any time zone specifier given in the literal form as it is now allowed in the ABNF and may therefore be generated by OData servers.

Fixed a bug in the OData server which meant that requests for JSON format responses were not being limited by the builtin topmax and would therefore attempt to return all matching entities in a single response.

Fixed a bug in the OData server which meant that use of $count was causing the $filter to be ignored!

Fixed a bug in the OData URI parser that prevent compound keys from working properly when zealous escaping was used.

Fixed a bug in the OData server which meant that error messages that contained non-ASCII characters were causing a 500 error due to character encoding issues when outputting the expected OData error format.

Fixed a bug in the OData expression evaluator when evaluating expressions that traversed navigation properties over optional relations. If there was no associated entity an error was being raised.

Fixed a bug in the SQL DAL implementation which means that navigation properties that require joining across a composite key were generating syntax errors, e.g., in SQLite the message 'near "=": syntax error' would be seen.

Fixed a bug in the SQLite DAL implementation which means that in-memory databases were not working correctly in multi-threaded environments.

Fixed XML parser bug, ID elements in namespaced documents were not being handled properly.

Fixed bug in the OData server when handling non-URI characters in entity keys

Fixed a bug with composite key handling in media streams when using the SQL layer

1.3 Version 0.5.20140801

Summary of New Features:

- OData Media Resources
- HTTP Package refactoring and retry handling
- Python 2.6 Support

Tracked issues addressed in this release:

#1 added a Makefile to make it easier for others to build and develop the code

Added a tox.ini file to enable support for tox (a tool for running the unittests in multiple Python environments).

#3 PEP-8 driven refactoring (ongoing)

#2 Migrated the code from SVN to git: https://github.com/swl10/pyslet

#4 Added support for read-only properties and tests for auto generated primary and foreign key values

#6 added integration between git and travis ci (thanks @sassman for your help with this)

#10 restored support for Python 2.6

1.3.1 Other Fixes

OData URLs with reserved values in their keys were failing. For example Entity('why%3F') was not being correctly percent-decoded by the URI parsing class ODataURI. Furthermore, the server implementation was fixed to deal with the fact that PATH_INFO in the WSGI environ dictionary follows the CGI convention of being URL-decoded.

1.4 Version 0.4 and earlier

These are obsolete, version 0.4 was developed on Google Code as an integral part of the QTI Migration tool.

1.5 PyAssess

A precursor to Pyslet. For more information see: https://code.google.com/p/qtimigration/wiki/PyAssess

CHAPTER 2

Compatibility

2.1 Python 2.6 Compatibility

When imported, this module modifies a number of standard modules. This patching is done at run time by the pyslet.py26 module and will affect any script that uses Pyslet. It does not modify your Python installation!

io Benign addition of the SEEK_* constants as defined in Python 2.7.

wsgiref.simple_server Modifies the behaviour of the WSGI server when procssing HEAD requests so that Content-Length headers are not stripped. There is an issue in Python 2.6 that causes HEAD requests to return a Content-Length of 0 if the WSGI application does not return any data. The behaviour changed in Python 2.7 to be more as expected.

zipfile Patches is_zipfile to add support for passing open files which is allowed under Python 2.7 but not under 2.6.

2.1.1 Module Reference

`pyslet.py26.`**`py26 = False`**
If you must know whether or not you are running under Python 2.6 then you can check using this flag,which is True in that case.

2.2 Python 2 Compatibility

The goal of Pyslet is to work using the same code in both Python 3 and Python 2. Pyslet was originally developed in very early versions of Python 2, it then became briefly dependent on Python 2.7 before settling down to target Python 2.6 and Python 2.7.

One approach to getting the code working with Python 3 would be to implement a compatibility module like six which helps code targeted at Python 2 to run more easily in Python 3. Unfortunately, the changes required are still extensive and so more significant transformation is required.

The purpose of this module is to group together the compatibility issues that specifically affect Pyslet. It provides definitions that make the intent of the Pyslet code clearer.

`pyslet.py2.`**`py2 = True`**
Unfortunately, sometimes you just need to know if you are running under Python 2, this flag provides a common way for version specific code to check. (There are multiple ways of checking, this flag just makes it easier to find places in Pyslet where we care.)

pyslet.py2.**suffix**
In some cases you may want to use a suffix to differentiate something that relates specifically to Python 3 versus Python 2. This string takes the value '3' when Python 3 is in use and is an empty string otherwise.

One example where Pyslet uses this is in the stem of a pickled file name as such objects tend to be version specific.

2.2.1 Text, Characters, Strings and Bytes

This is the main area where Pyslet has had to change. In most cases, Pyslet explicitly wants either Text or Binary data so the Python 3 handling of these concepts makes a lot of sense.

pyslet.py2.**u8**(*arg*)
A wrapper for string literals, obviating the need to use the 'u' character that is not allowed in Python 3 prior to 3.3. The return result is a unicode string in Python 2 and a str object in Python 3. The argument should be a binary string in UTF-8 format, it is not a simple replacement for 'u'. There are other approaches to this problem such as the *u* function defined by compatibility libraries such as six. Use whichever strategy best suits your application.

u8 is forgiving if you accidentally pass a unicode string provided that string contains only ASCII characters. Recommended usage:

```
my_string = u8(b'hello')
my_string = u8('hello') # works for ASCII text
my_string = u8(u'hello') # wrong, but will work for ASCII text
my_string = u8(b'\xe8\x8b\xb1\xe5\x9b\xbd')
my_string = u8('\xe8\x8b\xb1\xe5\x9b\xbd') # raises ValueError
my_string = u8(u'\u82f1\u56fd') # raises ValueError
my_string = u8('\u82f1\u56fd') # raises ValueError in Python 3 only
```

The latter examples above resolve to the following two characters: "".

In cases where you only want to encode characters from the ISO-8859-1 aka Latin-1 character set you may prefer to use the ul function instead.

pyslet.py2.**ul**(*arg*)
An alternative wrapper for string literals, similar to *u8()* but using the latin-1 codec. ul is a little more forgiving than u8:

```
my_string = ul(b'Caf\xe9')
my_string = ul('Caf\xe9') # works for Latin text
my_string = ul(u'Caf\xe9') # wrong, but will work for Latin text
```

Notice that unicode escapes for characters outside the first 256 are not allowed in either wrapper. If you want to use a wrapper that interprets strings like '\u82f1\u56fd' in both major Python versions you should use a module like six which will pass strings to the unicode_literal codec. The approach taken by Pyslet is deliberately different, but has the advantage of dealing with some awkward cases:

```
ul(b'\\user')
```

The u wrapper in six will throw an error for strings like this:

```
six.u('\\user')
Traceback (most recent call last):
    ...
UnicodeDecodeError: 'unicodeescape' codec can't decode bytes in
    position 0-4: end of string in escape sequence
```

Finally, given the increased overhead in calling a function when interpreting literals consider moving literal definitions to module level where they appear in performance critical functions:

```
CAFE = ul(b"Caf\xe9")

def at_cafe_1(location):
    return location == u"Caf\xe9"

def at_cafe_2(location):
    return location == CAFE

def at_cafe_3(location):
    return location == ul(b"Caf\xe9")
```

In a quick test with Python 2, using the execution time of version 1 as a bench mark version 2 was approximately 1.1 times slower but version 3 was 19 times slower (the results from six.u are about 16 times slower). The same tests with Python 3 yield about 9 and 3 times slower for ul and six.u respectvely.

Compatibility comes with a cost, if you only need to support Python 3.3 and higher (while retaining compatibility with Python 2) then you should use the first form and ignore these literal functions in performance critical code. If you want more compatibility then define all string literals ahead of time, e.g., at module level. One common case is provided for with the following constant:

```
..  data:: empty_text
```

    An empty character string. Frequently used as an object to join character strings:

```
    py2.empty_text.join(my_strings)
```

pyslet.py2.**is_text**(*arg*)
    Returns True if *arg* is text and False otherwise. In Python 3 this is simply a test of whether arg is of type str but in Python 2 both str and unicode types return True. An example usage of this function is when checking arguments that may be either text or some other type of object.

pyslet.py2.**force_text**(*arg*)
    Returns *arg* as text or raises TypeError. In Python 3 this simply checks that arg is of type str, in Python 2 this allows either string type but always returns a unicode string. No codec is used so this has the side effect of ensuring that only ASCII compatible str instances will be acceptable in Python 2.

pyslet.py2.**to_text**(*arg*)
    Returns *arg* as text, converting it if necessary. In Python 2 this always returns a unicode string. In Python 3, this function is almost identical to the built-in *str* except that it takes binary data that can be interpreted as ascii and converts it to text. In other words:

```
    to_text(b"hello") == "hello"
```

    In both Python 2 and Python 3. Whereas the following is only true in Python 2:

```
    str(b"hello") == "hello"
```

    arg need not be a string, this function will cause an arbitrary object's __str__ (or __unicode__ in Python 2) method to be evaluated.

pyslet.py2.**is_unicode**(*arg*)
    Returns True if *arg* is unicode text and False otherwise. In Python 3 this is simply a test of whether arg is of type str but in Python 2 arg must be a *unicode* string. This is used in contexts where we want to discriminate between bytes and text in all Python versions.

pyslet.py2.**character**(*codepoint*)
    Given an integer codepoint returns a single unicode character. You can also pass a single byte value (defined as

the type returned by indexing a binary string). Bear in mind that in Python 2 this is a single-character string, not an integer. See *byte()* for how to create byte values dynamically.

pyslet.py2.**force_bytes**(*arg*)
Given either a binary string or a character string, returns a binary string of bytes. If arg is a character string then it is encoded with the 'ascii' codec.

pyslet.py2.**byte**(*value*)
Given either an integer value in the range 0..255, a single-character binary string or a single-character with Unicode codepoint in the range 0..255: returns a single byte representing that value. This is one of the main differences between Python 2 and 3. In Python 2 bytes are characters and in Python 3 they're integers.

pyslet.py2.**byte_value**(*b*)
Given a value such as would be returned by *byte()* or by indexing a binary string, returns the corresponding integer value. In Python 3 this a no-op but in Python 2 it maps to the builtin function ord.

pyslet.py2.**join_bytes**(*arg*)
Given an arg that iterates to yield bytes, returns a bytes object containing those bytes.

class pyslet.py2.**UnicodeMixin**
Bases: object

Mixin class to handle string formatting

For classes that need to define a __unicode__ method of their own this class is used to ensure that the correct behaviour exists in Python versions 2 and 3.

The mixin class implements __str__ based on your existing __unicode__ implementation. In python 2, the output is encoded using the default system encoding. This may well generate errors but that seems more appropriate as it will catch cases where the *str* function has been used instead of *to_text()*.

2.2.2 Iterable Fixes

Python 3 made a number of changes to the way objects are iterated.

pyslet.py2.**range3**(**args*)
Uses Python 3 range semantics, maps to xrange in Python 2.

pyslet.py2.**dict_keys**(*d*)
Returns an iterable object representing the keys in the dictionary *d*.

pyslet.py2.**dict_values**(*d*)
Returns an iterable object representing the values in the dictionary *d*.

2.2.3 Comparisons

class pyslet.py2.**CmpMixin**
Bases: object

Mixin class for handling comparisons

For compatibility with Python 2's __cmp__ method this class defines an implementation of __eq__, __lt__ and __le__ that are redirected to __cmp__. These are the minimum methods required for Python's rich comparisons.

In Python 2 it also provides an implementation of __ne__ that simply inverts the result of __eq__. (This is not required in Python 3.)

2.2.4 Misc Fixes

Imports the builtins module enabling you to import it from py2 instead of having to guess between __builtin__ (Python 2) and builtins (Python 3).

pyslet.py2.**urlopen**(**args*, ***kwargs*)
Imported from urllib.request in Python 3, from urlib in Python 2.

2.3 PEP-8 Compatibility

Pyslet requires Python 2.6 or Python 2.7, with Python 2.7 being preferred.

2.4 Python 2.6

When run under Python 2.6 Pyslet will patch some modules to make them more compatible with Python 2.7 code. For details see:

Python 2.6 Compatibility

Earlier versions of Python 2.6 have typically been built with a version of sqlite3 that does not support validation of foreign key constraints, the unittests have been designed to skip these tests when such a version is encountered.

> **Note:** When run under Python 2.6, Pyslet may not support certificate validation of HTTP connections properly, this seems to depend on the version of OpenSSL that Python is linked to. If you have successfully used pip to install Pyslet then your Python is probably unaffected though.

Please be aware of the following bug in Python 2.6: http://bugs.python.org/issue2531 this problem caused a number of Pyslet's tests to fail initially and remains a potential source of problems if you are using Decimal types in OData models.

2.5 Python 3

Pyslet is not currently compatible with Python 3, though some work has been done towards a Python 3 version and the unittests are regularly run with the -3 flag to check for issues. Try running your own code that uses Pyslet with python options -3Wd to expose any issues that you are likely to need to fix on any future transition.

Work has now started on porting the core modules to be compatible with Python 3.3 (Pyslet may require use of the 'u' on unicode strings for some time so compatibility with Python 3 versions earlier than 3.3 is unlikely). Rather than just fix up the existing code using a module like six Pyslet now includes it's own module containing compatibility definitions that target the particular idioms I've used in the package.

Python 2 Compatibility

Although the package can't be built for distribution or installed using setup.py, if you include the source locally you can successfully import the following modules in Python 3 (in addition to compatibility modules described elsewhere on this page):

```
pyslet.info
pyslet.iso8601
pyslet.rfc2396
pyslet.unicode5
pyslet.vfs
```

2.6 PEP-8

The code is not currently PEP-8 compliant but it is slowly being refactored for compliance as modules are touched during development. Where critical, methods are renamed from CamelCase to PEP-8 compliant lower_case_form then the old names are defined as wrappers which raise deprecation warnings.

For more information see:

PEP-8 Compatibility

CHAPTER 3

IMS Global Learning Consortium Specifications

The section contains modules that implement specifications published by the IMS Global Learning Consortium. For more information see http://www.imsglobal.org/

Contents:

3.1 IMS Content Packaging (version 1.2)

The IMS Content Packaging specification defines methods for packaging and organizing resources and their associated metadata for transmission between systems. There is a small amount of information on Wikipedia about content packaging in general, see http://en.wikipedia.org/wiki/Content_package. The main use of IMS Content Packaging in the market place is through the SCORM profile. Content Packaging is also used as the basis for the new IMS Common Cartridge, and a method of packaging assessment materials using the speicifcation is also described by IMS QTI version 2.1.

Official information about the specification is available from the IMS GLC: http://www.imsglobal.org/content/packaging/index.html

3.1.1 Example

The following example script illustrates the use of this module. The script takes two arguments, a resource file to be packaged (such as an index.html file) and the path to save the zipped package to. The script creates a new package containing a single resource with the entry point set to point to the resource file. It also adds any other files in the same directory as the resource file, using the python os.walk function to include files in sub-directories too. The *ContentPackage.IgnoreFilePath()* method is used to ensure that hidden files are not added:

```
#! /usr/bin/env python

import sys, os, os.path, shutil
from pyslet.imscpv1p2 import ContentPackage, PathInPath
from pyslet.rfc2396 import URIFactory

def main():
        if len(sys.argv)!=3:
                print "Usage: makecp <resource file> <package file>"
                return
        resFile=sys.argv[1]
        pkgFile=sys.argv[2]
        pkg=ContentPackage()
        try:
```

```
                if os.path.isdir(resFile):
                        print "Resource entry point must be a file, not a directory."
                        return
                resHREF=URI.from_path(resFile)
                srcDir,srcFile=os.path.split(resFile)
                r=pkg.manifest.root.Resources.ChildElement(pkg.manifest.root.Resources.ResourceClass)
                r.href=str(resHREF.relative(URI.from_path(os.path.join(srcDir,'imsmanifest.xml'))))
                r.type=='webcontent'
                for dirpath,dirnames,filenames in os.walk(srcDir):
                        for f in filenames:
                                srcPath=os.path.join(dirpath,f)
                                if pkg.IgnoreFilePath(srcPath):
                                        print "Skipping: %s"%srcPath
                                        continue
                                dstPath=os.path.join(pkg.dPath,PathInPath(srcPath,srcDir))
                                # copy the file
                                dName,fName=os.path.split(dstPath)
                                if not os.path.isdir(dName):
                                        os.makedirs(dName)
                                print "Copying: %s"%srcPath
                                shutil.copy(srcPath,dstPath)
                                pkg.File(r,URI.from_path(dstPath))
                if os.path.exists(pkgFile):
                        if raw_input("Are you sure you want to overwrite %s? (y/n) "%pkgFile).lower()
                                return
                pkg.manifest.Update()
                pkg.ExportToPIF(pkgFile)
        finally:
                pkg.Close()

if __name__ == "__main__":
        main()
```

Note the use of the try:... finally: construct to ensure that the *ContentPackage* object is properly closed when it is finished with. Note also the correct way to create elements within the manifest, using the dependency safe *Class attributes:

```
r=pkg.manifest.root.Resources.ChildElement(pkg.manifest.root.Resources.ResourceClass)
```

This line creates a new resource element as a child of the (required) Resources element.

At the end of the script the *ManifestDocument* is updated on the disk using the inherited *Update()* method. The package can then be exported to the zip file format.

3.1.2 Reference

class pyslet.imscpv1p2.**ContentPackage**(*dPath=None*)

Represents a content package.

When constructed with no arguments a new package is created. A temporary folder to hold the contents of the package is created and will not be cleaned up until the *Close()* method is called.

Alternatively, you can pass an operating system or virtual file path to a content package directory, to an imsmanifest.xml file or to a Package Interchange Format file. In the latter case, the file is unzipped into a temporary folder to facilitate manipulation of the package contents.

A new manifest file is created and written to the file system when creating a new package, or if it is missing from an existing package or directory.

ManifestDocumentClass
the default class for representing the Manifest file

alias of *ManifestDocument*

dPath = None
the *VirtualFilePath* to the package's directory

manifest = None
The *ManifestDocument* object representing the imsmanifest.xml file.

The file is read (or created) on construction.

fileTable = None
The fileTable is a dictionary that maps package relative file paths to the *File* objects that represent them in the manifest.

It is possible for a file to be referenced multiple times (although dependencies were designed to take care of most cases it is still possible for two resources to share a physical file, or even for a resource to contain multiple references to the same file.) Therefore, the dictionary values are lists of *File* objects.

If a file path maps to an empty list then a file exists in the package which is not referenced by any resource. In some packages it is commone for auxiliary files such as supporting schemas to be included in packages without a corresponding *File* object so an empty list does not indicate that the file can be removed safely. These files are still included when packaging the content package for interchange.

Finally, if a file referred to by a *File* object in the manifest is missing an entry is still created in the fileTable. You can walk the keys of the fileTable testing if each file exists to determine if some expected files are missing from the package.

The keys in fileTable are VirtualFilePath instances. To convert a string to an appropriate instance use the *FilePath()* method.

FilePath(**path*)
Converts a string into a *pyslet.vfs.VirtualFilePath* instance suitable for using as a key into the *fileTable*. The conversion is done using the file system of the content package's directory, *dPath*.

SetIgnoreFiles(*ignoreFiles*)
Sets the regular expression used to determine if a file should be ignored.

Some operating systems and utilities create hidden files or other spurious data inside the content package directory. For example, Apple's OS X creates .DS_Store files and the svn source control utility creates .svn directories. The files shouldn't generally be included in exported packages as they may confuse the recipient (who may be using a system on which these files and directories are not hidden) and be deemed to violate the specification, not to mention adding unnecessarily to the size of the package and perhaps even leaking information unintentionally.

To help avoid this type of problem the class uses a regular expression to determine if a file should be considered part of the package. When listing directories, the names of the files found are compared against this regular expression and are ignored if they match.

By default, the pattern is set to match all directories and files with names beginning '.' so you will not normally need to call this method.

IgnoreFile(*f*)
Compares a file or directory name against the pattern set by *SetIgnoreFiles()*.

f is a unicode string.

IgnoreFilePath(*fPath*)
Compares a file path against the pattern set by *SetIgnoreFiles()*

The path is normalised before comparison and any segments consisting of the string '..' are skipped. The method returns True if any of the remaining path components matches the ignore pattern. In other words, if the path describes a file that is is in a directory that should be ignored it will also be ignored.

The path can be relative or absolute. Relative paths are *not* made absolute prior to comparison so this method is not affected by the current directory, even if the current diretory would itself be ignored.

RebuildFileTable()
Rescans the file system and manifest and rebuilds the `fileTable`.

PackagePath(*fPath*)
Converts an absolute file path into a canonical package-relative path

Returns None if fPath is not inside the package.

ExportToPIF(*zPath*)
Exports the content package, saving the zipped package in *zPath*

zPath is overwritten by this operation.

In order to make content packages more interoperable this method goes beyond the basic zip specification and ensures that pathnames are always UTF-8 encoded when added to the archive. When creating instances of `ContentPackage` from an existing archive the reverse transformation is performed. When exchanging PIF files between systems with different native file path encodings, encoding erros may occurr.

GetUniqueFile(*suggestedPath*)
Returns a unique file path suitable for creating a new file in the package.

suggestedPath is used to provide a suggested path for the file. This may be relative (to the root and manifest) or absolute but it must resolve to a file (potentially) in the package. The suggestedPath should either be a VirtualFilePath (of the same type as the content package's `dPath`) or a string suitable for conversion to a VirtualFilePath.

When suggestedPath is relative, it is forced to lower-case. This is consistent with the behaviour of normcase on systems that are case insensitive. The trouble with case insensitive file systems is that it may be impossible to unpack a content package created on a case sensitive system and store it on a case insenstive one. By channelling all file storage through this method (and constructing any URIs *after* the file has been stored) the resulting packages will be more portable.

If suggestedPath already corresponds to a file already in the package, or to a file already referred to in the manifest, then a random string is added to it while preserving the suggested extension in order to make it unique.

The return result is always normalized and returned relative to the package root.

File(*resource*, *href*)
Returns a new `File` object attached to *resource*

href is the URI of the file expressed relative to the resource element in the manifest. Although this is normally the same as the URI expressed relative to the package, a resource may have an xml:base attribute that alters the base for resolving relative URIs.

href may of course be an absolute URI to an external resource. If an absolute URI is given to a local file it must be located inside the package.

Attempting to add a `File` object representing the manifest file iteself will raise `CPFilePathError`.

The `fileTable` is updated automatically by this method.

FileCopy(*resource*, *srcURL*)
Returns a new `File` object copied into the package from *srcURL*, attached to *resource*.

The file is copied to the same directory as the resource's entry point or to the main package directory if the resource has no entry point.

The *File* object is actually created with the *File()* method.

Note that if srcURL points to a missing file then no file is copied to the package but the associated *File* is still created. It will point to a missing file.

DeleteFile(*href*)
Removes the file at *href* from the file system

This method also removes any file references to it from resources in the manifest. href may be given relative to the package root directory. The entry in *fileTable* is also removed.

CPFileTypeError is raised if the file is not a regular file

CPFilePathError is raised if the file is an *IgnoreFile()*, the manifest itself or outside of the content package.

CPProtocolError is raised if the indicated file is not in the local file system.

GetPackageName()
Returns a human readable name for the package

The name is determined by the method used to create the object. The purpose is to return a name that would be intuitive to the user if it were to be used as the name of the package directory or the stem of a file name when exporting to a PIF file.

Note that the name is returned as a unicode string suitable for showing to the user and may need to be encoded before being used in file path operations.

Close()
Closes the content package, removing any temporary files.

This method must be called to clean up any temporary files created when processing the content package. Temporary files are created inside a special temporary directory created using the builtin python tempdir.mkdtemp function. They are not automatically cleaned up when the process exits or when the garbage collector disposes of the object. Use of try:... finally: to clean up the package is recommended. For example:

```
pkg=ContentPackage("MyPackage.zip")
try:
        # do stuff with the content package here
finally:
        pkg.Close()
```

class pyslet.imscpv1p2.**ManifestDocument**(***args*)
Bases: pyslet.xmlnames20091208.XMLNSDocument

Represents the imsmanifest.xml file itself.

Buildong on pyslet.xmlnames20091208.XMLNSDocument this class is used for parsing and writing manifest files.

The constructor defines three additional prefixes using MakePrefix(), mapping xsi onto XML schema, imsmd onto the IMS LRM namespace and imsqti onto the IMS QTI 2.1 namespace. It also adds a schemaLocation attribute. The elements defined by the pyslet.imsmdv1p2p1 and *pyslet.imsqtiv2p1* modules are added to the classMap to ensure that metadata from those schemas are bound to the special classes defined there.

defaultNS = None
the default namespace is set to *IMSCP_NAMESPACE*

get_element_class(*name*)
Overrides pyslet.xmlnames20091208.XMLNSDocument.get_element_class() to look up name.

The class contains a mapping from (namespace,element name) pairs to class objects representing the elements. Any element not in the class map returns XMLNSElement() instead.

Constants

The following constants are used for setting and interpreting XML documents that conform to the Content Packaging specification

pyslet.imscpv1p2.**IMSCP_NAMESPACE = 'http://www.imsglobal.org/xsd/imscp_v1p1'**
str(object='') -> string

Return a nice string representation of the object. If the argument is a string, the return value is the same object.

pyslet.imscpv1p2.**IMSCP_SCHEMALOCATION = 'http://www.imsglobal.org/xsd/imscp_v1p1.xsd'**
str(object='') -> string

Return a nice string representation of the object. If the argument is a string, the return value is the same object.

pyslet.imscpv1p2.**IMSCPX_NAMESPACE = 'http://www.imsglobal.org/xsd/imscp_extensionv1p2'**
str(object='') -> string

Return a nice string representation of the object. If the argument is a string, the return value is the same object.

Elements

class pyslet.imscpv1p2.**CPElement**(*parent*, *name=None*)
Bases: pyslet.xmlnames20091208.XMLNSElement

Base class for all elements defined by the Content Packaging specification.

class pyslet.imscpv1p2.**Manifest**(*parent*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the manifest element, the root element of the imsmanifest file.

MetadataClass
the default class to represent the metadata element

alias of *Metadata*

OrganizationsClass
the default class to represent the organizations element

alias of *Organizations*

ResourcesClass
the default class to represent the resources element

alias of *Resources*

ManifestClass
the default class to represent child manifest elements

alias of *Manifest*

Metadata = None
the manifest's metadata element

Organizations = None
the organizations element

Resources = None
the resources element

Manifest = None
a list of child manifest elements

class pyslet.imscpv1p2.**Metadata**(*parent*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the Metadata element.

SchemaClass
the default class to represent the schema element

alias of *Schema*

SchemaVersionClass
alias of *SchemaVersion*

Schema = None
the optional schema element

SchemaVersion = None
the optional schemaversion element

class pyslet.imscpv1p2.**Schema**(*parent*, *name=None*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the schema element.

class pyslet.imscpv1p2.**SchemaVersion**(*parent*, *name=None*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the schemaversion element.

class pyslet.imscpv1p2.**Organizations**(*parent*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the organizations element.

OrganizationClass
the default class to represent the organization element

alias of *Organization*

Organization = None
a list of organization elements

class pyslet.imscpv1p2.**Organization**(*parent*, *name=None*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the organization element.

class pyslet.imscpv1p2.**Resources**(*parent*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the resources element.

ResourceClass
the default class to represent the resource element

alias of *Resource*

Resource = None
the list of resources in the manifest

class pyslet.imscpv1p2.**Resource**(*parent*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the resource element.

MetadataClass
the default class to represent the metadata element

alias of *Metadata*

FileClass
the default class to represent the file element

alias of *File*

DependencyClass
the default class to represent the dependency element

alias of *Dependency*

type = None
the type of the resource

href = None
the href pointing at the resource's entry point

Metadata = None
the resource's optional metadata element

File = None
a list of file elements associated with the resource

Dependency = None
a list of dependencies of this resource

GetEntryPoint()
Returns the *File* object that is identified as the entry point.

If there is no entry point, or no *File* object with a matching href, then None is returned.

SetEntryPoint(*f*)
Set's the *File* object that is identified as the resource's entry point.

The File must already exist and be associated with the resource.

class pyslet.imscpv1p2.**File**(*parent*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the file element.

href = None
the href used to locate the file object

PackagePath(*cp*)
Returns the normalized file path relative to the root of the content package, *cp*.

If the href does not point to a local file then None is returned. Otherwise, this function calculates an absolute path to the file and then calls the content package's *ContentPackage.PackagePath()* method.

class pyslet.imscpv1p2.**Dependency**(*parent*)
Bases: *pyslet.imscpv1p2.CPElement*

Represents the dependency element.

identifierref = None
the identifier of the resource in this dependency

Utilities

pyslet.imscpv1p2.**PathInPath**(*childPath*, *parentPath*)
Utility function that returns childPath expressed relative to parentPath

This function processes file system paths, not the path components of URI.

Both paths are normalized to remove any redundant navigational segments before any processing, the resulting path will not contain these either.

If childPath is not contained in parentPath then None is returned.

If childPath and parentPath are equal an empty string is returned.

3.2 IMS Question and Test Interoperability (version 1.2)

The IMS Question and Test Interoperability (QTI) specification version 1.2 was finalized in 2002. After a gap of 1-2 years work started on a major revision, culminating in version 2 of the specification, published first in 2005. For information about the history of the specification see http://en.wikipedia.org/wiki/QTI - official information about the specification is available from the IMS GLC: http://www.imsglobal.org/question/index.html

The purpose of this module is to allow documents in QTI v1 format to be parsed and then transformed into objects representing the QTI v2 data model where more sophisticated processing can be performed. Effectively, the native model of assessment items in Pyslet (and in the PyAssess package it supersedes) is QTI v2 and this module simply provides an import capability for legacy data marked up as QTI v1 items.

Class methods or functions with names beginning MigrateV2 use a common pattern for performing the conversion. Errors and warnings are logged during conversion to a list passed in as the *log* parameter.

3.2.1 Core Types and Utilities

This module contains a number core classes used to support the standard.

Enumerations

Where the DTD defines enumerated attribute values we define special enumeration classes. These follow a common pattern in which the values are represented by constant members of the class. The classes are not designed to be instantiated but they do define class methods for decoding and encoding from and to text strings.

class pyslet.qtiv1.core.**Action**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Action enumeration (for *pyslet.qtiv1.common.SetVar*:

```
(Set | Add | Subtract | Multiply | Divide )  'Set'
```

Defines constants for the above action types. Usage example:

```
Action.Add
```

Note that:

```
Action.DEFAULT == Action.Set
```

For more methods see *Enumeration*

class pyslet.qtiv1.core.**Area**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Area enumeration:

```
(Ellipse | Rectangle | Bounded )  'Ellipse'
```

Defines constants for the above area types. Usage example:

```
Area.Rectangle
```

Note that:

```
Area.DEFAULT == Area.Ellipse
```

For more methods see *Enumeration*

pyslet.qtiv1.core.**MigrateV2AreaCoords**(*area*, *value*, *log*)
Returns a tuple of (shape,coords object) representing the area.

- *area* is one of the *Area* constants.
- ***value* is the string containing the content of the element to which** the area applies.

This conversion is generous because the separators have never been well defined and in some cases content uses a mixture of space and ‘,’.

Note also that the definition of rarea was updated in the 1.2.1 errata and that affects this algorithm. The clarification on the definition of ellipse from radii to diameters might mean that some content ends up with hotspots that are too small but this is safer than hotspots that are too large.

Example:

```
import pyslet.qtiv1.core as qticore1
import pyslet.qtiv2.core as qticore2
import pyslet.html40_1991224 as html
log=[]
shape,coords=qticore1.MigrateV2AreaCoords(qticore1.Area.Ellipse,"10,10,2,2",log)
# returns (qticore2.Shape.circle, html.Coords([10, 10, 1]) )
```

Note that Ellipse was deprecated in QTI version 2:

```
import pyslet.qtiv1.core as qticore1
import pyslet.html40_1991224 as html
log=[]
shape,coords=qticore1.MigrateV2AreaCoords(qticore1.Area.Ellipse,"10,10,2,4",log)
print log
# outputs the following...

['Warning: ellipse shape is deprecated in version 2']
```

class pyslet.qtiv1.core.**FeedbackStyle**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

feedbackstyle enumeration:

```
(Complete | Incremental | Multilevel | Proprietary )  'Complete'
```

Defines constants for the above feedback style. Usage example:

```
FeedbackStyle.Decimal
```

Note that:

```
FeedbackStyle.DEFAULT == FeedbackStyle.Complete
```

For more methods see *Enumeration*

class pyslet.qtiv1.core.**FeedbackType**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

feedbacktype enumeration:

```
(Response | Solution | Hint )  'Response'
```

Defines constants for the above types of feedback. Usage example:

```
FeedbackType.Decimal
```

Note that:

```
FeedbackType.DEFAULT == FeedbackType.Response
```

For more methods see *Enumeration*

class pyslet.qtiv1.core.**FIBType**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Fill-in-the-blank type enumeration:

```
(String | Integer | Decimal | Scientific )  'String'
```

Defines constants for the above fill-in-the-blank types. Usage example:

```
FIBType.Decimal
```

Note that:

```
FIBType.DEFAULT == FIBType.String
```

For more methods see *Enumeration*

class pyslet.qtiv1.core.**MDOperator**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Metadata operator enumeration for pyslet.qtiv1.sao.SelectionMetadata:

```
(EQ | NEQ | LT | LTE | GT | GTE )
```

Defines constants for the above operators. Usage example:

```
MDOperator.EQ
```

Lower-case aliases of the constants are provided for compatibility.

For more methods see *Enumeration*

class pyslet.qtiv1.core.**NumType**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

numtype enumeration:

```
(Integer | Decimal | Scientific )  'Integer'
```

Defines constants for the above numeric types. Usage example:

```
NumType.Scientific
```

Note that:

```
NumType.DEFAULT == NumType.Integer
```

For more methods see *Enumeration*

class pyslet.qtiv1.core.**Orientation**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Orientation enumeration:

```
(Horizontal | Vertical )  'Horizontal'
```

Defines constants for the above orientation types. Usage example:

```
Orientation.Horizontal
```

Note that:

```
Orientation.DEFAULT == Orientation.Horizontal
```

For more methods see *Enumeration*

pyslet.qtiv1.core.**MigrateV2Orientation**(*orientation*)
Maps a v1 orientation onto the corresponding v2 constant.

Raises KeyError if *orientation* is not one of the *Orientation* constants.

class pyslet.qtiv1.core.**PromptType**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Prompt type enumeration:

```
(Box | Dashline | Asterisk | Underline )
```

Defines constants for the above prompt types. Usage example:

```
PromptType.Dashline
```

For more methods see *Enumeration*

class pyslet.qtiv1.core.**RCardinality**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

rcardinality enumeration:

```
(Single | Multiple | Ordered )  'Single'
```

Defines constants for the above cardinality types. Usage example:

```
RCardinality.Multiple
```

Note that:

```
RCardinality.DEFAULT == RCardinality.Single
```

For more methods see *Enumeration*

pyslet.qtiv1.core.**MigrateV2Cardinality**(*rCardinality*)
Maps a v1 cardinality onto the corresponding v2 constant.

Raises KeyError if *rCardinality* is not one of the *RCardinality* constants.

pyslet.qtiv1.core.**TestOperator = <class pyslet.qtiv1.core.MDOperator>**
A simple alias of *MDOperator* defined for pyslet.qtiv1.outcomes.VariableTest

class pyslet.qtiv1.core.**VarType**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

vartype enumeration:

```
(Integer | String | Decimal | Scientific | Boolean | Enumerated | Set )  'Integer'
```

Defines constants for the above view types. Usage example:

```
VarType.String
```

Note that:

```
VarType.DEFAULT == VarType.Integer
```

For more methods see *Enumeration*

pyslet.qtiv1.core.**MigrateV2VarType**(*vartype*, *log*)
Returns the v2 BaseType representing the v1 *vartype*.

Note that we reduce both Decimal and Scientific to the float types. In version 2 the BaseType values were chosen to map onto the typical types available in most programming languages. The representation of the number in decimal or exponent form is considered to be part of the interaction or the presentation rather than part of the underlying processing model. Although there clearly are use cases where retaining this distinction would have been an advantage the quality of implementation was likely to be poor and use cases that require a distinction are now implemented in more cumbersome, but probably more interoperable ways.

Note also that the poorly defined Set type in version 1 maps to an identifier in version 2 on the assumption that the cardinality will be upgraded as necessary.

Raises KeyError if *vartype* is not one of the *VarType* constants.

class pyslet.qtiv1.core.**View**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

View enumeration:

```
(All | Administrator | AdminAuthority | Assessor | Author | Candidate |
InvigilatorProctor | Psychometrician | Scorer | Tutor )  'All'
```

Defines constants for the above view types. Usage example:

```
View.Candidate
```

Note that:

```
View.DEFAULT == View.All
```

In addition to the constants defined in the specification we add two aliases which are in common use:

```
    (Invigilator | Proctor)
```

For more methods see *Enumeration*

pyslet.qtiv1.core.**MigrateV2View**(*view*, *log*)
Returns a list of v2 view values representing the v1 *view*.

The use of a list as the return type enables mapping of the special value 'All', which has no direct equivalent in version 2 other than providing all the defined views.

Raises KeyError if *view* is not one of the *View* constants.

This function will log warnings when migrating the following v1 values: Administrator, AdminAuthority, Assessor and Psychometrician

Utility Functions

pyslet.qtiv1.core.**MakeValidName**(*name*)
This function takes a string that is supposed to match the production for Name in XML and forces it to comply by replacing illegal characters with '_'. If name starts with a valid name character but not a valid name start character, it is prefixed with '_' too.

pyslet.qtiv1.core.**ParseYesNo**(*src*)
Returns a True/False parsed from a "Yes" / "No" string.

This function is generous in what it accepts, it will accept mixed case and strips surrounding space. It returns True if the resulting string matches "yes" and False otherwise.

Reverses the transformation defined by *FormatYesNo()*.

pyslet.qtiv1.core.**FormatYesNo**(*value*)
Returns "Yes" if *value* is True, "No" otherwise.

Reverses the transformation defined by *ParseYesNo()*.

Constants

pyslet.qtiv1.core.**QTI_SOURCE = 'QTIv1'**
str(object='') -> string

Return a nice string representation of the object. If the argument is a string, the return value is the same object.

Exceptions

class pyslet.qtiv1.core.**QTIError**
Bases: exceptions.Exception

All errors raised by this module are derived from QTIError.

class pyslet.qtiv1.core.**QTIUnimplementedError**
Bases: *pyslet.qtiv1.core.QTIError*

A feature of QTI v1 that is not yet implemented by this module.

Abstract Elements

class pyslet.qtiv1.core.**QTIElement**(*parent*, *name=None*)
Bases: *pyslet.xml20081126.structures.Element*

Base class for all elements defined by the QTI specification

DeclareMetadata(*label*, *entry*, *definition=None*)
Declares a piece of metadata to be associated with the element.

Most QTIElements will be contained by some type of metadata container that collects metadata in a format suitable for easy lookup and export to other metadata formats. The default implementation simply passes the call to the parent element or, if there is no parent, the declaration is ignored.

For more information see MetadataContainer.

class pyslet.qtiv1.core.**ObjectMixin**
Mix-in class for elements that can be inside ObjectBank:

```
(section | item)+
```

class pyslet.qtiv1.core.**SectionItemMixin**
Mix-in class for objects that can be in section objects:

```
(itemref | item | sectionref | section)*
```

class pyslet.qtiv1.core.**SectionMixin**
Bases: *pyslet.qtiv1.core.SectionItemMixin*

Mix-in class for objects that can be in assessment objects:

```
(sectionref | section)+
```

3.2.2 Common Classes

This module contains the common data elements defined in section 3.6 of the binding document. The doc string of each element defined by IMS is introduced with a quote from that document to provide context. For more information see: http://www.imsglobal.org/question/qtiv1p2/imsqti_asi_bindv1p2.html

Content Model

Perhaps the biggest change between version 1 and version 2 of the specification was the content model. There were attempts to improve the original model through the introduction of the flow concept in version 1.2 but it wasn't until the externally defined HTML content model was formally adopted in version 2 that some degree of predictability in rendering became possible.

class pyslet.qtiv1.common.**ContentMixin**
Mixin class for handling all content-containing elements.

This class is used by all elements that behave as content, the default implementation provides an additional contentChildren member that should be used to collect any content-like children.

contentChildren = None
the list of content children

ContentMixin(*childClass*)
Creates a new ContentMixin child of this element.

This factory method is called by the parser when it finds an element that is derived from ContentMixin. By default we accept any type of content but derived classes override this behaviour to limit the range of elements to match their content models.

GetContentChildren()
Returns an iterable of the content children.

IsInline()
True if this element can be inlined, False if it is block level

The default implementation returns True if all *contentChildren* can be inlined.

InlineChildren()
True if all of this element's *contentChildren* can all be inlined.

ExtractText()
Returns a tuple of (<text string>, <lang>).

Sometimes it is desirable to have a plain text representation of a content object. For example, an element may permit arbitrary content but a synopsis is required to set a metadata value.

Our algorithm for determining the language of the text is to first check if the language has been specified for the context. If it has then that language is used. Otherwise the first language attribute encountered in the content is used as the language. If no language is found then None is returned as the second value.

MigrateV2Content(*parent*, *childType*, *log*, *children=None*)
Migrates this content element to QTIv2.

The resulting QTIv2 content is added to *parent*.

childType indicates whether the context allows block, inline or a mixture of element content types (flow). It is set to one of the following HTML classes: `pyslet.html40_19991224.BlockMixin`, `pyslet.html40_19991224.InlineMixin` or `pyslet.html40_19991224.FlowMixin`.

The default implementation adds each of *children* or, if *children* is None, each of the local *contentChildren*. The algorithm handles flow elements by creating <p> elements where the context permits. Nested flows are handled by the addition of <br/>.

class pyslet.qtiv1.common.**Material**(*parent*)
Bases: *pyslet.qtiv1.common.QTICommentContainer*, *pyslet.qtiv1.common.ContentMixin*

This is the container for any content that is to be displayed by the question-engine. The supported content types are text (emphasized or not), images, audio, video, application and applet. The content can be internally referenced to avoid the need for duplicate copies. Alternative information can be defined - this is used if the primary content cannot be displayed:

```
<!ELEMENT material (qticomment? , (mattext | matemtext | matimage |
        mataudio | matvideo | matapplet | matapplication | matref | matbreak
        | mat_extension)+ , altmaterial*)>
<!ATTLIST material
        label CDATA  #IMPLIED
        xml:lang CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**AltMaterial**(*parent*)
Bases: *pyslet.qtiv1.common.QTICommentContainer*, *pyslet.qtiv1.common.ContentMixin*

This is the container for alternative content. This content is to be displayed if, for whatever reason, the primary content cannot be rendered. Alternative language implementations of the host <material> element are also supported using this structure:

```
<!ELEMENT altmaterial (qticomment? ,
        (mattext | matemtext | matimage | mataudio | matvideo |
```

```
            matapplet | matapplication | matref | matbreak | mat_extension)+)>
    <!ATTLIST altmaterial  xml:lang CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**MatThingMixin**
Bases: *pyslet.qtiv1.common.ContentMixin*

An abstract class used to help identify the mat* elements.

class pyslet.qtiv1.common.**PositionMixin**
Mixin to define the positional attributes

```
    width       CDATA  #IMPLIED
    height      CDATA  #IMPLIED
    y0          CDATA  #IMPLIED
    x0          CDATA  #IMPLIED
```

class pyslet.qtiv1.common.**MatText**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.PositionMixin*, *pyslet.qtiv1.common.MatThingMixin*

The <mattext> element contains any text that is to be displayed to the users

```
    <!ELEMENT mattext (#PCDATA)>
    <!ATTLIST mattext
            texttype    CDATA  'text/plain'
            label               CDATA  #IMPLIED
            charset             CDATA  'ascii-us'
            uri                 CDATA  #IMPLIED
            xml:space   (preserve | default )  'default'
            xml:lang    CDATA  #IMPLIED
            entityref   ENTITY  #IMPLIED
            width               CDATA  #IMPLIED
            height              CDATA  #IMPLIED
            y0                  CDATA  #IMPLIED
            x0                  CDATA  #IMPLIED >
```

inlineWrapper = None
an inline html object used to wrap inline elements

class pyslet.qtiv1.common.**MatEmText**(*parent*)
Bases: *pyslet.qtiv1.common.MatText*

The <matemtext> element contains any emphasized text that is to be displayed to the users. The type of emphasis is dependent on the question-engine rendering the text:

```
    <!ELEMENT matemtext (#PCDATA)>
    <!ATTLIST matemtext
            texttype    CDATA  'text/plain'
            label               CDATA  #IMPLIED
            charset             CDATA  'ascii-us'
            uri                 CDATA  #IMPLIED
            xml:space   (preserve | default )  'default'
            xml:lang    CDATA  #IMPLIED
            entityref   ENTITY  #IMPLIED
            width               CDATA  #IMPLIED
            height              CDATA  #IMPLIED
            y0                  CDATA  #IMPLIED
            x0                  CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**MatBreak**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.MatThingMixin*

The element that is used to insert a break in the flow of the associated material. The nature of the 'break' is dependent on the display-rendering engine:

```
<!ELEMENT matbreak EMPTY>
```

ExtractText()
Returns a simple line break

class pyslet.qtiv1.common.**MatImage**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.PositionMixin*, *pyslet.qtiv1.common.MatThingMixin*

The <matimage> element is used to contain image content that is to be displayed to the users:

```
<!ELEMENT matimage (#PCDATA)>
<!ATTLIST matimage
        imagtype    CDATA  'image/jpeg'
        label               CDATA  #IMPLIED
        height              CDATA  #IMPLIED
        uri                 CDATA  #IMPLIED
        embedded    CDATA  'base64'
        width               CDATA  #IMPLIED
        y0                  CDATA  #IMPLIED
        x0                  CDATA  #IMPLIED
        entityref   ENTITY #IMPLIED >
```

ExtractText()
We cannot extract text from matimage so we return a simple string.

class pyslet.qtiv1.common.**MatAudio**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.MatThingMixin*

The <mataudio> element is used to contain audio content that is to be displayed to the users:

```
<!ELEMENT mataudio (#PCDATA)>
<!ATTLIST mataudio
        audiotype   CDATA  'audio/base'
        label               CDATA  #IMPLIED
        uri                 CDATA  #IMPLIED
        embedded    CDATA  'base64'
        entityref   ENTITY  #IMPLIED >
```

ExtractText()
We cannot extract text from mataudio so we return a simple string.

class pyslet.qtiv1.common.**MatVideo**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.PositionMixin*, *pyslet.qtiv1.common.MatThingMixin*

The <matvideo> element is used to contain video content that is to be displayed to the users:

```
<!ELEMENT matvideo (#PCDATA)>
<!ATTLIST matvideo
        videotype   CDATA  'video/avi'
        label               CDATA  #IMPLIED
        uri                 CDATA  #IMPLIED
        width               CDATA  #IMPLIED
        height              CDATA  #IMPLIED
        y0                  CDATA  #IMPLIED
        x0                  CDATA  #IMPLIED
```

```
            embedded    CDATA  'base64'
            entityref   ENTITY  #IMPLIED >
```

ExtractText()
We cannot extract text from matvideo so we return a simple string.

class pyslet.qtiv1.common.**MatApplet**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.PositionMixin*, *pyslet.qtiv1.common.MatThingMixin*

The <matapplet> element is used to contain applet content that is to be displayed to the users. Parameters that are to be passed to the applet being launched should be enclosed in a CDATA block within the content of the <matapplet> element:

```
<!ELEMENT matapplet (#PCDATA)>
<!ATTLIST matapplet
        label               CDATA  #IMPLIED
        uri                 CDATA  #IMPLIED
        y0                  CDATA  #IMPLIED
        height              CDATA  #IMPLIED
        width               CDATA  #IMPLIED
        x0                  CDATA  #IMPLIED
        embedded    CDATA  'base64'
        entityref   ENTITY  #IMPLIED >
```

ExtractText()
We cannot extract text from matapplet so we return a simple string.

class pyslet.qtiv1.common.**MatApplication**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.MatThingMixin*

The <matapplication> element is used to contain application content that is to be displayed to the users. Parameters that are to be passed to the application being launched should be enclosed in a CDATA block within the content of the <matapplication> element:

```
<!ELEMENT matapplication (#PCDATA)>
<!ATTLIST matapplication
        apptype             CDATA  #IMPLIED
        label               CDATA  #IMPLIED
        uri                 CDATA  #IMPLIED
        embedded    CDATA  'base64'
        entityref   ENTITY  #IMPLIED >
```

ExtractText()
We cannot extract text from matapplication so we return a simple string.

class pyslet.qtiv1.common.**MatRef**(*parent*)
Bases: *pyslet.qtiv1.common.MatThingMixin*, *pyslet.qtiv1.core.QTIElement*

The <matref> element is used to contain a reference to the required material. This material will have had an identifier assigned to enable such a reference to be reconciled when the instance is parsed into the system. <matref> should only be used to reference a material component and not a <material> element (the element <material_ref> should be used for the latter):

```
<!ELEMENT matref EMPTY>
<!ATTLIST matref linkrefid CDATA  #REQUIRED >
```

class pyslet.qtiv1.common.**MatExtension**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.MatThingMixin*

The extension facility to enable proprietary types of material to be included with the corresponding data object:

```
<!ELEMENT mat_extension ANY>
```

class pyslet.qtiv1.common.**FlowMixin**
Mix-in class to identify all flow elements:

```
( flow | flow_mat | flow_label)
```

class pyslet.qtiv1.common.**FlowMatContainer**(*parent*)
Bases: *pyslet.qtiv1.common.QTICommentContainer*, *pyslet.qtiv1.common.ContentMixin*

Abstract class used to represent objects that contain flow_mat:

```
<!ELEMENT XXXXXXXXXX (qticomment? , (material+ | flow_mat+))>
```

class pyslet.qtiv1.common.**FlowMat**(*parent*)
Bases: *pyslet.qtiv1.common.FlowMatContainer*, *pyslet.qtiv1.common.FlowMixin*

This element allows the materials to be displayed to the users to be grouped together using flows. The manner in which these flows are handled is dependent upon the display-engine:

```
<!ELEMENT flow_mat (qticomment? , (flow_mat | material | material_ref)+)>
<!ATTLIST flow_mat  class CDATA  'Block' >
```

IsInline()
flowmat is always treated as a block if flowClass is specified, otherwise it is treated as a block unless it is an only child.

MigrateV2Content(*parent*, *childType*, *log*)
flow typically maps to a div element.

A flow with a specified class always becomes a div.

class pyslet.qtiv1.common.**PresentationMaterial**(*parent*)
Bases: *pyslet.qtiv1.common.FlowMatContainer*

This is material that must be presented to set the context of the parent evaluation. This could be at the Section level to contain common question material that is relevant to all of the contained Sections/Items. All the contained material must be presented:

```
<!ELEMENT presentation_material (qticomment? , flow_mat+)>
```

Our interpretation is generous here, we also accept <material> by default from *FlowMatContainer*. This element is one of the newer definitions in QTI v1, after the introduction of <flow>. It excludes <material> because it was assumed there would no legacy content. Adoption of flow was poor and it was replaced with direct inclusion of the html model in version 2 (where content is either inline or block level and flow is a general term to describe both for contexts where either is allowed).

class pyslet.qtiv1.common.**Reference**(*parent*)
Bases: *pyslet.qtiv1.common.QTICommentContainer*, *pyslet.qtiv1.common.ContentMixin*

The container for all of the materials that can be referenced by other structures e.g. feedback material, presentation material etc. The presentation of this material is under the control of the structure that is referencing the material. There is no implied relationship between any of the contained material components:

```
<!ELEMENT reference (qticomment? , (material | mattext | matemtext | matimage | mataudio |
        matvideo | matapplet | matapplication | matbreak | mat_extension)+)>
```

ContentMixin(*childClass*)
We override this method to prevent references from being included.

class pyslet.qtiv1.common.**MaterialRef**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*

The <material_ref> element is used to contain a reference to the required full material block. This material will have had an identifier assigned to enable such a reference to be reconciled when the instance is parsed into the system:

```
<!ELEMENT material_ref EMPTY>
<!ATTLIST material_ref  linkrefid CDATA  #REQUIRED >
```

Metadata Model

class pyslet.qtiv1.common.**MetadataContainerMixin**
A mix-in class used to hold dictionaries of metadata.

There is a single dictionary maintained to hold all metadata values, each value is a list of tuples of the form (value string, defining element). Values are keyed on the field label or tag name with any leading qmd_ prefix removed.

class pyslet.qtiv1.common.**QTIMetadata**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*

The container for all of the vocabulary-based QTI-specific meta-data. This structure is available to each of the four core ASI data structures:

```
<!ELEMENT qtimetadata (vocabulary? , qtimetadatafield+)>
```

class pyslet.qtiv1.common.**Vocabulary**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*

The vocabulary to be applied to the associated meta-data fields. The vocabulary is defined either using an external file or it is included as a comma separated list:

```
<!ELEMENT vocabulary (#PCDATA)>
<!ATTLIST vocabulary
        uri                 CDATA  #IMPLIED
        entityref   ENTITY  #IMPLIED
        vocab_type  CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**QTIMetadataField**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*

The structure responsible for containing each of the QTI-specific meta-data fields:

```
<!ELEMENT qtimetadatafield  (fieldlabel , fieldentry)>
<!ATTLIST qtimetadatafield  xml:lang CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**FieldLabel**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*

Used to contain the name of the QTI-specific meta-data field:

```
<!ELEMENT fieldlabel (#PCDATA)>
```

class pyslet.qtiv1.common.**FieldEntry**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*

Used to contain the actual data entry of the QTI-specific meta-data field named using the associated 'fieldlabel' element:

```
    <!ELEMENT fieldentry (#PCDATA)>
```

Objectives & Rubric

class pyslet.qtiv1.common.**Objectives**(*parent*)
Bases: *pyslet.qtiv1.common.FlowMatContainer*

The objectives element is used to store the information that describes the educational aims of the Item. These objectives can be defined for each of the different 'view' perspectives. This element should not be used to contain information specific to an Item because the question-engine may not make this information available to the Item during the actual test:

```
    <!ELEMENT objectives (qticomment? , (material+ | flow_mat+))>
    <!ATTLIST objectives  view  (All | Administrator | AdminAuthority | Assessor | Author |
                            Candidate | InvigilatorProctor | Psychometrician | Scorer |
                            Tutor ) 'All' >
```

MigrateV2(*v2Item*, *log*)
Adds rubric representing these objectives to the given item's body

LRMMigrateObjectives(*lom*, *log*)
Adds educational description from these objectives.

class pyslet.qtiv1.common.**Rubric**(*parent*)
Bases: *pyslet.qtiv1.common.FlowMatContainer*

The rubric element is used to contain contextual information that is important to the element e.g. it could contain standard data values that might or might not be useful for answering the question. Different sets of rubric can be defined for each of the possible 'views'. The material contained within the rubric must be displayed to the participant:

```
    <!ELEMENT rubric (qticomment? , (material+ | flow_mat+))>
    <!ATTLIST rubric  view      (All | Administrator | AdminAuthority | Assessor | Author |
                            Candidate | InvigilatorProctor | Psychometrician | Scorer |
                            Tutor ) 'All' >
```

Response Processing Model

class pyslet.qtiv1.common.**DecVar**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*

The <decvar> element permits the declaration of the scoring variables

```
    <!ELEMENT decvar (#PCDATA)>
    <!ATTLIST decvar  varname CDATA  'SCORE' ::
            vartype             (Integer |  String |  Decimal |  Scientific |  Boolean |
                    Enumerated | Set )  'Integer'
            defaultval  CDATA  #IMPLIED
            minvalue    CDATA  #IMPLIED
            maxvalue    CDATA  #IMPLIED
            members     CDATA  #IMPLIED
            cutvalue    CDATA  #IMPLIED >
```

content_changed()
The decvar element is supposed to be empty but QTI v1 content is all over the place.

class pyslet.qtiv1.common.**InterpretVar**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ContentMixin*

The <interpretvar> element is used to provide statistical interpretation information about the associated variables:

```
<!ELEMENT interpretvar (material | material_ref)>
<!ATTLIST interpretvar
        view        (All | Administrator | AdminAuthority | Assessor | Author | Candidate |
                InvigilatorProctor | Psychometrician | Scorer | Tutor )  'All'
                varname CDATA  'SCORE' >
```

class pyslet.qtiv1.common.**SetVar**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*

The <setvar> element is responsible for changing the value of the scoring variable as a result of the associated response processing test:

```
<!ELEMENT setvar (#PCDATA)>
<!ATTLIST setvar  varname CDATA  'SCORE'
        action     (Set | Add | Subtract | Multiply | Divide )  'Set' >
```

class pyslet.qtiv1.common.**DisplayFeedback**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*

The <displayfeedback> element is responsible for assigning an associated feedback to the response processing if the 'True' state is created through the associated response processing condition test:

```
<!ELEMENT displayfeedback (#PCDATA)>
<!ATTLIST displayfeedback
        feedbacktype        (Response | Solution | Hint )  'Response'
        linkrefid           CDATA  #REQUIRED >
```

class pyslet.qtiv1.common.**ConditionVar**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*

The conditional test that is to be applied to the user's response. A wide range of separate and combinatorial test can be applied:

```
<!ELEMENT conditionvar (not | and | or | unanswered | other | varequal | varlt |
        varlte | vargt | vargte | varsubset | varinside | varsubstring | durequal |
        durlt | durlte | durgt | durgte | var_extension)+>
```

class pyslet.qtiv1.common.**ExtendableExpressionMixin**
Abstract mixin class to indicate an expression, including var_extension

class pyslet.qtiv1.common.**ExpressionMixin**
Bases: *pyslet.qtiv1.common.ExtendableExpressionMixin*

Abstract mixin class to indicate an expression excluding var_extension

class pyslet.qtiv1.common.**VarThing**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

Abstract class for var* elements

```
<!ATTLIST *
        respident   CDATA #REQUIRED
        index               CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**VarEqual**(*parent*)
Bases: *pyslet.qtiv1.common.VarThing*

The <varequal> element is the test of equivalence. The data for the test is contained within the element's PCDATA string and must be the same as one of the <response_label> values (this were assigned using the ident attribute):

```
<!ELEMENT varequal (#PCDATA)>
<!ATTLIST varequal
        case  (Yes | No )  'No'
        respident CDATA  #REQUIRED"
        index CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**VarInequality**(*parent*)
Bases: *pyslet.qtiv1.common.VarThing*

Abstract class for varlt, varlte, vargt and vargte.

MigrateV2Inequality()
Returns the class to use in qtiv2

class pyslet.qtiv1.common.**VarLT**(*parent*)
Bases: *pyslet.qtiv1.common.VarInequality*

The <varlt> element is the 'less than' test. The data for the test is contained within the element's PCDATA string and is assumed to be numerical in nature:

```
<!ELEMENT varlt (#PCDATA)>
<!ATTLIST varlt
        respident   CDATA  #REQUIRED"
        index               CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**VarLTE**(*parent*)
Bases: *pyslet.qtiv1.common.VarInequality*

The <varlte> element is the 'less than or equal' test. The data for the test is contained within the element's PCDATA string and is assumed to be numerical in nature:

```
<!ELEMENT varlte (#PCDATA)>
<!ATTLIST varlte
        respident CDATA  #REQUIRED"
        index CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**VarGT**(*parent*)
Bases: *pyslet.qtiv1.common.VarInequality*

The <vargt> element is the 'greater than' test. The data for the test is contained within the element's PCDATA string and is assumed to be numerical in nature:

```
<!ELEMENT vargt (#PCDATA)>
<!ATTLIST vargt
        respident CDATA  #REQUIRED"
        index CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**VarGTE**(*parent*)
Bases: *pyslet.qtiv1.common.VarInequality*

The <vargte> element is the 'greater than or equal to' test. The data for the test is contained within the element's PCDATA string and is assumed to be numerical in nature:

```
<!ELEMENT vargte (#PCDATA)>
<!ATTLIST vargte
        respident CDATA  #REQUIRED"
        index CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**VarSubset**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <varsubset> element is the 'member of a list/set' test. The data for the test is contained within the element's PCDATA string. The set is a comma separated list with no enclosing parentheses:

```
<!ELEMENT varsubset (#PCDATA)>
<!ATTLIST varsubset
        respident CDATA  #REQUIRED"
        setmatch     (Exact | Partial )  'Exact'
        index CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**VarSubString**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <varsubstring> element is used to determine if a given string is a substring of some other string:

```
<!ELEMENT varsubstring (#PCDATA)>
<!ATTLIST varsubstring
        index CDATA  #IMPLIED
        respident CDATA  #REQUIRED"
        case  (Yes | No )  'No' >
```

class pyslet.qtiv1.common.**VarInside**(*parent*)
Bases: *pyslet.qtiv1.common.VarThing*

The <varinside> element is the 'xy-co-ordinate inside an area' test. The data for the test is contained within the element's PCDATA string and is a set of co-ordinates that define the area:

```
<!ELEMENT varinside (#PCDATA)>
<!ATTLIST varinside
        areatype     (Ellipse | Rectangle | Bounded )  #REQUIRED
        respident CDATA  #REQUIRED"
        index CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**DurEqual**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <durequal> element is the 'duration equal to' test i.e. a test on the time taken to make the response:

```
<!ELEMENT durequal (#PCDATA)>
<!ATTLIST durequal
        index CDATA  #IMPLIED
        respident CDATA  #REQUIRED" >
```

class pyslet.qtiv1.common.**DurLT**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <durlt> element is the 'duration less than' test i.e. a test on the time taken to make the response:

```
<!ELEMENT durlt (#PCDATA)>
<!ATTLIST durlt
        index               CDATA  #IMPLIED
        respident   CDATA  #REQUIRED" >
```

class pyslet.qtiv1.common.**DurLTE**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <durlte> element is the 'duration less than or equal to' test i.e. a test on the time taken to make the response:

```
<!ELEMENT durlte (#PCDATA)>
<!ATTLIST durlte
```

```
            index               CDATA  #IMPLIED
            respident   CDATA  #REQUIRED" >
```

class pyslet.qtiv1.common.**DurGT**(*parent*, *name=None*)

Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <durgt> element is the 'duration greater than' test i.e. a test on the time taken to make the response:

```
    <!ELEMENT durgt (#PCDATA)>
    <!ATTLIST durgt
            index               CDATA  #IMPLIED
            respident   CDATA  #REQUIRED" >
```

class pyslet.qtiv1.common.**DurGTE**(*parent*, *name=None*)

Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <durgte> element is the 'duration greater than or equal to' test i.e. a test on the time taken to make the response:

```
    <!ELEMENT durgte (#PCDATA)>
    <!ATTLIST durgte
            index               CDATA  #IMPLIED
            respident   CDATA  #REQUIRED" >
```

class pyslet.qtiv1.common.**Not**(*parent*)

Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <not> element inverts the logical test outcome that is required. In the case of the <varequal> element produces a 'not equals' test:

```
    <!ELEMENT not (and | or | not | unanswered | other | varequal | varlt | varlte |
            vargt | vargte | varsubset | varinside | varsubstring | durequal | durlt |
            durlte | durgt | durgte)>
```

class pyslet.qtiv1.common.**And**(*parent*)

Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <and> element is used to create the Boolean 'AND' operation between the two or more enclosed tests. The result 'True' is returned if all of the tests return a 'True' value:

```
    <!ELEMENT and (not | and | or | unanswered | other | varequal | varlt | varlte |
            vargt | vargte | varsubset | varinside | varsubstring | durequal | durlt |
            durlte | durgt | durgte)+>
```

class pyslet.qtiv1.common.**Or**(*parent*)

Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <or> element is used to create the Boolean 'OR' operation between the two or more enclosed tests. The result 'True' is returned if one or more of the tests return a 'True' value:

```
    <!ELEMENT or (not | and | or | unanswered | other | varequal | varlt | varlte |
            vargt | vargte | varsubset | varinside | varsubstring | durequal | durlt |
            durlte | durgt | durgte)+>
```

class pyslet.qtiv1.common.**Unanswered**(*parent*, *name=None*)

Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <unanswered> element is the condition to be applied if a response is not received for the Item i.e. it is unanswered:

```
    <!ELEMENT unanswered (#PCDATA)>
    <!ATTLIST unanswered  respident CDATA  #REQUIRED" >
```

class pyslet.qtiv1.common.**Other**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExpressionMixin*

The <other> element is used to trigger the condition when all of the other tests have not returned a 'True' state:

```
    <!ELEMENT other (#PCDATA)>
```

class pyslet.qtiv1.common.**VarExtension**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*, *pyslet.qtiv1.common.ExtendableExpressionMixin*

This element contains proprietary extensions to be applied to condition tests. This enables vendors to create their own conditional tests to be used on the participant responses:

```
    <!ELEMENT var_extension ANY>
```

Miscellaneous Classes

class pyslet.qtiv1.common.**QTICommentContainer**(*parent*)
Bases: *pyslet.qtiv1.core.QTIElement*

Basic element to represent all elements that can contain a comment as their first child:

```
    <!ELEMENT XXXXXXXXXXX (qticomment? , ..... )>
```

class pyslet.qtiv1.common.**QTIComment**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*

This element contains the comments that are relevant to the host element. The comment is contained as a string:

```
    <!ELEMENT qticomment (#PCDATA)>
    <!ATTLIST qticomment  xml:lang CDATA  #IMPLIED >
```

class pyslet.qtiv1.common.**Duration**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*

The duration permitted for the completion of a particular activity. The duration is defined as per the ISO8601 standard. The information is entered as a string:

```
    <!ELEMENT duration (#PCDATA)>
```

class pyslet.imsqtiv1p2p1.**QTIDocument**(***args*)
Bases: *pyslet.xml20081126.structures.Document*

Class for working with QTI documents.

We turn off the parsing of external general entities to prevent a missing DTD causing the parse to fail. This is a significant limitation as it is possible that some sophisticated users have used general entities to augment the specification or to define boiler-plate code. If this causes problems then you can turn the setting back on again for specific instances of the parser that will be used with that type of data.

XMLParser(*entity*)
Adds some options to the basic XMLParser to improve QTI compatibility.

get_element_class(*name*)
Returns the class to use to represent an element with the given name.

This method is used by the XML parser. The class object is looked up in the classMap, if no specialized class is found then the general pyslet.xml20081126.Element class is returned.

RegisterMatThing(*matThing*)
Registers a MatThing instance in the dictionary of matThings.

FindMatThing(*linkRefID*)
Returns the mat<thing> element with label matching the *linkRefID*.

The specification says that material_ref should be used if you want to refer a material object, not matref, however this rule is not universally observed so if we don't find a basic mat<thing> we will search the material objects too and return a `Material` instance instead.

RegisterMaterial(*material*)
Registers a Material instance in the dictionary of labelled material objects.

FindMaterial(*linkRefID*)
Returns the material element with label matching *linkRefID*.

Like *`FindMatThing()`* this method will search for instances of `MatThingMixin` if it can't find a `Material` element to match. The specification is supposed to be strict about matching the two types of reference but errors are common, even in the official example set.

MigrateV2(*cp*)
Converts the contents of this document to QTI v2

The output is stored into the content package passed in cp. Errors and warnings generated by the migration process are added as annotations to the resulting resource objects in the content package.

The function returns a list of 4-tuples, one for each object migrated.

Each tuple comprises (<QTI v2 Document>, <LOM Metadata>, <log>, <Resource>)

3.2.3 QuesTestInterop Elements

class pyslet.imsqtiv1p2p1.**QuesTestInterop**(*parent*)
Bases: *pyslet.qtiv1.common.QTICommentContainer*

The <questestinterop> element is the outermost container for the QTI contents i.e. the container of the Assessment(s), Section(s) and Item(s):

```
<!ELEMENT questestinterop (qticomment? , (objectbank | assessment | (section | item)+))>
```

MigrateV2()
Converts this element to QTI v2

Returns a list of tuples of the form: (<QTIv2 Document>, <Metadata>, <List of Log Messages>).

One tuple is returned for each of the objects found. In QTIv2 there is no equivalent of QuesTestInterop. The baseURI of each document is set from the baseURI of the QuesTestInterop element using the object identifier to derive a file name.

3.2.4 Object Bank Elements

class pyslet.imsqtiv1p2p1.**ObjectBank**(*parent*)
Bases: *pyslet.qtiv1.common.MetadataContainerMixin*, *pyslet.qtiv1.common.QTICommentContainer*

This is the container for the Section(s) and/or Item(s) that are to be grouped as an object-bank. The object-bank is assigned its own unique identifier and can have the full set of QTI-specific meta-data:

```
<!ELEMENT objectbank (qticomment? , qtimetadata* , (section | item)+)>
<!ATTLIST objectbank  ident CDATA  #REQUIRED >
```

3.2.5 Assessment Elements

class pyslet.imsqtiv1p2p1.**Assessment**(*parent*)
Bases: *pyslet.qtiv1.common.QTICommentContainer*

The Assessment data structure is used to contain the exchange of test data structures. It will always contain at least one Section and may contain meta-data, objectives, rubric control switches, assessment-level processing, feedback and selection and sequencing information for sections:

```
<!ELEMENT assessment (qticomment? ,
        duration? ,
        qtimetadata* ,
        objectives* ,
        assessmentcontrol* ,
        rubric* ,
        presentation_material? ,
        outcomes_processing* ,
        assessproc_extension? ,
        assessfeedback* ,
        selection_ordering? ,
        reference? ,
        (sectionref | section)+
        )>
<!ATTLIST assessment  ident CDATA  #REQUIRED
                                        %I_Title;
                                        xml:lang CDATA  #IMPLIED >
```

MigrateV2(*output*)
Converts this assessment to QTI v2

For details, see QuesTestInterop.MigrateV2.

class pyslet.imsqtiv1p2p1.**AssessmentControl**(*parent*)
Bases: *pyslet.qtiv1.common.QTICommentContainer*

The control switches that are used to enable or disable the display of hints, solutions and feedback within the Assessment:

```
<!ELEMENT assessmentcontrol (qticomment?)>
<!ATTLIST assessmentcontrol
        hintswitch  (Yes | No )  'Yes'
        solutionswitch  (Yes | No )  'Yes'
        view        (All | Administrator | AdminAuthority | Assessor | Author |
                        Candidate | InvigilatorProctor | Psychometrician | Scorer |
                        Tutor ) 'All'
        feedbackswitch  (Yes | No )  'Yes' >
```

class pyslet.imsqtiv1p2p1.**AssessProcExtension**(*parent*, *name=None*)
Bases: *pyslet.qtiv1.core.QTIElement*

This is used to contain proprietary alternative Assessment-level processing functionality:

```
<!ELEMENT assessproc_extension ANY>
```

class pyslet.imsqtiv1p2p1.**AssessFeedback**(*parent*)
Bases: *pyslet.qtiv1.common.QTICommentContainer*, *pyslet.qtiv1.common.ContentMixin*

The container for the Assessment-level feedback that is to be presented as a result of Assessment-level processing of the user responses:

```
    <!ELEMENT assessfeedback (qticomment? , (material+ | flow_mat+))>
    <!ATTLIST assessfeedback
            view        (All | Administrator | AdminAuthority | Assessor | Author |
                            Candidate | InvigilatorProctor | Psychometrician | Scorer |
                            Tutor ) 'All'
            ident CDATA  #REQUIRED
            title CDATA  #IMPLIED >
```

3.3 IMS Question and Test Interoperability (version 2.1)

The IMS Question and Test Interoperability specification version 2.1 has yet to be finalized and is currently only available as a "Public Draft Specification" from the IMS GLC website: http://www.imsglobal.org/question/index.html

Version 2.1 is an extension of the pre-existing version 2.0 which was finalized in 2005. For more information on the history of the specification see http://en.wikipedia.org/wiki/QTI

This module implements version 2.1 of the specification in anticipation of the finalization of the specification by the consortium.

3.3.1 Items

class pyslet.qtiv2.items.**AssessmentItem**(*parent*)

Bases: *pyslet.qtiv2.core.QTIElement*, pyslet.qtiv2.core.DeclarationContainer

An assessment item encompasses the information that is presented to a candidate and information about how to score the item:

```
    <xsd:attributeGroup name="assessmentItem.AttrGroup">
            <xsd:attribute name="identifier" type="string.Type" use="required"/>
            <xsd:attribute name="title" type="string.Type" use="required"/>
            <xsd:attribute name="label" type="string256.Type" use="optional"/>
            <xsd:attribute ref="xml:lang"/>
            <xsd:attribute name="adaptive" type="boolean.Type" use="required"/>
            <xsd:attribute name="timeDependent" type="boolean.Type" use="required"/>
            <xsd:attribute name="toolName" type="string256.Type" use="optional"/>
            <xsd:attribute name="toolVersion" type="string256.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="assessmentItem.ContentGroup">
            <xsd:sequence>
                    <xsd:element ref="responseDeclaration" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:element ref="outcomeDeclaration" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:element ref="templateDeclaration" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:element ref="templateProcessing" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="stylesheet" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:element ref="itemBody" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="responseProcessing" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="modalFeedback" minOccurs="0" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

SortDeclarations()

Sort each of the variable declaration lists so that they are in identifier order. This is not essential but it does help ensure that output is predictable. This method is called automatically when reading items from XML files.

RenderHTML(*itemState*, *htmlParent=None*)
Renders this item in html, adding nodes to *htmlParent*. The state of the item (e.g., the values of any controls and template variables), is taken from *itemState*, a `variables.ItemSessionState` instance.

The result is the top-level div containing the item added to the htmlParent. If htmlParent is None then a parentless div is created. If the item has no itemBody then an empty Div is returned.

AddToContentPackage(*cp*, *lom*, *dName=None*)
Adds a resource and associated files to the content package.

3.3.2 Tests

class pyslet.qtiv2.tests.**AssessmentTest**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*, pyslet.qtiv2.core.DeclarationContainer

A test is a group of assessmentItems with an associated set of rules that determine which of the items the candidate sees, in what order, and in what way the candidate interacts with them. The rules describe the valid paths through the test, when responses are submitted for response processing and when (if at all) feedback is to be given:

```
<xsd:attributeGroup name="assessmentTest.AttrGroup">
        <xsd:attribute name="identifier" type="string.Type" use="required"/>
        <xsd:attribute name="title" type="string.Type" use="required"/>
        <xsd:attribute name="toolName" type="string256.Type" use="optional"/>
        <xsd:attribute name="toolVersion" type="string256.Type" use="optional"/>
</xsd:attributeGroup>

<xsd:group name="assessmentTest.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="outcomeDeclaration" minOccurs="0" maxOccurs="unbounded"/>
                <xsd:element ref="timeLimits" minOccurs="0" maxOccurs="1"/>
                <xsd:element ref="testPart" minOccurs="1" maxOccurs="unbounded"/>
                <xsd:element ref="outcomeProcessing" minOccurs="0" maxOccurs="1"/>
                <xsd:element ref="testFeedback" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

SortDeclarations()
Sort the outcome declarations so that they are in identifier order. This is not essential but it does help ensure that output is predictable. This method is called automatically when reading items from XML files.

RegisterPart(*part*)
Registers a testPart, asssessmentSection or assessmentItemRef in `parts`.

GetPart(*identifier*)
Returns the testPart, assessmentSection or assessmentItemRef with the given identifier.

Navigation and Submission

class pyslet.qtiv2.tests.**NavigationMode**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

The navigation mode determines the general paths that the candidate may take. A testPart in linear mode restricts the candidate to attempt each item in turn. Once the candidate moves on they are not permitted to return. A testPart in nonlinear mode removes this restriction - the candidate is free to navigate to any item in the test at any time:

```
<xsd:simpleType name="navigationMode.Type">
        <xsd:restriction base="xsd:NMTOKEN">
                <xsd:enumeration value="linear"/>
                <xsd:enumeration value="nonlinear"/>
        </xsd:restriction>
</xsd:simpleType>
```

Defines constants for the above modes. Usage example:

```
NavigationMode.linear
```

Note that:

```
NavigationMode.DEFAULT == None
```

For more methods see *Enumeration*

class pyslet.qtiv2.tests.**SubmissionMode**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

The submission mode determines when the candidate's responses are submitted for response processing. A testPart in individual mode requires the candidate to submit their responses on an item-by-item basis. In simultaneous mode the candidate's responses are all submitted together at the end of the testPart:

```
<xsd:simpleType name="submissionMode.Type">
        <xsd:restriction base="xsd:NMTOKEN">
                <xsd:enumeration value="individual"/>
                <xsd:enumeration value="simultaneous"/>
        </xsd:restriction>
</xsd:simpleType>
```

Defines constants for the above modes. Usage example:

```
SubmissionMode.individual
```

Note that:

```
SubmissionMode.DEFAULT == None
```

For more methods see *Enumeration*

class pyslet.qtiv2.tests.**TestPart**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

Each test is divided into one or more parts which may in turn be divided into sections, sub-sections, and so on:

```
<xsd:attributeGroup name="testPart.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
        <xsd:attribute name="navigationMode" type="navigationMode.Type" use="required"/>
        <xsd:attribute name="submissionMode" type="submissionMode.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="testPart.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="preCondition" minOccurs="0" maxOccurs="unbounded"/>
                <xsd:element ref="branchRule" minOccurs="0" maxOccurs="unbounded"/>
                <xsd:element ref="itemSessionControl" minOccurs="0" maxOccurs="1"/>
                <xsd:element ref="timeLimits" minOccurs="0" maxOccurs="1"/>
                <xsd:element ref="assessmentSection" minOccurs="1" maxOccurs="unbounded"/>
                <xsd:element ref="testFeedback" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

CheckPreConditions(*state*)
Returns True if this testPart's pre-conditions are satisfied or if there are no pre-conditions in effect.

GetBranchTarget(*state*)
Returns the identifier of the testPart to branch to, or the pre-defined EXIT_TEST identifier. If there is no branch rule in effect then None is returned. *state* is a `variables.TestSessionState` instance used to evaluate the branch rule expressions.

Test Structure

class pyslet.qtiv2.tests.**Selection**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

The selection class specifies the rules used to select the child elements of a section for each test session:

```
<xsd:attributeGroup name="selection.AttrGroup">
        <xsd:attribute name="select" type="integer.Type" use="required"/>
        <xsd:attribute name="withReplacement" type="boolean.Type" use="optional"/>
        <xsd:anyAttribute namespace="##other"/>
</xsd:attributeGroup>

<xsd:group name="selection.ContentGroup">
        <xsd:sequence>
        <xsd:any namespace="##any" minOccurs="0" maxOccurs="unbounded" processContents="skip"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.tests.**Ordering**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

The ordering class specifies the rule used to arrange the child elements of a section following selection. If no ordering rule is given we assume that the elements are to be ordered in the order in which they are defined:

```
<xsd:attributeGroup name="ordering.AttrGroup">
        <xsd:attribute name="shuffle" type="boolean.Type" use="required"/>
        <xsd:anyAttribute namespace="##other"/>
</xsd:attributeGroup>

<xsd:group name="ordering.ContentGroup">
        <xsd:sequence>
        <xsd:any namespace="##any" minOccurs="0" maxOccurs="unbounded" processContents="skip"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.tests.**SectionPart**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

Sections group together individual item references and/or sub-sections. A number of common parameters are shared by both types of child element:

```
<xsd:attributeGroup name="sectionPart.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
        <xsd:attribute name="required" type="boolean.Type" use="optional"/>
        <xsd:attribute name="fixed" type="boolean.Type" use="optional"/>
</xsd:attributeGroup>

<xsd:group name="sectionPart.ContentGroup">
```

```
            <xsd:sequence>
                    <xsd:element ref="preCondition" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:element ref="branchRule" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:element ref="itemSessionControl" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="timeLimits" minOccurs="0" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

CheckPreConditions(*state*)
Returns True if this item or section's pre-conditions are satisfied or if there are no pre-conditions in effect.

GetBranchTarget(*state*)
Returns the identifier of the next item or section to branch to, or one of the pre-defined EXIT_* identifiers. If there is no branch rule in effect then None is returned. *state* is a `variables.TestSessionState` instance used to evaluate the branch rule expressions.

class pyslet.qtiv2.tests.**AssessmentSection**(*parent*)
Bases: *pyslet.qtiv2.tests.SectionPart*

Represents assessmentSection element

```
    <xsd:attributeGroup name="assessmentSection.AttrGroup">
            <xsd:attributeGroup ref="sectionPart.AttrGroup"/>
            <xsd:attribute name="title" type="string.Type" use="required"/>
            <xsd:attribute name="visible" type="boolean.Type" use="required"/>
            <xsd:attribute name="keepTogether" type="boolean.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="assessmentSection.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="sectionPart.ContentGroup"/>
                    <xsd:element ref="selection" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="ordering" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="rubricBlock" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:group ref="sectionPart.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.tests.**AssessmentItemRef**(*parent*)
Bases: *pyslet.qtiv2.tests.SectionPart*

Items are incorporated into the test by reference and not by direct aggregation:

```
    <xsd:attributeGroup name="assessmentItemRef.AttrGroup">
            <xsd:attributeGroup ref="sectionPart.AttrGroup"/>
            <xsd:attribute name="href" type="uri.Type" use="required"/>
            <xsd:attribute name="category" use="optional">
                    <xsd:simpleType>
                            <xsd:list itemType="identifier.Type"/>
                    </xsd:simpleType>
            </xsd:attribute>
    </xsd:attributeGroup>

    <xsd:group name="assessmentItemRef.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="sectionPart.ContentGroup"/>
                    <xsd:element ref="variableMapping" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:element ref="weight" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:element ref="templateDefault" minOccurs="0" maxOccurs="unbounded"/>
```

```
        </xsd:sequence>
</xsd:group>
```

GetItem()
Returns the AssessmentItem referred to by this reference.

3.3.3 Content Model

class pyslet.qtiv2.content.**ItemBody**(*parent*)
Bases: *pyslet.qtiv2.content.BodyElement*

The item body contains the text, graphics, media objects, and interactions that describe the item's content and information about how it is structured:

```
<xsd:attributeGroup name="itemBody.AttrGroup">
        <xsd:attributeGroup ref="bodyElement.AttrGroup"/>
</xsd:attributeGroup>

<xsd:group name="itemBody.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="block.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

RenderHTML(*parent*, *profile*, *itemState*)
Overrides *BodyElement.RenderHTML()*, the result is always a Div with class set to "itemBody". Unlike other such method *parent* may by None, in which case a new parentless Div is created.

class pyslet.qtiv2.content.**BodyElement**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

The root class of all content objects in the item content model is the bodyElement. It defines a number of attributes that are common to all elements of the content model:

```
<xsd:attributeGroup name="bodyElement.AttrGroup">
        <xsd:attribute name="id" type="identifier.Type" use="optional"/>
        <xsd:attribute name="class" use="optional">
                <xsd:simpleType>
                        <xsd:list itemType="styleclass.Type"/>
                </xsd:simpleType>
        </xsd:attribute>
        <xsd:attribute ref="xml:lang"/>
        <xsd:attribute name="label" type="string256.Type" use="optional"/>
</xsd:attributeGroup>
```

RenderHTML(*parent*, *profile*, *itemState*)
Renders this element in html form, adding nodes to *parent*. This method effectively overrides `html40_19991224.XHTMLElement.RenderHTML` enabling QTI and XHTML elements to be mixed freely.

The state of the item (e.g., the values of any controls), is taken from *itemState*, a `variables.ItemSessionState` instance.

RenderHTMLChildren(*parent*, *profile*, *itemState*)
Renders this element's children to an external document represented by the *parent* node

Basic Classes

Many of the basic classes are drawn directly from the html40_19991224 module, as a result there are slight modifications to some of the abstract base class definitions. See InlineMixin, BlockMixin and FlowMixin; there is no class corresponding to the objectFlow concept (see Object for more information). There is also no representation of the static base classes used to exclude interactions or any of the other basic container classes, these are all handled directly by their equivalent html abstractions.

class pyslet.qtiv2.content.**FlowContainerMixin**
Mixin class used for objects that can contain flows.

PrettyPrint()
Deteremins if this flow-container-like object should be pretty printed.

This is similar to the algorithm we use in HTML flow containers, suppressing pretty printing if we have inline elements (ignoring non-trivial data). This could be refactored in future.

XHMTL Elements

Again, these classes are defined in the accompanying html40_19991224 module, however we do define some profiles here to make it easier to constraint general HTML content to the profile defined here.

pyslet.qtiv2.content.**TextElements** = {'em': ('id', 'class', 'label'), 'pre': ('id', 'class', 'label'), 'code': ('id', 'class', 'la
Basic text formatting elements

pyslet.qtiv2.content.**ListElements** = {'dl': ('id', 'class', 'label'), 'ol': ('id', 'class', 'label'), 'dd': ('id', 'class', 'label'
Elements required for lists

pyslet.qtiv2.content.**ObjectElements** = {'object': ('id', 'class', 'label', 'data', 'type', 'width', 'height'), 'param': ('i
The object element

pyslet.qtiv2.content.**PresentationElements** = {'caption': ('id', 'class', 'label'), 'tfoot': ('id', 'class', 'label'), 'th': (
Tables

pyslet.qtiv2.content.**ImageElement** = {'img': ('id', 'class', 'label', 'src', 'alt', 'longdesc', 'height', 'width')}
Images

pyslet.qtiv2.content.**HypertextElement** = {'a': ('id', 'class', 'label', 'href', 'type')}
Hyperlinks

pyslet.qtiv2.content.**HTMLProfile** = {'em': ('id', 'class', 'label'), 'pre': ('id', 'class', 'label'), 'code': ('id', 'class', 'lab
The full HTML profile defined by QTI

3.3.4 Interactions

class pyslet.qtiv2.interactions.**Interaction**(*parent*)
Bases: *pyslet.qtiv2.content.BodyElement*

Interactions allow the candidate to interact with the item. Through an interaction, the candidate selects or constructs a response:

```
<xsd:attributeGroup name="interaction.AttrGroup">
        <xsd:attributeGroup ref="bodyElement.AttrGroup"/>
        <xsd:attribute name="responseIdentifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.interactions.**InlineInteraction**(*parent*)
Bases: pyslet.html40_19991224.InlineMixin, *pyslet.qtiv2.interactions.Interaction*

Abstract class for interactions that appear inline.

class pyslet.qtiv2.interactions.**BlockInteraction**(*parent*)
Bases: pyslet.html40_19991224.BlockMixin, *pyslet.qtiv2.interactions.Interaction*

An interaction that behaves like a block in the content model. Most interactions are of this type:

```
<xsd:group name="blockInteraction.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="prompt" minOccurs="0" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.interactions.**Prompt**(*parent*)
Bases: *pyslet.qtiv2.content.BodyElement*

The prompt used in block interactions

```
<xsd:group name="prompt.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="inlineStatic.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.interactions.**Choice**(*parent*)
Bases: *pyslet.qtiv2.content.BodyElement*

Many of the interactions involve choosing one or more predefined choices

```
<xsd:attributeGroup name="choice.AttrGroup">
        <xsd:attributeGroup ref="bodyElement.AttrGroup"/>
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
        <xsd:attribute name="fixed" type="boolean.Type" use="optional"/>
        <xsd:attribute name="templateIdentifier" type="identifier.Type" use="optional"/>
        <xsd:attribute name="showHide" type="showHide.Type" use="optional"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.interactions.**AssociableChoice**(*parent*)
Bases: *pyslet.qtiv2.interactions.Choice*

Other interactions involve associating pairs of predefined choices

```
<xsd:attributeGroup name="associableChoice.AttrGroup">
        <xsd:attributeGroup ref="choice.AttrGroup"/>
        <xsd:attribute name="matchGroup" use="optional">
                <xsd:simpleType>
                        <xsd:list itemType="identifier.Type"/>
                </xsd:simpleType>
        </xsd:attribute>
</xsd:attributeGroup>
```

Simple Interactions

class pyslet.qtiv2.interactions.**ChoiceInteraction**(*parent*)
Bases: *pyslet.qtiv2.interactions.BlockInteraction*

The choice interaction presents a set of choices to the candidate. The candidate's task is to select one or more of the choices, up to a maximum of maxChoices:

```
    <xsd:attributeGroup name="choiceInteraction.AttrGroup">
            <xsd:attributeGroup ref="blockInteraction.AttrGroup"/>
            <xsd:attribute name="shuffle" type="boolean.Type" use="required"/>
            <xsd:attribute name="maxChoices" type="integer.Type" use="required"/>
            <xsd:attribute name="minChoices" type="integer.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="choiceInteraction.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="blockInteraction.ContentGroup"/>
                    <xsd:element ref="simpleChoice" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**OrderInteraction**(*parent*)

Bases: *pyslet.qtiv2.interactions.BlockInteraction*

In an order interaction the candidate's task is to reorder the choices, the order in which the choices are displayed initially is significant:

```
    <xsd:attributeGroup name="orderInteraction.AttrGroup">
            <xsd:attributeGroup ref="blockInteraction.AttrGroup"/>
            <xsd:attribute name="shuffle" type="boolean.Type" use="required"/>
            <xsd:attribute name="minChoices" type="integer.Type" use="optional"/>
            <xsd:attribute name="maxChoices" type="integer.Type" use="optional"/>
            <xsd:attribute name="orientation" type="orientation.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="orderInteraction.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="blockInteraction.ContentGroup"/>
                    <xsd:element ref="simpleChoice" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**SimpleChoice**(*parent*)

Bases: *pyslet.qtiv2.content.FlowContainerMixin*, *pyslet.qtiv2.interactions.Choice*

A SimpleChoice is a choice that contains flow objects; it must not contain any nested interactions:

```
    <xsd:group name="simpleChoice.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="flowStatic.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**AssociateInteraction**(*parent*)

Bases: *pyslet.qtiv2.interactions.BlockInteraction*

An associate interaction is a blockInteraction that presents candidates with a number of choices and allows them to create associations between them:

```
    <xsd:attributeGroup name="associateInteraction.AttrGroup">
            <xsd:attributeGroup ref="blockInteraction.AttrGroup"/>
            <xsd:attribute name="shuffle" type="boolean.Type" use="required"/>
            <xsd:attribute name="maxAssociations" type="integer.Type" use="required"/>
            <xsd:attribute name="minAssociations" type="integer.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="associateInteraction.ContentGroup">
```

```
            <xsd:sequence>
                    <xsd:group ref="blockInteraction.ContentGroup"/>
                    <xsd:element ref="simpleAssociableChoice" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**MatchInteraction**(*parent*)

Bases: *pyslet.qtiv2.interactions.BlockInteraction*

A match interaction is a blockInteraction that presents candidates with two sets of choices and allows them to create associates between pairs of choices in the two sets, but not between pairs of choices in the same set:

```
    <xsd:attributeGroup name="matchInteraction.AttrGroup">
            <xsd:attributeGroup ref="blockInteraction.AttrGroup"/>
            <xsd:attribute name="shuffle" type="boolean.Type" use="required"/>
            <xsd:attribute name="maxAssociations" type="integer.Type" use="required"/>
            <xsd:attribute name="minAssociations" type="integer.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="matchInteraction.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="blockInteraction.ContentGroup"/>
                    <xsd:element ref="simpleMatchSet" minOccurs="2" maxOccurs="2"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**SimpleAssociableChoice**(*parent*)

Bases: *pyslet.qtiv2.content.FlowContainerMixin*, *pyslet.qtiv2.interactions.AssociableChoice*

associableChoice is a choice that contains flowStatic objects, it must not contain nested interactions:

```
    <xsd:attributeGroup name="simpleAssociableChoice.AttrGroup">
            <xsd:attributeGroup ref="associableChoice.AttrGroup"/>
            <xsd:attribute name="matchMax" type="integer.Type" use="required"/>
            <xsd:attribute name="matchMin" type="integer.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="simpleAssociableChoice.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="flowStatic.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**SimpleMatchSet**(*parent*)

Bases: *pyslet.qtiv2.core.QTIElement*

Contains an ordered set of choices for the set

```
    <xsd:group name="simpleMatchSet.ContentGroup">
            <xsd:sequence>
                    <xsd:element ref="simpleAssociableChoice" minOccurs="0" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**GapMatchInteraction**(*parent*)

Bases: *pyslet.qtiv2.interactions.BlockInteraction*

A gap match interaction is a blockInteraction that contains a number gaps that the candidate can fill from an associated set of choices:

```
    <xsd:attributeGroup name="gapMatchInteraction.AttrGroup">
            <xsd:attributeGroup ref="blockInteraction.AttrGroup"/>
            <xsd:attribute name="shuffle" type="boolean.Type" use="required"/>
    </xsd:attributeGroup>

    <xsd:group name="gapMatchInteraction.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="blockInteraction.ContentGroup"/>
                    <xsd:group ref="gapChoice.ElementGroup" minOccurs="1" maxOccurs="unbounded"/>
                    <xsd:group ref="blockStatic.ElementGroup" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**Gap**(*parent*)

Bases: pyslet.html40_19991224.InlineMixin, *pyslet.qtiv2.interactions.AssociableChoice*

A gap is an inline element that must only appear within a gapMatchInteraction

```
    <xsd:attributeGroup name="gap.AttrGroup">
            <xsd:attributeGroup ref="associableChoice.AttrGroup"/>
            <xsd:attribute name="required" type="boolean.Type" use="optional"/>
    </xsd:attributeGroup>
```

class pyslet.qtiv2.interactions.**GapChoice**(*parent*)

Bases: *pyslet.qtiv2.interactions.AssociableChoice*

The choices that are used to fill the gaps in a gapMatchInteraction are either simple runs of text or single image objects, both derived from gapChoice:

```
    <xsd:attributeGroup name="gapChoice.AttrGroup">
            <xsd:attributeGroup ref="associableChoice.AttrGroup"/>
            <xsd:attribute name="matchMax" type="integer.Type" use="required"/>
            <xsd:attribute name="matchMin" type="integer.Type" use="optional"/>
    </xsd:attributeGroup>
```

class pyslet.qtiv2.interactions.**GapText**(*parent*)

Bases: *pyslet.qtiv2.interactions.GapChoice*

A simple run of text to be inserted into a gap by the user, may be subject to variable value substitution with printedVariable:

```
    <xsd:group name="gapText.ContentGroup">
            <xsd:sequence>
                    <xsd:element ref="printedVariable" minOccurs="0" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**GapImg**(*parent*)

Bases: *pyslet.qtiv2.interactions.GapChoice*

A gap image contains a single image object to be inserted into a gap by the candidate:

```
    <xsd:attributeGroup name="gapImg.AttrGroup">
            <xsd:attributeGroup ref="gapChoice.AttrGroup"/>
            <xsd:attribute name="objectLabel" type="string.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="gapImg.ContentGroup">
            <xsd:sequence>
                    <xsd:element ref="object" minOccurs="1" maxOccurs="1"/>
```

```
        </xsd:sequence>
    </xsd:group>
```

Text-based Interactions

class pyslet.qtiv2.interactions.**InlineChoiceInteraction**(*parent*)
Bases: *pyslet.qtiv2.interactions.InlineInteraction*

An inline choice is an inlineInteraction that presents the user with a set of choices, each of which is a simple piece of text:

```
    <xsd:attributeGroup name="inlineChoiceInteraction.AttrGroup">
            <xsd:attributeGroup ref="inlineInteraction.AttrGroup"/>
            <xsd:attribute name="shuffle" type="boolean.Type" use="required"/>
            <xsd:attribute name="required" type="boolean.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="inlineChoiceInteraction.ContentGroup">
            <xsd:sequence>
                    <xsd:element ref="inlineChoice" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**InlineChoice**(*parent*)
Bases: *pyslet.qtiv2.interactions.Choice*

A simple run of text to be displayed to the user, may be subject to variable value substitution with printedVariable:

```
    <xsd:group name="inlineChoice.ContentGroup">
            <xsd:sequence>
                    <xsd:element ref="printedVariable" minOccurs="0" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.interactions.**StringInteractionMixin**
Abstract mix-in class for interactions based on free-text input. String interactions can be bound to numeric response variables, instead of strings, if desired:

```
    <xsd:attributeGroup name="stringInteraction.AttrGroup">
            <xsd:attribute name="base" type="integer.Type" use="optional"/>
            <xsd:attribute name="stringIdentifier" type="identifier.Type" use="optional"/>
            <xsd:attribute name="expectedLength" type="integer.Type" use="optional"/>
            <xsd:attribute name="patternMask" type="string.Type" use="optional"/>
            <xsd:attribute name="placeholderText" type="string.Type" use="optional"/>
    </xsd:attributeGroup>
```

class pyslet.qtiv2.interactions.**TextEntryInteraction**(*parent*)
Bases: *pyslet.qtiv2.interactions.StringInteractionMixin*, *pyslet.qtiv2.interactions.InlineInteraction*

A textEntry interaction is an inlineInteraction that obtains a simple piece of text from the candidate.

class pyslet.qtiv2.interactions.**TextFormat**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Used to control the format of the text entered by the candidate:

```
<xsd:simpleType name="textFormat.Type">
        <xsd:restriction base="xsd:NMTOKEN">
                <xsd:enumeration value="plain"/>
                <xsd:enumeration value="preFormatted"/>
                <xsd:enumeration value="xhtml"/>
        </xsd:restriction>
</xsd:simpleType>
```

Defines constants for the above formats. Usage example:

```
TextFormat.plain
```

Note that:

```
TextFormat.DEFAULT == TextFormat.plain
```

For more methods see *Enumeration*

class pyslet.qtiv2.interactions.**ExtendedTextInteraction**(*parent*)
Bases: *pyslet.qtiv2.interactions.StringInteractionMixin*, *pyslet.qtiv2.interactions.BlockInteraction*

An extended text interaction is a blockInteraction that allows the candidate to enter an extended amount of text:

```
<xsd:attributeGroup name="extendedTextInteraction.AttrGroup">
        <xsd:attributeGroup ref="blockInteraction.AttrGroup"/>
        <xsd:attributeGroup ref="stringInteraction.AttrGroup"/>
        <xsd:attribute name="maxStrings" type="integer.Type" use="optional"/>
        <xsd:attribute name="minStrings" type="integer.Type" use="optional"/>
        <xsd:attribute name="expectedLines" type="integer.Type" use="optional"/>
        <xsd:attribute name="format" type="textFormat.Type" use="optional"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.interactions.**HottextInteraction**(*parent*)
Bases: *pyslet.qtiv2.interactions.BlockInteraction*

The hottext interaction presents a set of choices to the candidate represented as selectable runs of text embedded within a surrounding context, such as a simple passage of text:

```
<xsd:attributeGroup name="hottextInteraction.AttrGroup">
        <xsd:attributeGroup ref="blockInteraction.AttrGroup"/>
        <xsd:attribute name="maxChoices" type="integer.Type" use="required"/>
        <xsd:attribute name="minChoices" type="integer.Type" use="optional"/>
</xsd:attributeGroup>

<xsd:group name="hottextInteraction.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="blockInteraction.ContentGroup"/>
                <xsd:group ref="blockStatic.ElementGroup" minOccurs="1" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.interactions.**Hottext**(*parent*)
Bases: pyslet.html40_19991224.FlowMixin, *pyslet.qtiv2.interactions.Choice*

A hottext area is used within the content of an hottextInteraction to provide the individual choices:

```
<xsd:group name="hottext.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="inlineStatic.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
```

```
        </xsd:sequence>
</xsd:group>
```

Graphical Interactions

class `pyslet.qtiv2.interactions.`**`GapImg`**(*parent*)

Bases: *pyslet.qtiv2.interactions.GapChoice*

A gap image contains a single image object to be inserted into a gap by the candidate:

```
<xsd:attributeGroup name="gapImg.AttrGroup">
        <xsd:attributeGroup ref="gapChoice.AttrGroup"/>
        <xsd:attribute name="objectLabel" type="string.Type" use="optional"/>
</xsd:attributeGroup>

<xsd:group name="gapImg.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="object" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class `pyslet.qtiv2.interactions.`**`GapImg`**(*parent*)

Bases: *pyslet.qtiv2.interactions.GapChoice*

A gap image contains a single image object to be inserted into a gap by the candidate:

```
<xsd:attributeGroup name="gapImg.AttrGroup">
        <xsd:attributeGroup ref="gapChoice.AttrGroup"/>
        <xsd:attribute name="objectLabel" type="string.Type" use="optional"/>
</xsd:attributeGroup>

<xsd:group name="gapImg.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="object" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class `pyslet.qtiv2.interactions.`**`GapImg`**(*parent*)

Bases: *pyslet.qtiv2.interactions.GapChoice*

A gap image contains a single image object to be inserted into a gap by the candidate:

```
<xsd:attributeGroup name="gapImg.AttrGroup">
        <xsd:attributeGroup ref="gapChoice.AttrGroup"/>
        <xsd:attribute name="objectLabel" type="string.Type" use="optional"/>
</xsd:attributeGroup>

<xsd:group name="gapImg.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="object" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

3.3.5 Item Variables

This module contains the basic run-time data model. Although the specification does contain elements to represent the values of variables set at runtime the XML schema sometimes relies too much on context for an efficient implementa-

tion. For example, a <value> element is always a value of a specific base type but the base type is rarely specified on the value element itself as it is normally implicit in the context. such as a variable declaration.

Although the expression model does contain an element that provides a more complete representation of single values (namely <baseValue>) we decide to make the distinction in this module with *ValueElement* representing the element and the abstract *Value* being used as the root of the runtime object model.

For example, to get the default value of a variable from a variable declaration you'll use the *GetDefaultValue()* method and it will return a *Value* instance which could be of any cardinality or base type.

class pyslet.qtiv2.variables.**VariableDeclaration**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

Item variables are declared by variable declarations... The purpose of the declaration is to associate an identifier with the variable and to identify the runtime type of the variable's value:

```
<xsd:attributeGroup name="variableDeclaration.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
        <xsd:attribute name="cardinality" type="cardinality.Type" use="required"/>
        <xsd:attribute name="baseType" type="baseType.Type" use="optional"/>
</xsd:attributeGroup>

<xsd:group name="variableDeclaration.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="defaultValue" minOccurs="0" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

GetDefaultValue()
Returns a *Value* instance representing either the default value or an appropriately typed NULL value if there is no default defined.

class pyslet.qtiv2.variables.**ValueElement**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

A class that can represent a single value of any baseType in variable declarations and result reports:

```
<xsd:attributeGroup name="value.AttrGroup">
        <xsd:attribute name="fieldIdentifier" type="identifier.Type" use="optional"/>
        <xsd:attribute name="baseType" type="baseType.Type" use="optional"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.variables.**DefaultValue**(*parent*)
Bases: pyslet.qtiv2.variables.DefinedValue

An optional default value for a variable. The point at which a variable is set to its default value varies depending on the type of item variable.

class pyslet.qtiv2.variables.**Cardinality**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

An expression or itemVariable can either be single-valued or multi-valued. A multi-valued expression (or variable) is called a container. A container contains a list of values, this list may be empty in which case it is treated as NULL. All the values in a multiple or ordered container are drawn from the same value set:

```
<xsd:simpleType name="cardinality.Type">
        <xsd:restriction base="xsd:NMTOKEN">
                <xsd:enumeration value="multiple"/>
                <xsd:enumeration value="ordered"/>
                <xsd:enumeration value="record"/>
                <xsd:enumeration value="single"/>
```

```
        </xsd:restriction>
</xsd:simpleType>
```

Defines constants for the above carinalities. Usage example:

```
Cardinality.multiple
```

There is no default:

```
Cardinality.DEFAULT == None
```

For more methods see *Enumeration*

class pyslet.qtiv2.variables.**BaseType**

Bases: *pyslet.xsdatatypes20041028.Enumeration*

A base-type is simply a description of a set of atomic values (atomic to this specification). Note that several of the baseTypes used to define the runtime data model have identical definitions to those of the basic data types used to define the values for attributes in the specification itself. The use of an enumeration to define the set of baseTypes used in the runtime model, as opposed to the use of classes with similar names, is designed to help distinguish between these two distinct levels of modelling:

```
<xsd:simpleType name="baseType.Type">
        <xsd:restriction base="xsd:NMTOKEN">
                <xsd:enumeration value="boolean"/>
                <xsd:enumeration value="directedPair"/>
                <xsd:enumeration value="duration"/>
                <xsd:enumeration value="file"/>
                <xsd:enumeration value="float"/>
                <xsd:enumeration value="identifier"/>
                <xsd:enumeration value="integer"/>
                <xsd:enumeration value="pair"/>
                <xsd:enumeration value="point"/>
                <xsd:enumeration value="string"/>
                <xsd:enumeration value="uri"/>
        </xsd:restriction>
</xsd:simpleType>
```

Defines constants for the above base types. Usage example:

```
BaseType.float
```

There is no default:

```
BaseType.DEFAULT == None
```

For more methods see *Enumeration*

class pyslet.qtiv2.variables.**Mapping**(*parent*)

Bases: *pyslet.qtiv2.core.QTIElement*

A special class used to create a mapping from a source set of any baseType (except file and duration) to a single float:

```
<xsd:attributeGroup name="mapping.AttrGroup">
        <xsd:attribute name="lowerBound" type="float.Type" use="optional"/>
        <xsd:attribute name="upperBound" type="float.Type" use="optional"/>
        <xsd:attribute name="defaultValue" type="float.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="mapping.ContentGroup">
```

```
            <xsd:sequence>
                    <xsd:element ref="mapEntry" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

content_changed()
Builds an internal dictionary of the values being mapped.

In order to fully specify the mapping we need to know the baseType of the source values. (The targets are always floats.) We do this based on our parent, orphan Mapping elements are treated as mappings from source strings.

MapValue(*value*)
Maps an instance of *Value* with the same base type as the mapping to an instance of *Value* with base type float.

class pyslet.qtiv2.variables.**MapEntry**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

An entry in a *Mapping*

```
    <xsd:attributeGroup name="mapEntry.AttrGroup">
            <xsd:attribute name="mapKey" type="valueType.Type" use="required"/>
            <xsd:attribute name="mappedValue" type="float.Type" use="required"/>
    </xsd:attributeGroup>
```

mapKey = None
The source value

mappedValue = None
The mapped value

Response Variables

class pyslet.qtiv2.variables.**ResponseDeclaration**(*parent*)
Bases: *pyslet.qtiv2.variables.VariableDeclaration*

Response variables are declared by response declarations and bound to interactions in the itemBody:

```
    <xsd:group name="responseDeclaration.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="variableDeclaration.ContentGroup"/>
                    <xsd:element ref="correctResponse" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="mapping" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="areaMapping" minOccurs="0" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

GetCorrectValue()
Returns a *Value* instance representing either the correct response value or an appropriately typed NULL value if there is no correct value.

GetStageDimensions()
For response variables with point type, returns a pair of integer values: width,height

In HTML, shapes (including those used in the AreaMapping) can use relative coordinates. To interpret relative coordinates we need to know the size of the stage used to interpret the point values. For a response variable that is typically the size of the image or object used in the interaction.

This method searches for the interaction associated with the response and obtains the width and height of the corresponding object.

[TODO: currently returns 100,100]

class pyslet.qtiv2.variables.**CorrectResponse**(*parent*)
Bases: pyslet.qtiv2.variables.DefinedValue

A response declaration may assign an optional correctResponse. This value may indicate the only possible value of the response variable to be considered correct or merely just a correct value.

class pyslet.qtiv2.variables.**AreaMapping**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

A special class used to create a mapping from a source set of point values to a target set of float values:

```
<xsd:attributeGroup name="areaMapping.AttrGroup">
        <xsd:attribute name="lowerBound" type="float.Type" use="optional"/>
        <xsd:attribute name="upperBound" type="float.Type" use="optional"/>
        <xsd:attribute name="defaultValue" type="float.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="areaMapping.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="areaMapEntry" minOccurs="1" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

MapValue(*value*, *width*, *height*)
Maps an instance of *Value* with point base type to an instance of *Value* with base type float.

- value is a *Value* of base type point
- width is the integer width of the object on which the area is defined
- height is the integer height of the object on which the area is defined

The width and height of the object are required because HTML allows relative values to be used when defining areas.

class pyslet.qtiv2.variables.**AreaMapEntry**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*, pyslet.qtiv2.core.ShapeElementMixin

An *AreaMapping* is defined by a set of areaMapEntries, each of which maps an area of the coordinate space onto a single float:

```
<xsd:attributeGroup name="areaMapEntry.AttrGroup">
        <xsd:attribute name="shape" type="shape.Type" use="required"/>
        <xsd:attribute name="coords" type="coords.Type" use="required"/>
        <xsd:attribute name="mappedValue" type="float.Type" use="required"/>
</xsd:attributeGroup>
```

mappedValue = None
The mapped value

Outcome Variables

class pyslet.qtiv2.variables.**OutcomeDeclaration**(*parent*)
Bases: *pyslet.qtiv2.variables.VariableDeclaration*

Outcome variables are declared by outcome declarations

```
    <xsd:attributeGroup name="outcomeDeclaration.AttrGroup">
            <xsd:attributeGroup ref="variableDeclaration.AttrGroup"/>
            <xsd:attribute name="view" use="optional">
                    <xsd:simpleType>
                            <xsd:list itemType="view.Type"/>
                    </xsd:simpleType>
            </xsd:attribute>
            <xsd:attribute name="interpretation" type="string.Type" use="optional"/>
            <xsd:attribute name="longInterpretation" type="uri.Type" use="optional"/>
            <xsd:attribute name="normalMaximum" type="float.Type" use="optional"/>
            <xsd:attribute name="normalMinimum" type="float.Type" use="optional"/>
            <xsd:attribute name="masteryValue" type="float.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="outcomeDeclaration.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="variableDeclaration.ContentGroup"/>
                    <xsd:group ref="lookupTable.ElementGroup" minOccurs="0" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.variables.**LookupTable**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

An abstract class associated with an outcomeDeclaration used to create a lookup table from a numeric source value to a single outcome value in the declared value set:

```
    <xsd:attributeGroup name="lookupTable.AttrGroup">
            <xsd:attribute name="defaultValue" type="valueType.Type" use="optional"/>
    </xsd:attributeGroup>
```

default = None
a *Value* instance representing the default

class pyslet.qtiv2.variables.**MatchTable**(*parent*)
Bases: *pyslet.qtiv2.variables.LookupTable*

A matchTable transforms a source integer by finding the first matchTableEntry with an exact match to the source:

```
    <xsd:group name="matchTable.ContentGroup">
            <xsd:sequence>
                    <xsd:element ref="matchTableEntry" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

content_changed()
Builds an internal dictionary of the values being mapped.

Lookup(*value*)
Maps an instance of *Value* with integer base type to an instance of *Value* with the base type of the match table.

class pyslet.qtiv2.variables.**MatchTableEntry**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

sourceValue The source integer that must be matched exactly.

targetValue The target value that is used to set the outcome when a match is found

```
    <xsd:attributeGroup name="matchTableEntry.AttrGroup">
            <xsd:attribute name="sourceValue" type="integer.Type" use="required"/>
```

```
        <xsd:attribute name="targetValue" type="valueType.Type" use="required"/>
    </xsd:attributeGroup>
```

class pyslet.qtiv2.variables.**InterpolationTable**(*parent*)
Bases: *pyslet.qtiv2.variables.LookupTable*

An interpolationTable transforms a source float (or integer) by finding the first interpolationTableEntry with a sourceValue that is less than or equal to (subject to includeBoundary) the source value:

```
    <xsd:group name="interpolationTable.ContentGroup">
        <xsd:sequence>
            <xsd:element ref="interpolationTableEntry" minOccurs="1" maxOccurs="unbounded"/>
        </xsd:sequence>
    </xsd:group>
```

content_changed()
Builds an internal table of the values being mapped.

Lookup(*value*)
Maps an instance of *Value* with integer or float base type to an instance of *Value* with the base type of the interpolation table.

class pyslet.qtiv2.variables.**InterpolationTableEntry**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

sourceValue The lower bound for the source value to match this entry.

includeBoundary Determines if an exact match of sourceValue matches this entry. If true, the default, then an exact match of the value is considered a match of this entry.

targetValue The target value that is used to set the outcome when a match is found

```
    <xsd:attributeGroup name="interpolationTableEntry.AttrGroup">
        <xsd:attribute name="sourceValue" type="float.Type" use="required"/>
        <xsd:attribute name="includeBoundary" type="boolean.Type" use="optional"/>
        <xsd:attribute name="targetValue" type="valueType.Type" use="required"/>
    </xsd:attributeGroup>
```

Template Variables

class pyslet.qtiv2.variables.**TemplateDeclaration**(*parent*)
Bases: *pyslet.qtiv2.variables.VariableDeclaration*

Template declarations declare item variables that are to be used specifically for the purposes of cloning items

```
    <xsd:attributeGroup name="templateDeclaration.AttrGroup">
        <xsd:attributeGroup ref="variableDeclaration.AttrGroup"/>
        <xsd:attribute name="paramVariable" type="boolean.Type" use="optional"/>
        <xsd:attribute name="mathVariable" type="boolean.Type" use="optional"/>
    </xsd:attributeGroup>
```

Runtime Object Model

class pyslet.qtiv2.variables.**SessionState**
Bases: object

Abstract class used as the base class for namespace-like objects used to track the state of an item or test session. Instances can be used as if they were dictionaries of *Value*.

GetDeclaration(*varName*)
Returns the declaration associated with *varName* or None if the variable is one of the built-in variables. If *varName* is not a variable KeyError is raised. To test for the existence of a variable just use the object as you would a dictionary:

```
# state is a SessionState instance
if 'RESPONSE' in state:
        print "RESPONSE declared!"
```

IsResponse(*varName*)
Return True if *varName* is the name of a response variable.

IsOutcome(*varName*)
Return True if *varName* is the name of an outcome variable.

IsTemplate(*varName*)
Return True if *varName* is the name of a template variable.

__getitem__(*varName*)
Returns the *Value* instance corresponding to *varName* or raises KeyError if there is no variable with that name.

__setitem__(*varName*, *value*)
Sets the value of *varName* to the *Value* instance *value*.

The *baseType* and cardinality of *value* must match those expected for the variable.

This method does not actually update the dictionary with the *value* instance but instead, it copies the value of *value* into the *Value* instance already stored in the session. The side-effect of this implementation is that a previous look-up will be updated by a subsequent assignment:

```
# state is a SessionState instance
state['RESPONSE']=IdentifierValue('Hello')
r1=state['RESPONSE']
state['RESPONSE']=IdentifierValue('Bye')
r2=state['RESPONSE']
r1==r2          # WARNING: r1 has been updated so still evaluates to True!
```

__weakref__
list of weak references to the object (if defined)

class pyslet.qtiv2.variables.**ItemSessionState**(*item*)
Bases: *pyslet.qtiv2.variables.SessionState*

Represents the state of an item session. *item* is the item from which the session should be created.

On construction, all declared variables (included built-in variables) are added to the session with NULL values, except the template variables which are set to their defaults.

In addition to the variables defined by the specification we add meta variables corresponding to response and outcome defaults, these have the same name as the variable but with ".DEFAULT" appended. Similarly, we define names for the correct values of response variables using ".CORRECT". The values of these meta-variables are all initialised from the item definition on construction.

SelectClone()
Item templates describe a range of possible items referred to as *clones*.

If the item used to create the session object is an item template then you must call SelectClone before beginning the candidate's session with *BeginSession()*.

The main purpose of this method is to run the template processing rules. These rules update the values of the template variables and may also alter correct responses and default outcome (or response) values.

BeginSession()
Called at the start of an item session. According to the specification:

> "The session starts when the associated item first becomes eligible for delivery to the candidate"

The main purpose of this method is to set the outcome values to their defaults.

BeginAttempt(*htmlParent=None*)
Called at the start of an attempt.

This method sets the default RESPONSE values and completionStatus if this is the first attempt and increments numAttempts accordingly.

SaveSession(*params*, *htmlParent=None*)
Called when we wish to save unsubmitted values.

SubmitSession(*params*, *htmlParent=None*)
Called when we wish to submit values (i.e., end an attempt).

EndAttempt()
Called at the end of an attempt. Invokes response processing if present.

IsResponse(*varName*)
Return True if *varName* is the name of a response variable.

We add handling of the built-in response variables numAttempts and duration.

IsOutcome(*varName*)
Return True if *varName* is the name of an outcome variable.

We add handling of the built-in outcome variable completionStatus.

class pyslet.qtiv2.variables.**TestSessionState**(*form*)
Bases: *pyslet.qtiv2.variables.SessionState*

Represents the state of a test session. The keys are the names of the variables *including* qualified names that can be used to look up the value of variables from the associated item session states. *form* is the test form from which the session should be created.

On construction, all declared variables (included built-in variables) are added to the session with NULL values.

test = None
the tests.AssessmentTest that this session is an instance of

t = None
the time of the last event

salt = None
a random string of bytes used to add entropy to the session key

key = None
A key representing this session in its current state, this key is initialised to a random value and changes as each event is received. The key must be supplied when triggering subsequent events. The key is designed to be unguessable and unique so a caller presenting the correct key when triggering an event can be securely assumed to be the owner of the existing session.

prevKey = None
The key representing the previous state. This can be used to follow session state transitions back through a chain of states back to the beginning of the session (i.e., for auditing).

keyMap = None
A mapping of keys previously used by this session. A caller presenting an expired key when triggering an event generates a SessionKeyExpired exception. This condition might indicate that a session

response was not received (e.g., due to a connection failure) and that the session should be re-started with the previous response.

GetCurrentTestPart()
Returns the current test part or None if the test is finished.

GetCurrentQuestion()
Returns the current question or None if the test is finished.

BeginSession(*key*, *htmlParent=None*)
Called at the start of a test session. Represents a 'Start Test' event.

The main purpose of this method is to set the outcome values to their defaults and to select the first question.

GetNamespace(*varName*)
Takes a variable name *varName* and returns a tuple of namespace/varName.

The resulting namespace will be a dictionary or a dictionary-like object from which the value of the returned varName object can be looked up.

IsResponse(*varName*)
Return True if *varName* is the name of a response variable. The test-level duration values are treated as built-in responses and return True.

__len__()
Returns the total length of all namespaces combined.

__getitem__(*varName*)
Returns the *Value* instance corresponding to *varName* or raises KeyError if there is no variable with that name.

class pyslet.qtiv2.variables.**Value**
Bases: object

Represents a single value in the processing model.

This class is the heart of the QTI processing model. This is an abstract base class of a class hierarchy that represents the various types of value that may be encountered when processing.

baseType = None
One of the *BaseType* constants or None if the baseType is unknown.

An unknown baseType acts like a wild-card. It means that the baseType is not determined and could potentially be any of the *BaseType* values. This distinction has implications for the way evaluation is done. A value with a baseType of None will not raise TypeErrors during evaluation if the cardinalities match the context. This allows expressions which contain types bound only at runtime to be evaluated for validity checking.

value = None
The value of the variable. The following representations are used for values of single cardinality:

NULL value Represented by None

boolean One of the built-in Python values True and False

directedPair A tuple of strings (<source identifier>, <destination identifier>)

duration real number of seconds

file a file like object (supporting seek)

float real number

identifier A text string

integer A plain python integer (QTI does not support long integer values)

pair A *sorted* tuple of strings (<identifier A>, <identifier B>). We sort the identifiers in a pair by python's native string sorting to ensure that pair values are comparable.

point A tuple of integers (<x-coordinate>, <y-coordinate>)

string A python string

uri An instance of *URI*

For containers, we use the following structures:

ordered A list of one of the above value types.

multiple: A dictionary with keys that are one of the above value types and values that indicate the frequency of that value in the container.

record: A dictionary with keys that are the field identifiers and values that Value instances.

SetValue(*value*)
Sets the value.

All single values can be set from a single text string corresponding to their XML schema defined lexical values (*without* character level escaping). If v is a single Value instance then the following always leaves v unchanged:

```
v.SetValue(unicode(v))
```

Value instances can also be set from values of the appropriate type as described in *value*. For base types that are represented with tuples we also accept and convert lists.

Containers values cannot be set from strings.

ValueError(*value*)
Raises a ValueError with a debug-friendly message string.

Cardinality()
Returns the cardinality of this value. One of the *Cardinality* constants.

By default we return None - indicating unknown cardinality. This can only be the case if the value is a NULL.

IsNull()
Returns True is this value is NULL, as defined by the QTI specification.

classmethod NewValue(*cardinality*, *baseType=None*)
Creates a new value instance with *cardinality* and *baseType*.

classmethod CopyValue(*value*)
Creates a new value instance copying *value*.

class pyslet.qtiv2.variables.**SingleValue**
Bases: *pyslet.qtiv2.variables.Value*

Represents all values with single cardinality.

classmethod NewValue(*baseType*, *value=None*)
Creates a new instance of a single value with *baseType* and *value*

class pyslet.qtiv2.variables.**BooleanValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.SingleValue*

Represents single values of type BaseType.boolean.

SetValue(*value*)
If value is a string it will be decoded according to the rules for representing boolean values. Booleans and integers can be used directly in the normal python way but other values will raise ValueError. To take advantage of a non-zero test you must explicitly force it to be a boolean. For example:

```
# x is a value of unknown type with non-zero test implemented
v=BooleanValue()
v.SetValue(True if x else False)
```

class pyslet.qtiv2.variables.**DirectedPairValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.SingleValue*

Represents single values of type BaseType.directedPair.

SetValue(*value*, *nameCheck=False*)
See comment on Identifier.SetValue() for usage of *nameCheck*.

Note that if value is a string then nameCheck is ignored and identifier validation is always performed.

class pyslet.qtiv2.variables.**DurationValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.FloatValue*

Represents single value of type BaseType.duration.

class pyslet.qtiv2.variables.**FileValue**
Bases: *pyslet.qtiv2.variables.SingleValue*

Represents single value of type BaseType.file.

contentType = None
The content type of the file, a *pyslet.http.params.MediaType* instance.

file_name = None
The file name to use for the file.

SetValue(*value*, *type='application/octet-stream'*, *name='data.bin'*)
Sets a file value from a file like object or a string.

There are some important and subtle distinctions in this method.

If value is a Unicode text string then it is parsed according to the MIME-like format defined in the QTI specification. The values of *type* and *name* are only used as defaults if those values cannot be read from the value's headers.

If value is a plain string then it is assumed to represent the file's data directly, *type* and *name* are used to interpret the data. Other file type objects are set in the same way.

class pyslet.qtiv2.variables.**FloatValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.SingleValue*

Represents single value of type BaseType.float.

SetValue(*value*)
This method will *not* convert integers to float values, you must do this explicitly if you want automatic conversion, for example

```
# x is a numeric value that may be float or integer
v=FloatValue()
v.SetValue(float(x))
```

class pyslet.qtiv2.variables.**IdentifierValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.SingleValue*

Represents single value of type BaseType.identifier.

SetValue(*value*, *nameCheck=True*)
In general, to speed up computation we do not check the validity of identifiers unless parsing the value from a string representation (such as a value read from an XML input document).

As values of baseType identifier are represented natively as strings we cannot tell if this method is being called with an existing, name-checked value or a new value being parsed from an external source. To speed up computation you can suppress the name check in the first case by setting *nameCheck* to False (the default is True).

class pyslet.qtiv2.variables.**IntegerValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.SingleValue*

Represents single value of type BaseType.integer.

SetValue(*value*)
Note that integers and floats are distinct types in QTI: we do not accept floats where we would expect integers or *vice versa*. However, integers are accepted from long or plain integer values provided they are within the ranges specified in the QTI specification: -2147483648...2147483647.

class pyslet.qtiv2.variables.**PairValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.DirectedPairValue*

Represents single values of type BaseType.pair.

SetValue(*value*, *nameCheck=True*)
Overrides DirectedPair's implementation to force a predictable ordering on the identifiers.

class pyslet.qtiv2.variables.**PointValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.SingleValue*

Represents single value of type BaseType.point.

class pyslet.qtiv2.variables.**StringValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.SingleValue*

Represents single value of type BaseType.string.

class pyslet.qtiv2.variables.**URIValue**(*value=None*)
Bases: *pyslet.qtiv2.variables.SingleValue*

Represents single value of type BaseType.uri.

SetValue(*value*)
Sets a uri value from a string or another URI instance.

class pyslet.qtiv2.variables.**Container**(*baseType=None*)
Bases: *pyslet.qtiv2.variables.Value*

An abstract class for all container types.

By default containers are empty (and are treated as NULL values). You can force the type of an empty container by passing a baseType constant to the constructor. This will cause the container to generate TypeError if used in a context where the specified baseType is not allowed.

GetValues()
Returns an iterable of the container's values.

classmethod NewValue(*cardinality*, *baseType=None*)
Creates a new container with *cardinality* and *baseType*.

class pyslet.qtiv2.variables.**OrderedContainer**(*baseType=None*)
Bases: *pyslet.qtiv2.variables.Container*

Represents containers with ordered *Cardinality*.

SetValue(*value*, *baseType=None*)
Sets the value of this container from a list, tuple or other iterable. The list must contain valid representations of *baseType*, items may be None indicating a NULL value in the list. In accordance with the specification's multiple operator NULL values are ignored.

If the input list of values empty, or contains only NULL values then the resulting container is empty.

If *baseType* is None the base type specified when the container was constructed is assumed.

GetValues()
Returns an iterable of values in the ordered container.

class pyslet.qtiv2.variables.**MultipleContainer**(*baseType=None*)
Bases: *pyslet.qtiv2.variables.Container*

Represents containers with multiple *Cardinality*.

SetValue(*value*, *baseType=None*)
Sets the value of this container from a list, tuple or other iterable. The list must contain valid representations of *baseType*, items may be None indicating a NULL value in the list. In accordance with the specification's multiple operator NULL values are ignored.

If the input list of values is empty, or contains only NULL values then the resulting container is empty.

If *baseType* is None the base type specified when the container was constructed is assumed.

GetValues()
Returns an iterable of values in the ordered container.

class pyslet.qtiv2.variables.**RecordContainer**
Bases: *pyslet.qtiv2.variables.Container*

Represents containers with record *Cardinality*.

SetValue(*value*)
Sets the value of this container from an existing dictionary in which the keys are the field identifiers and the values are *Value* instances. You cannot parse containers from strings.

Records are always treated as having a wild-card base type.

If the input *value* contains any keys which map to None or to a NULL value then these fields are omitted from the resulting value.

__getitem__(*fieldIdentifier*)
Returns the *Value* instance corresponding to *fieldIdentifier* or raises KeyError if there is no field with that name.

__setitem__(*fieldIdentifier*, *value*)
Sets the value in the named field to *value*.

We add some special behaviour here. If *value* is None or is a NULL value then we remove the field with the give name. In other words:

```
r=RecordContainer()
r['pi']=FloatValue(3.14)
r['pi']=FloatValue()      # a NULL value
print r['pi']             # raises KeyError
```

3.3.6 Response Processing

Generalized Response Processing

class pyslet.qtiv2.processing.**ResponseProcessing**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

Response processing is the process by which the Delivery Engine assigns outcomes based on the candidate's responses:

```
<xsd:attributeGroup name="responseProcessing.AttrGroup">
        <xsd:attribute name="template" type="uri.Type" use="optional"/>
        <xsd:attribute name="templateLocation" type="uri.Type" use="optional"/>
</xsd:attributeGroup>

<xsd:group name="responseProcessing.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="responseRule.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

Run(*state*)
Runs response processing using the values in *state*.

- *state* is an *ItemSessionState* instance.

class pyslet.qtiv2.processing.**ResponseRule**(*parent*, *name=None*)
Bases: *pyslet.qtiv2.core.QTIElement*

Abstract class to represent all response rules.

Run(*state*)
Abstract method to run this rule using the values in *state*.

class pyslet.qtiv2.processing.**ResponseCondition**(*parent*)
Bases: *pyslet.qtiv2.processing.ResponseRule*

If the expression given in a responseIf or responseElseIf evaluates to true then the sub-rules contained within it are followed and any following responseElseIf or responseElse parts are ignored for this response condition:

```
<xsd:group name="responseCondition.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="responseIf" minOccurs="1" maxOccurs="1"/>
                <xsd:element ref="responseElseIf" minOccurs="0" maxOccurs="unbounded"/>
                <xsd:element ref="responseElse" minOccurs="0" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**ResponseIf**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

A responseIf part consists of an expression which must have an effective baseType of boolean and single cardinality. If the expression is true then the sub-rules are processed, otherwise they are skipped (including if the expression is NULL):

```
<xsd:group name="responseIf.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
                <xsd:group ref="responseRule.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

Run(*state*)
Run this test and, if True, any resulting rules.

Returns *True* if the condition evaluated to *True*.

class pyslet.qtiv2.processing.**ResponseElseIf**(*parent*)
Bases: *pyslet.qtiv2.processing.ResponseIf*

Represents the responseElse element, see *ResponseIf*

```
<xsd:group name="responseElseIf.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
                <xsd:group ref="responseRule.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**ResponseElse**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

Represents the responseElse element, see *ResponseCondition*

```
<xsd:group name="responseElse.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="responseRule.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

Run(*state*)
Runs the sub-rules.

class pyslet.qtiv2.processing.**SetOutcomeValue**(*parent*)
Bases: *pyslet.qtiv2.processing.ResponseRule*

The setOutcomeValue rule sets the value of an outcome variable to the value obtained from the associated expression:

```
<xsd:attributeGroup name="setOutcomeValue.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="setOutcomeValue.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**StopProcessing**
Bases: *pyslet.qtiv2.core.QTIError*

Raised when a rule which stops processing is encountered.

class pyslet.qtiv2.processing.**ExitResponse**(*parent*, *name=None*)
Bases: *pyslet.qtiv2.processing.ResponseRule*

The exit response rule terminates response processing immediately (for this invocation). It does this by raising *StopProcessing*:

```
<xsd:complexType name="exitResponse.Type"/>
```

3.3.7 Template Processing

class pyslet.qtiv2.processing.**TemplateProcessing**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

Template processing consists of one or more templateRules that are followed by the cloning engine or delivery system in order to assign values to the template variables:

```
<xsd:group name="templateProcessing.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="templateRule.ElementGroup" minOccurs="1" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>

<xsd:complexType name="templateProcessing.Type" mixed="false">
        <xsd:group ref="templateProcessing.ContentGroup"/>
</xsd:complexType>
```

Run(*state*)
Runs template processing rules using the values in *state*.

- *state* is an *ItemSessionState* instance.

class pyslet.qtiv2.processing.**TemplateRule**(*parent*, *name=None*)
Bases: *pyslet.qtiv2.core.QTIElement*

Abstract class to represent all template rules.

Run(*state*)
Abstract method to run this rule using the values in *state*.

class pyslet.qtiv2.processing.**TemplateCondition**(*parent*)
Bases: *pyslet.qtiv2.processing.TemplateRule*

If the expression given in the templateIf or templateElseIf evaluates to true then the sub-rules contained within it are followed and any following templateElseIf or templateElse parts are ignored for this template condition:

```
<xsd:group name="templateCondition.ContentGroup">
        <xsd:sequence>
                <xsd:element ref="templateIf" minOccurs="1" maxOccurs="1"/>
                <xsd:element ref="templateElseIf" minOccurs="0" maxOccurs="unbounded"/>
                <xsd:element ref="templateElse" minOccurs="0" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**TemplateIf**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

A templateIf part consists of an expression which must have an effective baseType of boolean and single cardinality. If the expression is true then the sub-rules are processed, otherwise they are skipped (including if the expression is NULL):

```
<xsd:group name="templateIf.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
                <xsd:group ref="templateRule.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

Run(*state*)
Run this test and, if True, any resulting rules.

Returns *True* if the condition evaluated to *True*.

class pyslet.qtiv2.processing.**TemplateElseIf**(*parent*)
Bases: *pyslet.qtiv2.processing.TemplateIf*

Represents the templateElse element, see `templateIf`

```
<xsd:group name="templateElseIf.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
                <xsd:group ref="templateRule.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**TemplateElse**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

Represents the templateElse element, see *TemplateCondition*

```
<xsd:group name="templateElse.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="templateRule.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

Run(*state*)
Runs the sub-rules.

class pyslet.qtiv2.processing.**SetTemplateValue**(*parent*)
Bases: *pyslet.qtiv2.processing.TemplateRule*

The setTemplateValue rule sets the value of a template variable to the value obtained from the associated expression:

```
<xsd:attributeGroup name="setTemplateValue.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="setTemplateValue.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**SetCorrectResponse**(*parent*)
Bases: *pyslet.qtiv2.processing.TemplateRule*

The setCorrectResponse rule sets the correct value of a response variable to the value obtained from the associated expression:

```
<xsd:attributeGroup name="setCorrectResponse.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="setCorrectResponse.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**SetDefaultValue**(*parent*)
Bases: *pyslet.qtiv2.processing.TemplateRule*

The setDefaultValue rule sets the default value of a response or outcome variable to the value obtained from the associated expression:

```
<xsd:attributeGroup name="setDefaultValue.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="setDefaultValue.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**ExitTemplate**(*parent*, *name=None*)
Bases: *pyslet.qtiv2.processing.TemplateRule*

The exit template rule terminates template processing immediately. It does this by raising *StopProcessing*:

```
<xsd:complexType name="exitTemplate.Type"/>
```

3.3.8 Pre-conditions and Branching

class pyslet.qtiv2.processing.**TestPartCondition**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

Evaluate(*state*)
Evaluates the condition using the values in *state*.

- *state* is a *TestSessionState* instance.

class pyslet.qtiv2.processing.**PreCondition**(*parent*)
Bases: *pyslet.qtiv2.processing.TestPartCondition*

A preCondition is a simple expression attached to an assessmentSection or assessmentItemRef that must evaluate to true if the item is to be presented:

```
<xsd:group name="preCondition.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**BranchRule**(*parent*)
Bases: *pyslet.qtiv2.processing.TestPartCondition*

A branch-rule is a simple expression attached to an assessmentItemRef, assessmentSection or testPart that is evaluated after the item, section, or part has been presented to the candidate:

```
<xsd:attributeGroup name="branchRule.AttrGroup">
        <xsd:attribute name="target" type="identifier.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="branchRule.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.processing.**TemplateDefault**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

Overrides the default value of a template variable based on the test context in which the template is instantiated:

```
<xsd:attributeGroup name="templateDefault.AttrGroup">
        <xsd:attribute name="templateIdentifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="templateDefault.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

Run(*itemState*, *testState*)
Updates the value of a template variable in *itemState* based on the values in *testState*.

3.3.9 Expressions

class pyslet.qtiv2.expressions.**Expression**(*parent*, *name=None*)
Bases: *pyslet.qtiv2.core.QTIElement*

Abstract class for all expression elements.

Evaluate(*state*)
Evaluates this expression in the context of the session *state*.

IntegerOrTemplateRef(*state*, *value*)
Given a value of type integerOrTemplateRef this method returns the corresponding integer by looking up the value, if necessary, in *state*. If value is a variable reference to a variable with NULL value then None is returned.

FloatOrTemplateRef(*state*, *value*)
Given a value of type floatOrTemplateRef this method returns the corresponding float by looking up the value, if necessary, in *state*. If value is a variable reference to a variable with NULL value then None is returned.

StringOrTemplateRef(*state*, *value*)
Given a value of type stringOrTemplateRef this method returns the corresponding string by looking up the value, if necessary, in *state*. If value is a variable reference to a variable with NULL value then None is returned. Note that unlike the integer and float expansions this expansion will not raise an error if *value* is a syntactically valid reference to a non-existent template variable, as per this condition in the specification.

> "if a string attribute appears to be a reference to a template variable but there is no variable with the given name it should be treated simply as string value"

class pyslet.qtiv2.expressions.**NOperator**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

An abstract class to help implement operators which take multiple sub-expressions.

EvaluateChildren(*state*)
Evaluates all child expressions, returning an iterable of `Value` instances.

class pyslet.qtiv2.expressions.**UnaryOperator**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

An abstract class to help implement unary operators.

Built-in General Expressions

class pyslet.qtiv2.expressions.**BaseValue**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

The simplest expression returns a single value from the set defined by the given baseType

```
<xsd:attributeGroup name="baseValue.AttrGroup">
        <xsd:attribute name="baseType" type="baseType.Type" use="required"/>
</xsd:attributeGroup>

<xsd:complexType name="baseValue.Type">
        <xsd:simpleContent>
                <xsd:extension base="xsd:string">
                        <xsd:attributeGroup ref="baseValue.AttrGroup"/>
                </xsd:extension>
        </xsd:simpleContent>
</xsd:complexType>
```

class pyslet.qtiv2.expressions.**Variable**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

This expression looks up the value of an itemVariable that has been declared in a corresponding variableDeclaration or is one of the built-in variables:

```
<xsd:attributeGroup name="variable.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
        <xsd:attribute name="weightIdentifier" type="identifier.Type" use="optional"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.expressions.**Default**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

This expression looks up the declaration of an itemVariable and returns the associated defaultValue or NULL if no default value was declared:

```
<xsd:attributeGroup name="default.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.expressions.**Correct**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

This expression looks up the declaration of a response variable and returns the associated correctResponse or NULL if no correct value was declared:

```
<xsd:attributeGroup name="correct.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.expressions.**MapResponse**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

This expression looks up the value of a response variable and then transforms it using the associated mapping, which must have been declared. The result is a single float:

```
<xsd:attributeGroup name="mapResponse.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.expressions.**MapResponsePoint**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

This expression looks up the value of a response variable that must be of base-type point, and transforms it using the associated areaMapping:

```
<xsd:attributeGroup name="mapResponsePoint.AttrGroup">
        <xsd:attribute name="identifier" type="identifier.Type" use="required"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.expressions.**Null**(*parent*, *name=None*)
Bases: *pyslet.qtiv2.expressions.Expression*

null is a simple expression that returns the NULL value - the null value is treated as if it is of any desired baseType

```
<xsd:complexType name="null.Type"/>
```

class pyslet.qtiv2.expressions.**RandomInteger**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

Selects a random integer from the specified range [min,max] satisfying min + step * n for some integer n:

```
<xsd:attributeGroup name="randomInteger.AttrGroup">
        <xsd:attribute name="min" type="integerOrTemplateRef.Type" use="required"/>
        <xsd:attribute name="max" type="integerOrTemplateRef.Type" use="required"/>
        <xsd:attribute name="step" type="integerOrTemplateRef.Type" use="optional"/>
</xsd:attributeGroup>
```

class pyslet.qtiv2.expressions.**RandomFloat**(*parent*)
Bases: *pyslet.qtiv2.expressions.Expression*

Selects a random float from the specified range [min,max]

```
<xsd:attributeGroup name="randomFloat.AttrGroup">
        <xsd:attribute name="min" type="floatOrTemplateRef.Type" use="required"/>
        <xsd:attribute name="max" type="floatOrTemplateRef.Type" use="required"/>
</xsd:attributeGroup>
```

Expressions Used only in Outcomes Processing

Operators

class pyslet.qtiv2.expressions.**Multiple**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The multiple operator takes 0 or more sub-expressions all of which must have either single or multiple cardinality:

```
<xsd:group name="multiple.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**Ordered**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The multiple operator takes 0 or more sub-expressions all of which must have either single or multiple cardinality:

```
    <xsd:group name="ordered.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**ContainerSize**(*parent*)
Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The containerSize operator takes a sub-expression with any base-type and either multiple or ordered cardinality:

```
    <xsd:group name="containerSize.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**IsNull**(*parent*)
Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The isNull operator takes a sub-expression with any base-type and cardinality

```
    <xsd:group name="isNull.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Index**(*parent*)
Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The index operator takes a sub-expression with an ordered container value and any base-type

```
    <xsd:attributeGroup name="index.AttrGroup">
            <xsd:attribute name="n" type="integer.Type" use="required"/>
    </xsd:attributeGroup>

    <xsd:group name="index.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**FieldValue**(*parent*)
Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The field-value operator takes a sub-expression with a record container value. The result is the value of the field with the specified fieldIdentifier:

```
    <xsd:attributeGroup name="fieldValue.AttrGroup">
            <xsd:attribute name="fieldIdentifier" type="identifier.Type" use="required"/>
    </xsd:attributeGroup>

    <xsd:group name="fieldValue.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Random**(*parent*)
Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The random operator takes a sub-expression with a multiple or ordered container value and any base-type. The result is a single value randomly selected from the container:

```
<xsd:group name="random.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**Member**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The member operator takes two sub-expressions which must both have the same base-type. The first sub-expression must have single cardinality and the second must be a multiple or ordered container. The result is a single boolean with a value of true if the value given by the first sub-expression is in the container defined by the second sub-expression:

```
<xsd:group name="member.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**Delete**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The delete operator takes two sub-expressions which must both have the same base-type. The first sub-expression must have single cardinality and the second must be a multiple or ordered container. The result is a new container derived from the second sub-expression with all instances of the first sub-expression removed:

```
<xsd:group name="delete.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**Contains**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The contains operator takes two sub-expressions which must both have the same base-type and cardinality – either multiple or ordered. The result is a single boolean with a value of true if the container given by the first sub-expression contains the value given by the second sub-expression and false if it doesn't:

```
<xsd:group name="contains.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**SubString**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The substring operator takes two sub-expressions which must both have an effective base-type of string and single cardinality. The result is a single boolean with a value of true if the first expression is a substring of the second expression and false if it isn't:

```
<xsd:attributeGroup name="substring.AttrGroup">
        <xsd:attribute name="caseSensitive" type="boolean.Type" use="required"/>
</xsd:attributeGroup>
```

```
    <xsd:group name="substring.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Not**(*parent*)

Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The not operator takes a single sub-expression with a base-type of boolean and single cardinality. The result is a single boolean with a value obtained by the logical negation of the sub-expression's value:

```
    <xsd:group name="not.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**And**(*parent*)

Bases: *pyslet.qtiv2.expressions.NOperator*

The and operator takes one or more sub-expressions each with a base-type of boolean and single cardinality. The result is a single boolean which is true if all sub-expressions are true and false if any of them are false:

```
    <xsd:group name="and.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Or**(*parent*)

Bases: *pyslet.qtiv2.expressions.NOperator*

The or operator takes one or more sub-expressions each with a base-type of boolean and single cardinality. The result is a single boolean which is true if any of the sub-expressions are true and false if all of them are false:

```
    <xsd:group name="or.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**AnyN**(*parent*)

Bases: *pyslet.qtiv2.expressions.NOperator*

The anyN operator takes one or more sub-expressions each with a base-type of boolean and single cardinality. The result is a single boolean which is true if at least min of the sub-expressions are true and at most max of the sub-expressions are true:

```
    <xsd:attributeGroup name="anyN.AttrGroup">
            <xsd:attribute name="min" type="integerOrTemplateRef.Type" use="required"/>
            <xsd:attribute name="max" type="integerOrTemplateRef.Type" use="required"/>
    </xsd:attributeGroup>

    <xsd:group name="anyN.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Match**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The match operator takes two sub-expressions which must both have the same base-type and cardinality. The result is a single boolean with a value of true if the two expressions represent the same value and false if they do not:

```
<xsd:group name="match.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**StringMatch**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The stringMatch operator takes two sub-expressions which must have single and a base-type of string. The result is a single boolean with a value of true if the two strings match:

```
<xsd:attributeGroup name="stringMatch.AttrGroup">
        <xsd:attribute name="caseSensitive" type="boolean.Type" use="required"/>
        <xsd:attribute name="substring" type="boolean.Type" use="optional"/>
</xsd:attributeGroup>

<xsd:group name="stringMatch.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**PatternMatch**(*parent*)
Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The patternMatch operator takes a sub-expression which must have single cardinality and a base-type of string. The result is a single boolean with a value of true if the sub-expression matches the regular expression given by pattern and false if it doesn't:

```
<xsd:attributeGroup name="patternMatch.AttrGroup">
        <xsd:attribute name="pattern" type="stringOrTemplateRef.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="patternMatch.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**Equal**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The equal operator takes two sub-expressions which must both have single cardinality and have a numerical base-type. The result is a single boolean with a value of true if the two expressions are numerically equal and false if they are not:

```
<xsd:attributeGroup name="equal.AttrGroup">
        <xsd:attribute name="toleranceMode" type="toleranceMode.Type" use="required"/>
        <xsd:attribute name="tolerance" use="optional">
                <xsd:simpleType>
                        <xsd:list itemType="floatOrTemplateRef.Type"/>
                </xsd:simpleType>
```

```
            </xsd:attribute>
            <xsd:attribute name="includeLowerBound" type="boolean.Type" use="optional"/>
            <xsd:attribute name="includeUpperBound" type="boolean.Type" use="optional"/>
    </xsd:attributeGroup>

    <xsd:group name="equal.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**ToleranceMode**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

When comparing two floating point numbers for equality it is often desirable to have a tolerance to ensure that spurious errors in scoring are not introduced by rounding errors. The tolerance mode determines whether the comparison is done exactly, using an absolute range or a relative range:

```
    <xsd:simpleType name="toleranceMode.Type">
            <xsd:restriction base="xsd:NMTOKEN">
                    <xsd:enumeration value="absolute"/>
                    <xsd:enumeration value="exact"/>
                    <xsd:enumeration value="relative"/>
            </xsd:restriction>
    </xsd:simpleType>
```

Defines constants for the above modes. Usage example:

```
    ToleranceMode.exact
```

The default value is exact:

```
    ToleranceMode.DEFAULT == ToleranceMode.exact
```

For more methods see *Enumeration*

class pyslet.qtiv2.expressions.**EqualRounded**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The equalRounded operator takes two sub-expressions which must both have single cardinality and have a numerical base-type. The result is a single boolean with a value of true if the two expressions are numerically equal after rounding and false if they are not:

```
    <xsd:attributeGroup name="equalRounded.AttrGroup">
            <xsd:attribute name="roundingMode" type="roundingMode.Type" use="required"/>
            <xsd:attribute name="figures" type="integerOrTemplateRef.Type" use="required"/>
    </xsd:attributeGroup>

    <xsd:group name="equalRounded.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**RoundingMode**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Numbers are rounded to a given number of significantFigures or decimalPlaces:

```
    <xsd:simpleType name="roundingMode.Type">
            <xsd:restriction base="xsd:NMTOKEN">
```

```
                <xsd:enumeration value="decimalPlaces"/>
                <xsd:enumeration value="significantFigures"/>
        </xsd:restriction>
</xsd:simpleType>
```

Defines constants for the above modes. Usage example:

```
RoundingMode.decimalPlaces
```

The default value is significantFigures:

```
RoundingMode.DEFAULT == RoundingMode.significantFigures
```

For more methods see *Enumeration*

class pyslet.qtiv2.expressions.**Inside**(*parent*)

Bases: *pyslet.qtiv2.expressions.UnaryOperator*, pyslet.qtiv2.core.ShapeElementMixin

The inside operator takes a single sub-expression which must have a baseType of point. The result is a single boolean with a value of true if the given point is inside the area defined by shape and coords. If the sub-expression is a container the result is true if any of the points are inside the area:

```
<xsd:attributeGroup name="inside.AttrGroup">
        <xsd:attribute name="shape" type="shape.Type" use="required"/>
        <xsd:attribute name="coords" type="coords.Type" use="required"/>
</xsd:attributeGroup>

<xsd:group name="inside.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**LT**(*parent*)

Bases: *pyslet.qtiv2.expressions.NOperator*

The lt operator takes two sub-expressions which must both have single cardinality and have a numerical base-type. The result is a single boolean with a value of true if the first expression is numerically less than the second and false if it is greater than or equal to the second:

```
<xsd:group name="lt.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**GT**(*parent*)

Bases: *pyslet.qtiv2.expressions.NOperator*

The gt operator takes two sub-expressions which must both have single cardinality and have a numerical base-type. The result is a single boolean with a value of true if the first expression is numerically greater than the second and false if it is less than or equal to the second:

```
<xsd:group name="gt.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**LTE**(*parent*)

Bases: *pyslet.qtiv2.expressions.NOperator*

The lte operator takes two sub-expressions which must both have single cardinality and have a numerical base-type. The result is a single boolean with a value of true if the first expression is numerically less than or equal to the second and false if it is greater than the second:

```
<xsd:group name="lte.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**GTE**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The gte operator takes two sub-expressions which must both have single cardinality and have a numerical base-type. The result is a single boolean with a value of true if the first expression is numerically less than or equal to the second and false if it is greater than the second:

```
<xsd:group name="durationGTE.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**DurationLT**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The durationLT operator takes two sub-expressions which must both have single cardinality and base-type duration. The result is a single boolean with a value of true if the first duration is shorter than the second and false if it is longer than (or equal) to the second:

```
<xsd:group name="durationLT.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**DurationGTE**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The durationGTE operator takes two sub-expressions which must both have single cardinality and base-type duration. The result is a single boolean with a value of true if the first duration is longer (or equal, within the limits imposed by truncation) than the second and false if it is shorter than the second:

```
<xsd:group name="durationGTE.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
        </xsd:sequence>
</xsd:group>
```

class pyslet.qtiv2.expressions.**Sum**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The sum operator takes 1 or more sub-expressions which all have single cardinality and have numerical base-types. The result is a single float or, if all sub-expressions are of integer type, a single integer that corresponds to the sum of the numerical values of the sub-expressions:

```
<xsd:group name="sum.ContentGroup">
        <xsd:sequence>
                <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="unbounded"/>
```

```
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Product**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The product operator takes 1 or more sub-expressions which all have single cardinality and have numerical base-types. The result is a single float or, if all sub-expressions are of integer type, a single integer that corresponds to the product of the numerical values of the sub-expressions:

```
    <xsd:group name="product.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Subtract**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The subtract operator takes 2 sub-expressions which all have single cardinality and numerical base-types. The result is a single float or, if both sub-expressions are of integer type, a single integer that corresponds to the first value minus the second:

```
    <xsd:group name="subtract.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Divide**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The divide operator takes 2 sub-expressions which both have single cardinality and numerical base-types. The result is a single float that corresponds to the first expression divided by the second expression:

```
    <xsd:group name="divide.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Power**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The power operator takes 2 sub-expression which both have single cardinality and numerical base-types. The result is a single float that corresponds to the first expression raised to the power of the second:

```
    <xsd:group name="power.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**IntegerDivide**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The integer divide operator takes 2 sub-expressions which both have single cardinality and base-type integer. The result is the single integer that corresponds to the first expression (x) divided by the second expression (y) rounded down to the greatest integer (i) such that i<=(x/y):

```
    <xsd:group name="integerDivide.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**IntegerModulus**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The integer modulus operator takes 2 sub-expressions which both have single cardinality and base-type integer. The result is the single integer that corresponds to the remainder when the first expression (x) is divided by the second expression (y). If z is the result of the corresponding integerDivide operator then the result is x-z*y:

```
    <xsd:group name="integerModulus.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="2" maxOccurs="2"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Truncate**(*parent*)
Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The truncate operator takes a single sub-expression which must have single cardinality and base-type float. The result is a value of base-type integer formed by truncating the value of the sub-expression towards zero:

```
    <xsd:group name="truncate.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**Round**(*parent*)
Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The round operator takes a single sub-expression which must have single cardinality and base-type float. The result is a value of base-type integer formed by rounding the value of the sub-expression. The result is the integer n for all input values in the range [n-0.5,n+0.5):

```
    <xsd:group name="round.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**IntegerToFloat**(*parent*)
Bases: *pyslet.qtiv2.expressions.UnaryOperator*

The integer to float conversion operator takes a single sub-expression which must have single cardinality and base-type integer. The result is a value of base type float with the same numeric value:

```
    <xsd:group name="integerToFloat.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="1" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

class pyslet.qtiv2.expressions.**CustomOperator**(*parent*)
Bases: *pyslet.qtiv2.expressions.NOperator*

The custom operator provides an extension mechanism for defining operations not currently supported by this specification:

```
    <xsd:attributeGroup name="customOperator.AttrGroup">
            <xsd:attribute name="class" type="identifier.Type" use="optional"/>
            <xsd:attribute name="definition" type="uri.Type" use="optional"/>
            <xsd:anyAttribute namespace="##other"/>
    </xsd:attributeGroup>

    <xsd:group name="customOperator.ContentGroup">
            <xsd:sequence>
                    <xsd:group ref="expression.ElementGroup" minOccurs="0" maxOccurs="unbounded"/>
            </xsd:sequence>
    </xsd:group>
```

3.3.10 Core Types and Utilities

This module contains a number core classes used to support the standard.

Constants

pyslet.qtiv2.core.**IMSQTI_NAMESPACE = 'http://www.imsglobal.org/xsd/imsqti_v2p1'**
The namespace used to recognise elements in XML documents.

pyslet.qtiv2.core.**IMSQTI_SCHEMALOCATION = 'http://www.imsglobal.org/xsd/imsqti_v2p1.xsd'**
The location of the QTI 2.1 schema file on the IMS website.

pyslet.qtiv2.core.**IMSQTI_ITEM_RESOURCETYPE = 'imsqti_item_xmlv2p1'**
The resource type to use for the QTI 2.1 items when added to content packages.

XML Basics

class pyslet.qtiv2.core.**QTIElement**(*parent*, *name=None*)
Bases: pyslet.xmlnames20091208.XMLNSElement

Basic element to represent all QTI elements

AddToCPResource(*cp*, *resource*, *beenThere*)
We need to add any files with URL's in the local file system to the content package.

beenThere is a dictionary we use for mapping URLs to File objects so that we don't keep adding the same linked resource multiple times.

This implementation is a little more horrid, we avoid circular module references by playing dumb about our children. HTML doesn't actually know anything about QTI even though QTI wants to define children for some XHTML elements so we pass the call only to "CP-Aware" elements.

class pyslet.qtiv2.core.**QTIDocument**(***args*)
Bases: pyslet.xmlnames20091208.XMLNSDocument

Used to represent all documents representing information from the QTI v2 specification.

AddToContentPackage(*cp*, *metadata*, *dName=None*)
Copies this QTI document into a content package and returns the resource ID used.

An optional directory name can be specified in which to put the resource files.

Exceptions

class pyslet.qtiv2.core.**QTIError**
Bases: exceptions.Exception

Abstract class used for all QTI v2 exceptions.

class pyslet.qtiv2.core.**DeclarationError**
Bases: *pyslet.qtiv2.core.QTIError*

Error raised when a variable declaration is invalid.

class pyslet.qtiv2.core.**ProcessingError**
Bases: *pyslet.qtiv2.core.QTIError*

Error raised when an invalid processing element is encountered.

class pyslet.qtiv2.core.**SelectionError**
Bases: *pyslet.qtiv2.core.QTIError*

Error raised when there is a problem with creating test forms.

Basic Data Types

Basic data types in QTI v2 are a mixture of custom types and basic types defined externally, for example, by XMLSchema.

The external types used are:

boolean Represented by python's boolean values True and False. See *DecodeBoolean()* and *EncodeBoolean()*

coords Defined as part of support for HTML. See *Coords*

date Although QTI draws on the definitions in XML schema it restricts values to those from the nontimezoned timeline. This restriction is effectively implemented in the basic *Date* class.

datetime: See *DecodeDateTime()* and *EncodeDateTime()*

duration: Earlier versions of QTI drew on the ISO8601 representation of duration but QTI v2 simplifies this with a basic representation in seconds bound to XML Schema's double type which we, in turn, represent with python's float. See *DecodeDouble()* and *EncodeDouble()*

float: implemented by python's float. Note that this is defined as having "machine-level double precision" and the python specification goes on to warn that "You are at the mercy of the underlying machine architecture". See *DecodeDouble()* and *EncodeDouble()*

identifier: represented by python's (unicode) string. The type is effectively just the NCName from the XML namespace specification. See pyslet.xmlnames20091208.IsValidNCName().

pyslet.qtiv2.core.**ValidateIdentifier**(*value*, *prefix='_'*)
Decodes an identifier from a string:

```
<xsd:simpleType name="identifier.Type">
        <xsd:restriction base="xsd:NCName"/>
</xsd:simpleType>
```

This function takes a string that is supposed to match the production for NCName in XML and forces it to comply by replacing illegal characters with '_', except the ':' which is replaced with a hyphen for compatibility with previous versions of the QTI migraiton script. If name starts with a valid name character but not a valid name start character, it is prefixed with '_' too, but the prefix string used can be overridden.

integer: XML schema's integer, implemented by python's integer. See *DecodeInteger()* and *EncodeInteger()*

language: Currently implemented as a simple python string.

length: Defined as part of support for HTML. See *LengthType*

mimeType: Currently implemented as a simple python string

string: XML schema string becomes python's unicode string

string256: Length restriction not yet implemented, see string above.

styleclass: Inherited from HTML, implemented with a simple (unicode) string.

uri: In some instances this is implemented as a simple (unicode) string, for example, in cases where a URI is being used as global identifier. In contexts where the URI will need to be interpreted it is implemented with instances of *pyslet.rfc2396.URI*.

QTI-specific types:

class pyslet.qtiv2.core.**Orientation**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Orientation attribute values provide a hint to rendering systems that an element has an inherent vertical or horizontal interpretation:

```
<xsd:simpleType name="orientation.Type">
        <xsd:restriction base="xsd:NMTOKEN">
                <xsd:enumeration value="horizontal"/>
                <xsd:enumeration value="vertical"/>
        </xsd:restriction>
</xsd:simpleType>
```

Defines constants for the above orientations. Usage example:

```
Orientation.horizontal
```

Note that:

```
Orientation.DEFAULT == None
```

For more methods see *Enumeration*

class pyslet.qtiv2.core.**Shape**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

A value of a shape is always accompanied by coordinates and an associated image which provides a context for interpreting them:

```
<xsd:simpleType name="shape.Type">
        <xsd:restriction base="xsd:NMTOKEN">
                <xsd:enumeration value="circle"/>
                <xsd:enumeration value="default"/>
                <xsd:enumeration value="ellipse"/>
                <xsd:enumeration value="poly"/>
                <xsd:enumeration value="rect"/>
        </xsd:restriction>
</xsd:simpleType>
```

Defines constants for the above types of Shape. Usage example:

```
Shape.circle
```

Note that:

```
Shape.DEFAULT == Shape.default
```

For more methods see *Enumeration*

class pyslet.qtiv2.core.**ShowHide**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Used to control content visibility with variables

```
<xsd:simpleType name="showHide.Type">
        <xsd:restriction base="xsd:NMTOKEN">
                <xsd:enumeration value="hide"/>
                <xsd:enumeration value="show"/>
        </xsd:restriction>
</xsd:simpleType>
```

Note that ShowHide.DEFAULT == ShowHide.show

class pyslet.qtiv2.core.**View**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

Used to represent roles when restricting view:

```
<xsd:simpleType name="view.Type">
        <xsd:restriction base="xsd:NMTOKEN">
                <xsd:enumeration value="author"/>
                <xsd:enumeration value="candidate"/>
                <xsd:enumeration value="proctor"/>
                <xsd:enumeration value="scorer"/>
                <xsd:enumeration value="testConstructor"/>
                <xsd:enumeration value="tutor"/>
        </xsd:restriction>
</xsd:simpleType>
```

Defines constants for the above views. Usage example:

```
View.candidate
```

There is no default view. Views are represented in XML as space-separated lists of values. Typical usage:

```
view=View.DecodeValueDict("tutor scorer")
# returns...
{ View.tutor:'tutor', View.scorer:'scorer' }
View.EncodeValueDict(view)
# returns...
"scorer tutor"
```

For more methods see *Enumeration*

The QTI specification lists valueType as a basic data type. In pyslet this is implemented as a core part of the processing model. See *pyslet.qtiv2.variables.Value* for details.

3.3.11 Meta-data and Usage Data

class pyslet.qtiv2.metadata.**QTIMetadata**(*parent*)
Bases: *pyslet.qtiv2.core.QTIElement*

A new category of meta-data for the recording of QTI specific information. It is designed to be treated as an additional top-level category to augment the LOM profile:

```
    <xsd:group name="qtiMetadata.ContentGroup">
            <xsd:sequence>
                    <xsd:element ref="itemTemplate" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="timeDependent" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="composite" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="interactionType" minOccurs="0" maxOccurs="unbounded"/>
                    <xsd:element ref="feedbackType" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="solutionAvailable" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="toolName" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="toolVersion" minOccurs="0" maxOccurs="1"/>
                    <xsd:element ref="toolVendor" minOccurs="0" maxOccurs="1"/>
            </xsd:sequence>
    </xsd:group>
```

3.4 IMS Basic Learning Tools Interoperability (version 1.0)

The IMS Basic Learning Tools Interoperability (BLTI) specification was released in 2010. The purpose of the specification is to provide a link between tool consumers (such as Learning Management Systems and portals) and Tools (such as specialist assessment management systems). Official information about the specification is available from the IMS GLC under the general name LTI:

This module implements the Basic LTI specification documented in the Best Practice Guide

This module requires the oauthlib module to be installed. The oauthlib module is available from PyPi. This module is written from the point of view of the Tool Provider. There are a number of pre-defined classes to help you implement LTI in your own Python applications.

3.4.1 Classes

The *ToolProviderApp* class is a mini-web framework in itself which makes writing LTI tools much easier. The framework does *not* include a page templating language but it should be easy to integrate with your templating system of choice.

Instances of ToolProviderApp are callable objects that support the WSGI protocol for ease of integration into a wide variety of deployment scenarios.

The base class implementation takes care of many aspects of your LTI tool:

1. Application settings are read from a JSON-encoded settings file.
2. Data storage is configured using one of the concrete implementations of Pyslet's own data access layer API. No SQL necessary in your code, minimising the risk of SQL injection vulnerabilities!
3. Session handling: the base class handles the setting of a session cookie and an initial set of redirects to ensure that cookies are being supported properly by the browser. If session handling is broken a fail page method is called. The session logic contains special measures to prevent common session-related attacks (such as session fixation, hijacking and cross-site request forgery) and the redirection sequence is designed to overcome limitaions imposed by broswer restrictions on third party cookies or P3P-related policy issues by providing a user-actionable flow, opening your tool in a new window if necessary. End user messages are customisable.
4. Launch authorisation is handled automatically, launch requests are checked using OAuth for validity and rejected automatically if invalid. Successful requests are automatically redirected to a resource-specific page.
5. Each resource is given its own path in your application of the form /<script.wsgi>/resource/<id>/ allowing you to spread your tool application across multiple pages if necessary. A special method, *ToolProviderApp.load_visit()*, is provided to extract the resource ID from the URL path and load

the corresponding entity from the data store. This method also loads the related entities for the the context, user and visit entities from the session according to the parameters passed in the original launch.

6. An overridable tool permission model is provided with a default implementation that provides read/write/configure permissions to Instructors (and sub-roles) and read permissions to Learners (and sub-roles). This enables your tool to simply test a permission bit at runtime to determine whether or not to display certain page elements.

7. Tools can be launched multiple times in the same browser session. Authorisations remain active allowing the user to interact with your tool in separate tabs or even in multiple iframes on the same page. Authorisations are automatically expired if a conflicting launch request is received. In other words, if a browser session receives a new launch from the same consumer but for a different user then all the previous user's activity is automatically logged out.

8. Consumer secrets can be encrypted when persisted in the data store using an application key. By default the application key is configured in the settings file. (The PyCrypto module is required for encryption.)

The *ToolConsumer* and *ToolProvider* classes are largely for internal use. You may want to use them if you are integrating the basic LTI functionality into a different web framework, they contain utility methods for reading information from the data store. You would use the *ToolProvider.launch()* method in your application when the user POSTs to your launch endpoint to check that the LTI launch has been authorised.

3.4.2 The Data Model

Implementing LTI requires some data storage to persist information between HTTP requests. This module is written using Pyslet's own data access layer, based on the concepts of OData. For more information see *The Open Data Protocol (OData)*.

A sample metadata file describing the required elements of the model is available as part of Pyslet itself. The entity sets (cf SQL Tables) it describes are as follows:

AppKeys This entity set is used to store information about encryption keys used to encrypt the consumer secrets in the data store. For more information see *pyslet.wsgi.WSGIDataApp*

Silos This entity set is the root of the information space for each tool. LTI tools tend to be multi-tenanted, that is, the same tool application can be used by multiple consumers with complete isolation between each consumer's data. The Silo provides this level of protection. Normally, each Silo will link to a single consumer but there may be cases where two or more consumers should share some data, in these cases a single Silo may link to multiple consumers.

Consumers This entity set contains information about the tool consumers. Each consumer is identified by a consumer key and access is protected using a consumer secret (which can be stored in an encrypted form in the data store).

Nonces LTI tools are launched from the consumer using OAuth. The protocol requires the use of a nonce (number used once only) to prevent the launch request being 'replayed' by an unauthorised person. This entity set is used to record which nonces have been used and when.

Resources The primary launch concept in LTI is the resource. Every launch must have a resource_link_id which identifies the specific 'place' or 'page' in which the tool has been placed.

Contexts LTI defines a context as an optional course or group-like organisation that provides context for a launch request. The context provides another potential scope for sharing data across launches.

Users An LTI launch is typically identifed with a specific user of the Tool Consumer (though this isn't required). Information about the users is recorded in the data store so that they can be associated with any data generated by the tool using simple extensions to the data model.

Visits Each time someone launches your tool a visit entity is created with information about the resource, the context and the user.

Sessions Used to store information about the browser session, see *pyslet.wsgi.SessionApp* for details. The basic session entity is extended to link to the visits that are active (i.e., currently authorised) for this session.

These entities are related using navigation properties enabling you to determine, for example, which Consumer a Resource belongs to, which Visits are active in a Session, and so on.

You can extend the core model by adding additional data properties (which should be nullable) or by adding optional navigation properties. For example, you might create an entity set to store information created by users of the tool and add a navigation property from the User entity to your new entity to indicate ownership. The sample Noticeboard application uses this technique and can be used as a guide.

Hello LTI

Writing your first LTI tool is easy:

```
from optparse import OptionParser
import pyslet.imsbltiv1p0 as lti

if __name__ == '__main__':
    parser = OptionParser()
    lti.ToolProviderApp.add_options(parser)
    (options, args) = parser.parse_args()
    lti.ToolProviderApp.setup(options, args)
    app = lti.ToolProviderApp()
    app.run_server()
```

Save this script as mytool.py and run it from the command line like this:

```
$ python mytool.py --help
```

Built-in to the WSGI base classes is support for running your tool from the command line during development. The script above just uses Python's builtin options parsing feature to set up the tool class before creating an instance (the WSGI callable object) and running a basic WSGI server using Python's builtin wsgiref module.

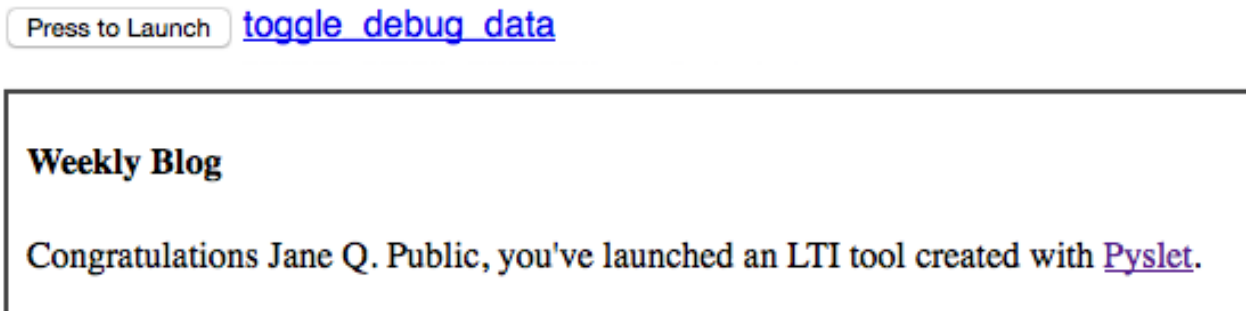
Try running your application with the -m and –create_silo options to use an in-memory SQLite data store and a default consumer.

    $ python mytool.py -m

The script may print a warning message to the console warning you that the in-memory database does not support multiple connections, it then just sits waiting for connections on the default port, 8080. The default consumer has key '12345' and secret 'secret' (these can be changed using a configuration file!). The launch URL for your running tool is:

```
http://localhost:8080/launch
```

If you try it in the IMS test consumer at: http://www.imsglobal.org/developers/LTI/test/v1p1/lms.php you should get something that looks a bit like this:



For a more complete example see the *NoticeBoard Sample LTI Tool*.

3.4.3 Reference

class pyslet.imsbltiv1p0.**ToolProviderApp**(***kwargs*)
Bases: *pyslet.wsgi.SessionApp*

Represents WSGI applications that provide LTI Tools

The key 'ToolProviderApp' is reserved for settings defined by this class in the settings file. The defined settings are:

silo ('testing') The name of a default silo to create when the –create_silo option is used.

key ('12345') The default consumer key created when –create_silo is used.

secret ('secret') The consumer secret of the default consumer created when –create_silo is used.

ContextClass
We have our own context class

alias of *ToolProviderContext*

SessionClass
We have our own LTI-specific Session class

alias of *ToolProviderSession*

classmethod add_options(*parser*)
Adds the following options:

--create_silo	create default silo and consumer

init_dispatcher()
Provides ToolProviderApp specific bindings.

This method adds bindings for /launch as the launch URL for the tool and all paths within /resource as the resource pages themselves.

set_launch_group(*context*)
Sets the group in the context from the launch parameters

set_launch_resource(*context*)
Sets the resource in the context from the launch parameters

set_launch_user(*context*)
Sets the user in the context from the launch parameters

set_launch_permissions(*context*)
Sets the permissions in the context from the launch params

READ_PERMISSION = 1
Permission bit mask representing 'read' permission

WRITE_PERMISSION = 2
Permission bit mask representing 'write' permission

CONFIGURE_PERMISSION = 4
Permission bit mask representing 'configure' permission

classmethod get_permissions(*role*)
Returns the permissions that apply to a single role

role A single URN instance

Specific LTI tools can override this method to provide more complex permission models. Each permission type is represented by an integer bit mask, permissions can be combined with binary or '|' to make an overal permissions integer. The default implementation uses the *READ_PERMISSION*, *WRITE_PERMISSION* and *CONFIGURE_PERMISSION* bit masks but you are free to use any values you wish.

In this implementation, Instructors (and all sub-roles) are granted read, write and configure whereas Learners (and all subroles) are granted read only. Any other role returns 0 (no permissions).

An LTI consumer can specify multiple roles on launch, this method is called for *each* role and the resulting permissions integers are combined to provide an overall permissions integer.

get_user_display_name(*context*, *user=None*)
Given a user entity, returns a display name

If user is None then the user from the context is used instead.

get_resource_title(*context*)
Given a resource entity, returns a display title

new_visit(*context*)
Called during launch to create a new visit entity

The visit entity is bound to the resource entity referred to in the launch and stores the permissions and a link to the (optional) user entity.

load_visit(*context*)
Loads an existing LTI visit into the context

You'll normally call this method from each session decorated method of your tool provider that applies to a protected resource.

This method sets the following attributes of the context...

ToolProviderContext.resource The resource record is identified from the resource id given in the URL path.

ToolProviderContext.visit The session is searched for a visit record matching the resource.

ToolProviderContext.permissions Set from the visit record

ToolProviderContext.user The optional user is loaded from the visit.

ToolProviderContext.group The context record identified from the resource id given in the URL path. This may be None if the resource link was not created in any context.

ToolProviderContext.consumer The consumer object is looked up from the visit entity.

If the visit can't be set then an exception is raised, an unknown resource raises *pyslet.wsgi.PageNotFound* whereas the absence of a valid visit for a known resource raises *pyslet.wsgi.PageNotAuthorized*. These are caught automatically by the WSGI handlers and return 404 and 403 errors respectively.

launch_redirect(*context*)
Redirects to the resource identified on launch

A POST request should pretty much always redirect to a GET page and our tool launches are no different. This allows you to reload a tool page straight away if desired without the risk of double-POST issues.

class pyslet.imsbltiv1p0.**ToolProviderSession**(*entity*)
Bases: *pyslet.wsgi.Session*

add_visit(*consumer*, *visit*)
Adds a visit entity to this session

This method creates a link from the current session entity to the visit entity. If the session entity already exists then the existing collection of linked visits is examined.

If a visit to the same resource is already associated with the entity is replaced. This ensures that information about the resource, the user, roles and permissions always corresponds to the most recent launch.

Any visits from the same consumer but with a different user are also removed. This handles the case where a previous user of the browser session needs to be logged out of the tool.

find_visit(*resource_id*)
Finds a visit that matches this resource_id

class pyslet.imsbltiv1p0.**ToolProviderContext**(*environ*, *start_response*)
Bases: *pyslet.wsgi.SessionContext*

consumer = None
a *ToolConsumer* instance identified from the launch

parameters = None
a dictionary of non-oauth parameters from the launch

visit = None
the effective visit entity

resource = None
the effective resource entity

user = None
the effective user entity

group = None
the effective group (context) entity

permissions = None
the effective permissions (an integer for bitwise testing)

class pyslet.imsbltiv1p0.**ToolConsumer**(*entity*, *cipher*)
Bases: object

An LTI consumer object

entity An *Entity* instance.

cipher An *AppCipher* instance.

This class is a light wrapper for the entity object that is used to persist information on the server about the consumer. The consumer is persisted in a data store using a single entity passed on construction which must have the following required properties:

ID: Int64 A database key for the consumer.

Handle: String A convenient handle for referring to this consumer in the user interface of the silo's owner. This handle is never exposed to users launching the tool through the LTI protocol. For example, you might use handles like "LMS Prod" and "LMS Staging" as handles to help distinguish different consumers.

Key: String The consumer key

Secret: String The consumer secret (encrypted using *cipher*).

Silo: Entity Required navigation property to the Silo this consumer is associated with.

Contexts: Entity Collection Navigation property to the associated contexts from which this tool has been launched.

Resources: Entity Collection Navigation property to the associated resources from which this tool has been launched.

Users: Entity Collection Navigation property to the associated users that have launched the tool.

entity = None
the entity that persists this consumer

cipher = None
the cipher used to

key = None
the consumer key

secret = None
the consumer secret

classmethod new_from_values(*entity*, *cipher*, *handle*, *key=None*, *secret=None*)
Create an instance from an new entity

entity An *Entity* instance from a suitable entity set.

cipher An *AppCipher* instance, used to encrypt the secret before storing it.

handle A string

key (optional) A string, defaults to a string generated with *generate_key()*

secret (optional) A string, defaults to a string generated with *generate_key()*

The fields of the entity are set from the passed in parameters (or the defaults) and then a new instance of *cls* is constructed from the entity and cipher and returned as a the result.

update_from_values(*handle*, *secret*)
Updates an instance from new values

handle A string used to update the consumer's handle

secret A string used to update the consumer's secret

It is not possible to update the consumer key as this is used to set the ID of the consumer itself.

nonce_key(*nonce*)
Returns a key into the nonce table

nonce A string received as a nonce during an LTI launch.

This method hashes the nonce, along with the consumer entity's *ID*, to return a hex digest string that can be used as a key for comparing against the nonces used in previous launches.

Mixing the consumer entity's *ID* into the hash reduces the chance of a collision between two nonces from separate consumers.

get_context(*context_id*, *title=None*, *label=None*, *ctypes=None*)
Returns a context entity

context_id The context_id string passed on launch

title (optional) The title string passed on launch

label (optional) The label string passed on launch

ctypes (optional) An array of *URI* instances representing the context types of this context. See *CONTEXT_TYPE_HANDLES* for more information.

Returns the context entity.

If this context has never been seen before then a new entity is created and bound to the consumer. Otherwise, the additional information (if supplied) is compared and updated as necessary.

get_resource(*resource_link_id*, *title=None*, *description=None*, *context=None*)
Returns a resource entity

resource_link_id The resource_link_id string passed on launch (required).

title (optional) The title string passed on launch, or None.

description (optional) The description string passed on launch, or None.

context (optional) The context entity referred to in the launch, or None.

If this resource has never been seen before then a new entity is created and bound to the consumer and (if specified) the context. Otherwise, the additional information (if supplied) is compared and updated as necessary, with the proviso that a resource can never change context, as per the following quote from the specification:

> [resource_link_id] will also change if the item is exported from one system or context and imported into another system or context.

get_user(*user_id*, *name_given=None*, *name_family=None*, *name_full=None*, *email=None*)
Returns a user entity

user_id The user_id string passed on launch

name_given The user's given name (or None)

name_family The user's family name (or None)

name_full The user's full name (or None)

email The user's email (or None)

If this user has never been seen before then a new entity is created and bound to the consumer, otherwise the

class pyslet.imsbltiv1p0.**ToolProvider**(*consumers*, *nonces*, *cipher*)
Bases: pyslet.imsbltiv1p0.OAuthMissing

An LTI tool provider object

consumers The *EntitySet* containing the tool *Consumers*.

nonces The *EntitySet* containing the used *Nonces*.

cipher An *AppCipher* instance. Used to decrypt the consumer secret from the database.

Implements the RequestValidator object required by the oauthlib package. Internally creates an instance of SignatureOnlyEndpoint

consumers = None
The entity set containing Silos

nonces = None
The entity set containing Nonces

cipher = None
The cipher object used for encrypting consumer secrets

lookup_consumer(*key*)
Implements the required method for consumer lookup

Returns a *ToolConsumer* instance or raises a KeyError if key is not the key of any known consumer.

launch(*command*, *url*, *headers*, *body_string*)
Checks a launch request for authorization

command The HTTP method, as an upper-case string. Should be POST for LTI.

url The full URL of the page requested as part of the launch. This will be the launch URL specified in the LTI protocol and configured in the consumer.

headers A dictionary of headers, must include the Authorization header but other values are ignored.

body_string The query string (in the LTI case, this is the content of the POST request).

Returns a *ToolConsumer* instance and a dictionary of parameters on success. If the incoming request is not authorized then *LTIAuthenticationError* is raised.

This method also checks the LTI message type and protocol version and will raise LTIProtcolError if this is not a recognized launch request.

Metadata

pyslet.imsbltiv1p0.**load_metadata**()
Loads the default metadata document

Returns a *pyslet.odata2.metadata.Document* instance. The schema is loaded from a bundled metadata document which contains the minimum schema required for an LTI tool provider.

Constants and Data

pyslet.imsbltiv1p0.**LTI_VERSION = 'LTI-1p0'**
The version of LTI we support

pyslet.imsbltiv1p0.**LTI_MESSAGE_TYPE = 'basic-lti-launch-request'**
The message type we support

pyslet.imsbltiv1p0.**SYSROLE_HANDLES = {'Administrator': <pyslet.urn.URN object at 0x7ff24991d750>, 'Creator': <p**
A mapping from a system role handle to the full URN for the role as a *URI* instance.

pyslet.imsbltiv1p0.**INSTROLE_HANDLES = {'None': <pyslet.urn.URN object at 0x7ff24991db10>, 'Guest': <pyslet.urn.**
A mapping from a institution role handle to the full URN for the role as a *URI* instance.

pyslet.imsbltiv1p0.**ROLE_HANDLES = {'Manager/CourseCoordinator': <pyslet.urn.URN object at 0x7ff24992a090>, 'M**
A mapping from LTI role handles to the full URN for the role as a *URI* instance.

pyslet.imsbltiv1p0.**split_role**(*role*)
Splits an LTI role into vocab, type and sub-type

role A URN instance containing the full definition of the role.

Returns a triple of:

vocab One of 'role', 'sysrole', 'instrole' or some future vocab extension.

rtype The role type, e.g., 'Learner', 'Instructor'

rsubtype The role sub-type , e.g., 'NonCreditLearner', 'Lecturer'. Will be None if there is no sub-type.

If this is not an LTI defined role, or the role descriptor does not start with the path ims/lis then ValueError is raised.

pyslet.imsbltiv1p0.**is_subrole**(*role*, *parent_role*)
True if role is a sub-role of parent_role

role A URN instance containing the full definition of the role to be tested.

parent_role A URN instance containing the full definition of the parent role. It must *not* define a subrole of ValueError is raised.

In the special case that role does not have subrole then it is simply matched against parent_role. This ensures that:

```
is_subrole(role, ROLE_HANDLES['Learner'])
```

will return True in all cases where role is a Learner role.

pyslet.imsbltiv1p0.**CONTEXT_TYPE_HANDLES = {'CourseSection': <pyslet.urn.URN object at 0x7ff24992a910>, 'Cours**
A mapping from LTI context type handles to the full URN for the context type as a *URI* instance.

Exceptions

class pyslet.imsbltiv1p0.**LTIError**
Bases: exceptions.Exception

Base class for all LTI errors

class pyslet.imsbltiv1p0.**LTIAuthenticationError**
Bases: *pyslet.imsbltiv1p0.LTIError*

Indicates an authentication error (on launch)

class pyslet.imsbltiv1p0.**LTIProtocolError**
Bases: *pyslet.imsbltiv1p0.LTIError*

Indicates a protocol violoation

This may be raised if the message type or protocol version in a launch request do not match the expected values or if a required parameter is missing.

Legacy Classes

Earlier Pyslet versions contained a very rudimentary memory based LTI tool provider implementation based on the older oauth module. These classes have been superceded but the main BLTIToolProvider class has been refactored as a derived class of *ToolProvider* using a SQLite ':memory:' database (instead of a Python dictionary) and the existing method signatures should continue to work as before.

The only change you'll need to make is to install the newer oauthlib. Bear in mind that these classes are now deprecated and you should refactor to use the base *ToolProvider* class directly for future compatibility. Please raise an issue on GitHub if you anticipate problems.

class pyslet.imsbltiv1p0.**BLTIToolProvider**
Bases: *pyslet.imsbltiv1p0.ToolProvider*

Legacy class for tool provider.

Refactored to build directly on the newer *ToolProvider*. A single Silo entity is created containing all defined consumers. An in-memory SQLite database is used as the data store. Consumer keys are not encrypted (a plaintext cipher is used) as they will not be persisted.

generate_key(*key_length=128*)
Generates a new key

Also available as GenerateKey. This method is deprecated, it has been replaced by the similarly named function *pyslet.wsgi.generate_key()*.

key_length The minimum key length in bits. Defaults to 128.

The key is returned as a sequence of 16 bit hexadecimal strings separated by '.' to make them easier to read and transcribe into other systems.

new_consumer(*key=None*, *secret=None*)
Creates a new BLTIConsumer instance

Also available as NewConsumer

The new instance is added to the database of consumers authorized to use this tool. The consumer key and secret are automatically generated using *generate_key()* but key and secret can be passed as optional arguments instead.

load_from_file(*f*)
Loads the list of trusted consumers

Also available as LoadFromFile

The consumers are loaded from a simple file of key, secret pairs formatted as:

```
<consumer key> [SPACE]+ <consumer secret>
```

Lines starting with a '#' are ignored as comments.

save_to_file(*f*)
Saves the list of trusted consumers

Also available as SaveToFile

The consumers are saved in a simple file suitable for reading with *load_from_file()*.

CHAPTER 4

The Open Data Protocol (OData)

This sub-package defines functions and classes for working with OData, a data access protocol based on Atom and Atom Pub: http://www.odata.org/

This sub-package only deals with version 2 of the protocol *at the moment*.

OData is not an essential part of supporting the Standards for Learning, Education and Training (SLET) that gives pyslet its name, though I have actively promoted its use in these communities. As technical standards move towards using REST-ful web services it makes sense to converge around some common patterns for common use cases. Many of the protocols now being worked on are much more like basic data-access layers spread over the web between two co-operating systems. HTTP on its own is often good enough for these applications but when the data lends itself to tabular representations I think the OData standard is the best protocol available.

The purpose of this group of modules is to make is easy to use the conventions of the OData protocol as a general purpose data-access layer (DAL) for Python applications. To get started, look at the Data Consumers section which gives a high-level overview of the API with examples that use Microsoft's Northwind data-service.

If you are interested in writing an OData provider, or you simply want to use these classes to implement a data access layer for your own application then look in OData Providers.

4.1 Data Consumers

Warning: the OData client doesn't support certificate validation when accessing servers through https URLs. This feature is coming soon...

4.1.1 Introduction

Let's start with a simple illustration of how to consume data using the DAL API by walking through the use of the OData client.

The client implementation uses Python's logging module to provide logging, when learning about the client it may help to turn logging up to "INFO" as it makes it clearer what the client is doing. "DEBUG" would show exactly what is passing over the wire.:

```
>>> import logging
>>> logging.basicConfig(level=logging.INFO)
```

To create a new client simply instantiate a Client object. You can pass the URL of the service root you wish to connect to directly to the constructor which will then call the service to download the list of feeds and the metadata document from which it will set the `Client.model`.

```
>>> from pyslet.odata2.client import Client
>>> c = Client("http://services.odata.org/V2/Northwind/Northwind.svc/")
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/ HTTP/1.1
INFO:root:Finished Response, status 200
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/$metadata HTTP/1.1
INFO:root:Finished Response, status 200
>>>
```

The `Client.feeds` attribute is a dictionary mapping the exposed feeds (by name) onto *EntitySet* instances. This makes it easy to open the feeds as EDM collections. In your code you'd typically use the with statement when opening the collection but for clarity we'll continue on the python command line:

```
>>> products = c.feeds['Products'].OpenCollection()
>>> for p in products: print p
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products HTTP/1.1
INFO:root:Finished Response, status 200
1
2
3
... [and so on]
...
20
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$skiptoken=20 HTTP/1.1
INFO:root:Finished Response, status 200
21
22
23
... [and so on]
...
76
77
>>>
```

Note that products behaves like a dictionary, iterating through it iterates through the keys in the dictionary. In this case these are the keys of the entities in the collection of products. Notice that the client logs several requests to the server interspersed with the printed output. Subsequent requests use $skiptoken because the server is limiting the maximum page size. These calls are made as you iterate through the collection allowing you to iterate through very large collections.

The keys alone are of limited interest, let's try a similar loop but this time we'll print the product names as well:

```
>>> for k, p in products.iteritems(): print k, p['ProductName'].value
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products HTTP/1.1
INFO:root:Finished Response, status 200
1 Chai
2 Chang
3 Aniseed Syrup
...
...
20 Sir Rodney's Marmalade
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$skiptoken=20 HTTP/1.1
```

```
INFO:root:Finished Response, status 200
21 Sir Rodney's Scones
22 Gustaf's Knäckebröd
23 Tunnbröd
...
...
76 Lakkalikööri
77 Original Frankfurter grüne Soße
>>>
```

Sir Rodney's Scones sound interesting, we can grab an individual record in the usual way:

```
>>> scones = products[21]
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21) HTTP/1.1
INFO:root:Finished Response, status 200
>>> for k, v in scones.data_items(): print k, v.value
...
ProductID 21
ProductName Sir Rodney's Scones
SupplierID 8
CategoryID 3
QuantityPerUnit 24 pkgs. x 4 pieces
UnitPrice 10.0000
UnitsInStock 3
UnitsOnOrder 40
ReorderLevel 5
Discontinued False
>>>
```

Well, I've simply got to have some of these, let's use one of the navigation properties to load information about the supplier:

```
>>> supplier = scones['Supplier'].GetEntity()
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21)/Supplier HTTP/1.1
INFO:root:Finished Response, status 200
>>> for k, v in supplier.data_items(): print k, v.value
...
SupplierID 8
CompanyName Specialty Biscuits, Ltd.
ContactName Peter Wilson
ContactTitle Sales Representative
Address 29 King's Way
City Manchester
Region None
PostalCode M14 GSD
Country UK
Phone (161) 555-4448
Fax None
HomePage None
```

Attempting to load a non existent entity results in a KeyError of course:

```
>>> p = products[211]
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(211) HTTP/1.1
INFO:root:Finished Response, status 404
Traceback (most recent call last):
```

```
  File "<stdin>", line 1, in <module>
  File "/Library/Python/2.7/site-packages/pyslet/odata2/client.py", line 165, in __getitem__
    raise KeyError(key)
KeyError: 211
```

Finally, when we're done, it is a good idea to close the open collection:

```
>>> products.close()
```

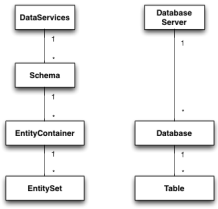
4.1.2 The Data Access Layer in Depth

In the introduction we created an OData Client object using a URL, but in general the way you connect to a data service will vary depending on the implementation. The Client class itself isn't actually part of the DAL API itself.

The API starts with a model of the *data service*. The model is typically parsed from an XML file. For the OData client the XML file is obtained from the service's $metadata URL. Here's an extract from the Northwind $metadata file showing the definition of the data service, I've removed the XML namespace definitions for brevity:

```
<?xml version="1.0" encoding="utf-8" standalone="yes"?>
<edmx:Edmx Version="1.0">
        <edmx:DataServices m:DataServiceVersion="1.0">
        <Schema Namespace="NorthwindModel">
                <EntityType Name="Category">
                        <!-- rest of the definitions go here... -->
```

Each element is represented by an object in Pyslet, the starting point for the API is the `DataServices` object. A DataServices object can contain multiple *`Schema`* elements, which in turn can contain multiple *`EntityContainer`* elements which in turn can contain multiple *`EntitySet`* elements. The following diagram illustrates these relationships and compares them with approximate equivalent concepts in a typical SQL-scenario.



In the OData client example we used a short-cut to get to the EntitySet objects we were interested in by using the feeds property of the client itself. However, we could have used the model directly as follows, continuing with the same session:

```
>>> c.model
<pyslet.odata2.metadata.Edmx object at 0x10140a9d0>
>>> c.model.DataServices
<pyslet.odata2.metadata.DataServices object at 0x107fdb990>
>>> for s in c.model.DataServices.Schema: print s.name
...
NorthwindModel
ODataWeb.Northwind.Model
>>> c.model.DataServices['ODataWeb.Northwind.Model']
<pyslet.odata2.csdl.Schema object at 0x10800cd90>
>>> c.model.DataServices['ODataWeb.Northwind.Model']['NorthwindEntities']
<pyslet.odata2.metadata.EntityContainer object at 0x10800cdd0>
>>> c.model.DataServices['ODataWeb.Northwind.Model']['NorthwindEntities']['Products']
<pyslet.odata2.metadata.EntitySet object at 0x10800f150>
```

```
>>> c.feeds['Products']
<pyslet.odata2.metadata.EntitySet object at 0x10800f150>
```

As you can see, the same EntitySet object can be obtained by looking it up in the parent container which behaves like a dictionary, this in turn can be looked up in the parent Schema which in turn can be looked up in the DataServices enclosing object. Elements of the model also support deep references using dot-concatenation of names which makes the code easier to read:

```
>>> print c.model.DataServices['ODataWeb.Northwind.Model']['NorthwindEntities']['Products'].GetFQName
ODataWeb.Northwind.Model.NorthwindEntities.Products
>>> c.model.DataServices['ODataWeb.Northwind.Model.NorthwindEntities.Products']
<pyslet.odata2.metadata.EntitySet object at 0x10800f150>
```

When writing an application that would normally use a single database you should pass an EntityCollection object to it as a data source rather than the DataServices ancestor. It is best not to pass an implementation-specific class like the OData Client as that will make the application dependent on a particular type of data source.

Entity Sets

The following attributes are useful for consumers of the API (and should be treated as read only)

name The name of the entity set

entityTypeName The name of the entity set's EntityType

entityType The *EntityType* object that defines the properties for entities in this set.

keys A list of the names of the keys for this EntitySet. For example:

```
>>> print products.keys
[u'ProductID']
```

For entity types with compound keys this list will contain multiple items of course.

The following methods are useful for consumers of the API.

GetFQName() Returns the fully qualified name of the entity set, suitable for looking up the entity set in the enclosing DataServices object.

get_location() Returns a *pyslet.rfc2396.URI* object that represents this entity set:

```
>>> print products.get_location()
http://services.odata.org/V2/Northwind/Northwind.svc/Products
```

(If there is no base URL available this will be a relative URI.)

OpenCollection() Returns a *pyslet.odata2.csdl.EntityCollection* object that can be used to access the entities in the set.

NavigationTarget() Returns the target entity set of a named navigation property.

NavigationMultiplicity() Returns a tuple of multiplicity constants for the named navigation property. Constants for these values are defined in *pyslet.odata2.csdl.Multiplicity*, for example:

```
>>> from pyslet.odata2.csdl import Multiplicity, EncodeMultiplicity
>>> print Multiplicity.ZeroToOne, Multiplicity.One, Multiplicity.Many
0 1 2
>>> products.NavigationMultiplicity('Supplier')
(2, 0)
>>> map(lambda x:EncodeMultiplicity(x),products.NavigationMultiplicity('Supplier'))
['*', '0..1']
```

IsEntityCollection() Returns True if the named navigation property points to a collection of entities or a single entity. In Pyslet, you can treat all navigation properties as collections. In the above example the collection of Supplier entities obtained by following the 'Supplier' navigation property of a Product entity will have at most 1 member.

Entity Collections

To continue with database analogy above, if EntitySets are like SQL Tables EntityCollections are somewhat like the database cursors that you use to actually read data - the difference is that EntityCollections can only read entities from a single EntitySet.

An *EntityCollection* may consume physical resources (like a database connection) and so must be closed with its `close()` method when you're done. They support the context manager protocol to make this easier so you can use them in with statements to make clean-up easier:

```
with c.feeds['Products'].OpenCollection() as products:
        if 42 in products:
                print "Found it!"
```

The close method is called automatically when the with statement exits.

Entity collections also behave like a python dictionary of *Entity* instances keyed on a value representing the Entity's key property or properties. The keys are either single values (as in the above code example) or tuples in the case of compound keys. The order of the values in the tuple is taken from the order of the PropertyRef definitions in the model.

There are two ways to obtain an EntityCollection object. You can open an entity set directly or you can open a collection by navigating from a specific entity through a named navigation property. Although dictionary-like there are some differences with true dictionaries.

When you have opened a collection from the base entity set the following rules apply:

collection[key] Returns a new *Entity* instance by looking up the *key* in the collection. As a result, subsequent calls will return a different object, but with the same key!

collection[key] = new_entity For an existing entity this is essentially a no-operation. This form of assignment cannot be used to create a new entity in the collection because the act of inserting the entity may alter its key (for example, when the entity set represents a database table with an auto-generated primary key). See below for information on how to create and update entities.

del collection[key] In contrast, del will remove an entity from the collection completely.

When an EntityCollection represents a collection of entities obtained by navigation then these rules are updated as follows:

collection[key] Normally returns a new *Entity* instance by looking up the *key* in the collection but when the navigation property has been expanded it will return a cached Entity (so subsequent calls will return the same object without looking up the key in the data source again).

collection[key]=existingEntity Provided that *key* is the key of *existingEntity* this will add an existing entity to this collection, effectively creating a link from the entity you were navigating from to an existing entity.

del collection[key] Removes the entity with *key* from this collection. The entity is not deleted from its EntitySet, is merely unlinked from the entity you were navigating from.

The following attribute is useful for consumers of the API (and should be treated as read only)

entity_set The *EntitySet* of this collection. In the case of a collection opened through navigation this is the base entity set.

In addition to all the usual dictionary methods like *len*, *itervalues* and so on, the following methods are useful for consumers of the API:

get_location() Returns a *pyslet.rfc2396.URI* object that represents this entity collection.

get_title() Returns a user-friendly title to represent this entity collection.

new_entity() Creates a new entity suitable for inserting into this collection. The entity does not exist until it is inserted with insert_entity.

CopyEntity() Creates a new entity by copying all non-key properties from another entity. The entity does not exist until it is inserted with insert_entity.

insert_entity() Inserts an entity previously created by new_entity or CopyEntity. When inserting an entity any active filter is ignored.

Warning: an active filter may result in a paradoxical KeyError:

```
import pyslet.odata2.core as core
with people.OpenCollection() as collection:
        collection.set_filter(
            core.CommonExpression.from_str("startswith(Name,'D')"))
        new_entity = collection.new_entity()
        new_entity['Key'].set_from_value(1)
        new_entity['Name'].set_from_value(u"Steve")
        collection.insert_entity(new_entity)
        # new_entity now exists in the base collection but...
        e1 = collection[1]
        # ...raises KeyError as new_entity did not match the filter!
```

It is recommended that collections used to insert entities are not filtered.

update_entity() Updates an existing entity following changes to the Entity's values. You can't update the values of key properties. To change the key you will need to create a new entity with CopyEntity, insert the new entity and then remove the old one. Like insert_entity, the current filter is ignored.

set_page() Sets the top and skip values for this collection, equivalent to the $top and $skip options in OData. This value only affects calls to iterpage. See *Paging* for more information.

iterpage() Iterates through a subset of the entities returned by itervalues defined by the top and skip values. See *Paging* for more information.

set_filter() Sets the filter for this collection, equivalent to the $filter option in OData. Once set this value effects all future entities returned from the collection (with the exception of new_entity). See *Filtering Collections* for more information.

set_orderby() Sets the filter for this collection, equivalent to the $orderby option in OData. Once set this value effects all future iterations through the collection. See *Ordering Collections* for more information.

set_expand() Sets expand and select options for this collection, equivalent to the $expand and $select system query options in OData. Once set these values effect all future entities returned from the collection (with the exception of new_entity). See *Expand and Select* for more information.

Paging

Supported from build 0.4.20140215 onwards

The $top/$skip options in OData are a useful way to restrict the amount of data that an OData server returns. The collection dictionary always behaves as if it contains all entities so the value returned by *len* doesn't change if you set top and skip values and nor does the set of entities returned by itervalues and similar methods.

In most cases, the server will impose a reasonable maximum on each request using server-enforced paging. However, you may wish to set a smaller *top* value or simply have more control over the automatic paging implemented by the default iterators.

To iterate through a single page of entities you'll start by using the the *set_page()* method to specify values for top and, optinally, skip. You must then use the *iterpage()* method to iterate through the entities in just that page. The *set_next* boolean parameter indicates whether or not the next call to iterpage iterates over the same page or the next page of the collection.

To continue the example above, in which *products* is an open collection from the Northwind data service:

```
>>> products.set_page(5,50)
>>> for p in products.iterpage(True): print p.key(), p['ProductName'].value
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$skip=50&$top=5 HTTP/1.1
INFO:root:Finished Response, status 200
51 Manjimup Dried Apples
52 Filo Mix
53 Perth Pasties
54 Tourtière
55 Pâté chinois
>>> for p in products.iterpage(True): print p.key(), p['ProductName'].value
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$skip=55&$top=5 HTTP/1.1
INFO:root:Finished Response, status 200
56 Gnocchi di nonna Alice
57 Ravioli Angelo
58 Escargots de Bourgogne
59 Raclette Courdavault
60 Camembert Pierrot
```

In some cases, the server will restrict the page size and fewer entities will be returned than expected, in these cases the skiptoken is used automatically when the next page is requested:

```
>>> products.set_page(30, 50)
>>> for p in products.iterpage(True): print p.key(), p['ProductName'].value
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$skip=50&$top=30 HTTP/1.1
INFO:root:Finished Response, status 200
51 Manjimup Dried Apples
52 Filo Mix
53 Perth Pasties
... [and so on]
...
69 Gudbrandsdalsost
70 Outback Lager
>>> for p in products.iterpage(True): print p.key(), p['ProductName'].value
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$top=30&$skiptoken=70 HTTP/1.1
INFO:root:Finished Response, status 200
71 Flotemysost
72 Mozzarella di Giovanni
73 Röd Kaviar
74 Longlife Tofu
75 Rhönbräu Klosterbier
```

```
76 Lakkalikööri
77 Original Frankfurter grüne Soße
```

Filtering Collections

By default, an entity collection contains all items in the entity set or, if the collection was obtained by navigation, all items linked to the entity by the property being navigated. Filtering a collection (potentially) selects a sub-set of the these entities based on a filter expression.

Filter expressions are set using the *set_filter()* method of the collection. Once a filter is set, the dictionary methods, and iterpage, will only return entities that match the filter.

The easiest way to set a filter is to compile one directly from a string representation using OData's query language. For example:

```
>>> import pyslet.odata2.core as core
>>> filter = core.CommonExpression.from_str("substringof('one',ProductName)")
>>> products.set_filter(filter)
>>> for p in products.itervalues(): print p.key(), p['ProductName'].value
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$filter=substringof('one'%2CProductName) HTTP/1.1
INFO:root:Finished Response, status 200
21 Sir Rodney's Scones
32 Mascarpone Fabioli
```

To remove a filter, set the filter expression to None:

```
>>> products.set_filter(None)
```

Ordering Collections

Like OData and python dictionaries, this API does not specify a default order in which entities will be returned by the iterators. However, unlike python dictionaries you can control this order using an orderby option.

OrderBy expressions are set using the *set_orderby()* method of the collection. Once an order by expression is set, the dictionary methods, and iterpage, will return entities in the order specified.

The easiest way to define an ordering is to compile one directly from a string representation using OData's query language. For example:

```
>>> ordering=core.CommonExpression.OrderByFromString("ProductName desc")
>>> products.set_orderby(ordering)
>>> for p in products.itervalues(): print p.key(), p['ProductName'].value
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$orderby=ProductName%20desc HTTP/1.1
INFO:root:Finished Response, status 200
47 Zaanse koeken
64 Wimmers gute Semmelknödel
63 Vegie-spread
50 Valkoinen suklaa
7 Uncle Bob's Organic Dried Pears
23 Tunnbröd
... [and so on]
...
```

```
56 Gnocchi di nonna Alice
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$orderby=ProductName%20desc&$skiptoken='Gnocchi%20
INFO:root:Finished Response, status 200
15 Genen Shouyu
33 Geitost
71 Flotemysost
... [and so on]
...
40 Boston Crab Meat
3 Aniseed Syrup
17 Alice Mutton
```

To remove an ordering, set the orderby expression to None:

```
>>> products.Orderby(None)
```

Expand and Select

Expansion and selection are two interrelated concepts in the API. Expansion allows you to follow specified navigation properties retrieving the entities they link to in the same way that simple and complex property values are retrieved.

Expand options are represented by nested dictionaries of strings. For example, to expand the Supplier navigation property of Products you would use a dictionary like this:

```
expansion={'Supplier':None}
```

The value in the dictionary is either None, indicating no further expansion, or another dictionary specifying the expansion to apply to any linked Suppliers:

```
>>> products.set_expand({'Supplier':None}, None)
>>> scones = products[21]
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21)?$expand=Supplier HTTP/1.1
INFO:root:Finished Response, status 200
>>> supplier=scones['Supplier'].GetEntity()
>>> for k, v in supplier.data_items(): print k, v.value
...
SupplierID 8
CompanyName Specialty Biscuits, Ltd.
ContactName Peter Wilson
ContactTitle Sales Representative
Address 29 King's Way
City Manchester
Region None
PostalCode M14 GSD
Country UK
Phone (161) 555-4448
Fax None
HomePage None
```

A critical point to note is that applying an expansion to a collection means that linked entities are retrieved at the same time as the entity they are linked to and cached. In the example above, the GetEntity call does not generate a call to the server. Compare this with the same code executed without the expansion:

```
>>> products.set_expand(None, None)
>>> scones = products[21]
INFO:root:Sending request to services.odata.org
```

```
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21) HTTP/1.1
INFO:root:Finished Response, status 200
>>> supplier = scones['Supplier'].GetEntity()
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21)/Supplier HTTP/1.1
INFO:root:Finished Response, status 200
```

The select option complements expansion, narrowing down the simple and complex properties that are retrieved from the data source. You specify a select option in a similar way, using nested dictionaries. Simple and complex properties must always map to None, for a more complex example with navigation properties see below. Suppose we are only interested in the product name:

```
>>> products.set_expand(None, {'ProductName':None})
>>> scones = products[21]
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21)?$select=ProductID%2CProductName HTTP/1.1
INFO:root:Finished Response, status 200
>>> for k, v in scones.data_items(): print k, v.value
...
ProductID 21
ProductName Sir Rodney's Scones
SupplierID None
CategoryID None
QuantityPerUnit None
UnitPrice None
UnitsInStock None
UnitsOnOrder None
ReorderLevel None
Discontinued None
```

In Pyslet, the values of the key properties are *always* retrieved, even if they are not selected. This is required to maintain the dictionary-like behaviour of the collection. An entity retrieved this way has NULL values for any properties that weren't retrieved. The *`Selected()`* method allows you to determine if a value is NULL in the data source or NULL because it is not selected:

```
>>> for k, v in scones.data_items():
...  if scones.Selected(k): print k, v.value
...
ProductID 21
ProductName Sir Rodney's Scones
```

The expand and select options can be combined in complex ways:

```
>>> products.set_expand({'Supplier':None}, {'ProductName':None, 'Supplier':{'Phone':None}})
>>> scones = products[21]
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21)?$expand=Supplier&$select=ProductID%2CProductNa
INFO:root:Finished Response, status 200
>>> supplier = scones['Supplier'].GetEntity()
>>> for k, v in scones.data_items():
...  if scones.Selected(k): print k, v.value
...
ProductID 21
ProductName Sir Rodney's Scones
>>> for k, v in supplier.data_items():
...  if supplier.Selected(k): print k, v.value
...
SupplierID 8
Phone (161) 555-4448
```

Entity Objects

Continuing further with the database analogy and *Entity* is like a single record.

Entity instances behave like a read-only dictionary mapping property names onto their values. The values are either *SimpleValue*, *Complex* or *DeferredValue* instances. All property values are created on construction and cannot be assigned. To update a SimpleValue, whether it is a direct child or part of a Complex value, use its *set_from_value()* method:

```
entity['Name'].set_from_value("Steve")
entity['Address']['City'].set_from_value("Cambridge")
```

The following attributes are useful for consumers of the API (and should be treated as read only):

entity_set The *EntitySet* to which this entity belongs.

type_def The *EntityType* which defines this entity's type.

exists True if this entity exists in the collection, i.e., it was returned by one of the dictionary methods of an entity collection such as *itervalues* or [key] look-up.

The following methods are useful for consumers of the API:

key() Returns the entity's key, as a single python value or tuple in the case of compound keys

get_location() Returns a *pyslet.rfc2396.URI* object that represents this entity:

```
>>> print scones.get_location()
http://services.odata.org/V2/Northwind/Northwind.svc/Products(21)
```

DataKeys() Iterates over the simple and complex property names:

```
>>> list(scones.DataKeys())
[u'ProductID', u'ProductName', u'SupplierID', u'CategoryID', u'QuantityPerUnit', u'UnitPrice', u
```

data_items() Iterates over tuples of simple and complex property (name,value) pairs. See above for examples of usage.

Selected() Tests if the given data property is selected.

NavigationKeys() Iterates over the navigation property names:

```
>>> list(scones.NavigationKeys())
[u'Category', u'Order_Details', u'Supplier']
```

NavigationItems() Iterates over tuples of navigation property (name,DeferredValue) pairs.

IsNavigationProperty() Tests if a navigation property with the given name exists

The following methods can be used only on entities that exists, i.e., entities that have been returned from one of the collection's dictionary methods:

commit() Normally you'll use the the update_entity method of an open EntityCollection but in cases where the originating collection is no longer open this method can be used as a convenience method for opening the base collection, updating the entity and then closing the collection collection again.

Delete() Deletes this entity from the base entity set. If you already have the base entity set open it is more efficient to use the *del* operator but if the collection is no longer open or the entity was obtained from a collection opened through navigation then this method can be used to delete the entity.

The following method can only be used on entities that don't exist, i.e., entities returned from the collection's new_entity or CopyEntity methods that have not been inserted.

set_key() Sets the entity's key

SimpleValue

Simple property values are represented by (sub-classes of) *SimpleValue*, they share a number of common methods:

IsNull() Returns True if this value is NULL. This method is also used by Python's non-zero test so:

```
if entity['Property']:
        print entity['Property'].value
        # prints even if value is 0
```

will print the Property value of entity if it is non-NULL. In particular, it will print empty strings or other representations of zero. If you want to exclude these from the test you should test the value attribute directly:

```
if entity['Property'].value:
        print entity['Property'].value
        # will not print if value is 0
```

set_from_value() Updates the value, coercing the argument to the correct type and range checking its value.

SetFromSimpleValue() Updates the value from another SimpleValue, if the types match then the value is simply copied, otherwise the value is coerced using set_from_value.

SetFromLiteral() Updates the value by parsing it from a (unicode) string. This is the opposite to the unicode function. The literal form is the form used when serializing the value to XML (but does not include XML character escaping).

set_null() Updates the value to NULL

The value attribute is always an immutable value in python and so can be used as a key in your own dictionaries. The following list describes the mapping from the EDM-defined simple types to their corresponding native Python types.

Edm.Boolean: one of the Python constants True or False

Edm.Byte, Edm.SByte, Edm.Int16, Edm.Int32: int

Edm.Int64: long

Edm.Double, Edm.Single: python float

Edm.Decimal: python Decimal instance (from the built-in decimal module)

Edm.DateTime, Edm.DateTimeOffset: py:class:*pyslet.iso8601.TimePoint* instance

This is a custom object in Pyslet, see *Working with Dates* for more information.

Edm.Time: py:class:*pyslet.iso8601.Time* instance

Early versions of the OData specification incorrectly mapped this type to the XML Schema duration. The use of a Time object to represent it, rather than a duration, reflects this correction.

See *Working with Dates* for more information.

Edm.Binary: raw string

Edm.String: unicode string

Edm.Guid: Python UUID instance (from the built-in uuid module)

Complex

Complex values behave like dictionaries of data properties. They do not have keys or navigation properties. They are never NULL, IsNull and the Python non-zero test will always return True.

set_null() Although a Complex value can never be NULL, this method will set all of its data properties (recursively if necessary) to NULL

DeferredValue

Navigation properties are represented as `DeferredValue` instances. All deferred values can be treated as an entity collection and opened in a similar way to an entity set:

```
>>> sconeSuppliers=scones['Supplier'].OpenCollection()
>>> for s in sconeSuppliers.itervalues(): print s['CompanyName'].value
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21)/Supplier HTTP/1.1
INFO:root:Finished Response, status 200
Specialty Biscuits, Ltd.
>>>
```

For reading, a collection opened from a deferred value behaves in exactly the same way as a collection opened from a base entity set. However, for writing there are some difference described above in *Entity Collections*.

If you use the dictionary methods to update the collection the changes are made straight away by accessing the data source directly. If you want to make a number of changes simultaneously, or you want to link entities to entities that don't yet exist, then you should use the BindEntity method described below instead. This method defers the changes until the parent entity is updated (or inserted, in the case of non-existent entities.)

Read-only attributes useful to data consumers:

name The name of the navigation property

from_entity The parent entity of this navigation property

pDef The *NavigationProperty* that defines this navigation property in the model.

isRequired True if the target of this property has multiplicity 1, i.e., it is required.

isCollection True if the target of this property has multiplicity *

isExpanded True if this navigation property has been expanded. Expanded navigation keep a cached version of the target collection. Although you can open it and use it in the same way any other collection the values returned are returned from the cache and not by accessing the data source.

Methods useful to data consumers:

OpenCollection() Returns an *pyslet.odata2.csdl.EntityCollection* object that can be used to access the target entities.

GetEntity() Convenience method that returns the entity that is the target of the link when the target has multiplicity 1 or 0..1. If no entity is linked by the association then None is returned.

BindEntity() Marks the target entity for addition to this navigation collection on next update or insert. If this navigation property is not a collection then the target entity will replace any existing target of the link.

Target() The target entity set of this navigation property.

Working with Dates

In the EDM there are two types of date, DateTime and DateTimeOffset. The first represents a time-point in an implicit zone and the second represents a time-point with the zone offset explicitly set.

Both types are represented by the custom :py:class:pyslet.iso8601.TimePoint‘ class in Pyslet.

time module from build 0.4.20140217 onwards

Interacting with Python's time module is done using the struct_time type, or lists that have values corresponding to those in struct_time:

```
>>> import time
>>> orders = c.feeds['Orders'].OpenCollection()
>>> orders.set_page(5)
>>> top = list(orders.iterpage())
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Orders?$skip=0&$top=5 HTTP/1.1
INFO:root:Finished Response, status 200
>>> print top[0]['OrderDate'].value
1996-07-04T00:00:00
>>> t = [None]*9
>>> top[0]['OrderDate'].value.update_struct_time(t)
>>> t
[1996, 7, 4, 0, 0, 0, 3, 186, -1]
>>> time.strftime("%a, %d %b %Y %H:%M:%S",t)
'Thu, 04 Jul 1996 00:00:00'
```

You can set values obtained from the time module in a similar way:

```
>>> import pyslet.iso8601 as iso
>>> t = time.gmtime(time.time())
>>> top[0]['OrderDate'].set_from_value(iso.TimePoint.from_struct_time(t))
>>> print top[0]['OrderDate'].value
2014-02-17T21:51:41
```

But if you just want a timestamp use one of the built-in factory methods:

```
>>> top[0]['OrderDate'].set_from_value(iso.TimePoint.from_now_utc())
>>> print top[0]['OrderDate'].value
2014-02-17T21:56:23
```

In future versions, look out for better support for datetime and calendar module conversion methods.

Working with Media Resources

OData is based on Atom and the Atom Publishing Protocol (APP) and inherits the concept of media resources and media link entries from those specifications.

In OData, an entity can be declared as a media link entry indicating that the main purpose of the entity is to hold a media stream. If the entity with the following URL is a media link entry:

```
http://host/Documents(123)
```

then the following URL provides access to the associated media resource:

```
http://host/Documents(123)/$value
```

In the DAL this behaviour is modelled by operations on the *collection* containing the entities. The methods you'll use are:

is_medialink_collection() Returns True if the entities are media link entries

read_stream() Reads information about a stream, optionally copying the stream's data to a file-like object.

new_stream() Creates a new media resource, copying the stream's data from a file-like object.

This method implicitly creates an associated media link entry and returns the resulting *Entity* object. By its nature, APP does not guarantee the URL that will be used to store a posted resource. The implication for OData is that you can't specify the key that will be used for the media resource's entry, though this method does allow you to supply a hint.

udpate_stream() Updates a media resource, copying the stream's new data from a file-like object.

If a collection is a collection of media link entries then the behaviour of :py:meth:~pyslet.odata2.core.EntityCollection.insert_entity‘ is modified as entities are created implicitly when a new stream is added to the collection. In this case, insert_entity creates an empty stream of type application/octet-stream and then merges the property values from the entity being inserted into the new media link entry created for the stream.

4.2 OData Providers

The approach to writing a data access layer (DAL) taken by Pyslet is to use the Entity Data Model (EDM), and the extensions defined by OData, and to encapsulate them in an API defined by a set of abstract Python classes. The Data Consumers section goes through this API from the point of view of the consumer and provides a good primer for understanding what is required from a provider.

Pyslet includes three derived classes that implement the API in a variety of different storage scenarios:

1. OData Client - an implementation of the DAL that makes calls over the web to an OData server. Defined in the module `pyslet.odatav2.client` and used in the examples in the section Data Consumers.
2. In-memory data service - an implementation of the DAL that stores all entities and associations in python dictionaries. Defined in the module `pyslet.odatav2.memds`.
3. SQL data service - an implementation of the DAL that maps on to python's database API. Defined in the module `pyslet.odatav2.sqlds`. In practice, the classes defined by this module will normally need to be sub-classed to deal with database-specific issues but a full implementation for SQLite is provided and a quick look at the source code for that should give you courage to tackle any modifications necessary for your favourite database. Using this DAL API is much easier than having to do these tweaks when they are distributed throughout your code in embedded SQL-statements.

A high-level plan for writing an OData provider would therefore be:

0. Identify the underlying DAL class that is most suited to your needs or, if there isn't one, create a new DAL implementation using the existing implementations as a guide.
1. Create a metadata document to describe your data model
2. Write a test program that uses the DAL classes directly to validate that your model and the DAL implementation are working correctly
3. Create `pyslet.odata2.server.Server` that is bound to your model test it with an OData client to ensure that it works as expected.
4. Finally, create a sub-class of the server with any specific customisations needed by your application: mainly to implement your applications authentication and authorization model. (For a read-only service there may be nothing to do here.)

Of course, if all you want to do is use these interfaces as a DAL in your own application you can stop at item 3 above.

4.2.1 Sample Project: InMemory Data Service

The sample code for this service is in the samples directory in the Pyslet distribution.

This project demonstrates how to construct a simple OData service based on the `InMemoryEntityContainer` class. We don't need any customisations, this class does everything we need 'out of the box'.

Step 1: Creating the Metadata Model

Unlike other frameworks for implementing OData services Pyslet starts with the metadata model, it is not automatically generated: you must write it yourself!

Fortunately, there are plenty of examples you can use as a template. In this sample project we'll write a very simple memory cache capable of storing a key-value pair. Here's our data model:

```
<?xml version="1.0" encoding="utf-8" standalone="yes" ?>
<edmx:Edmx Version="1.0" xmlns:edmx="http://schemas.microsoft.com/ado/2007/06/edmx"
        xmlns:m="http://schemas.microsoft.com/ado/2007/08/dataservices/metadata">
        <edmx:DataServices m:DataServiceVersion="2.0">
                <Schema Namespace="MemCacheSchema" xmlns="http://schemas.microsoft.com/ado/2006/04/ed
                        <EntityContainer Name="MemCache" m:IsDefaultEntityContainer="true">
                                <EntitySet Name="KeyValuePairs" EntityType="MemCacheSchema.KeyValuePa
                        </EntityContainer>
                        <EntityType Name="KeyValuePair">
                                <Key>
                                        <PropertyRef Name="Key"/>
                                </Key>
                                <Property Name="Key" Type="Edm.String" Nullable="false" MaxLength="25
                                        Unicode="true" FixedLength="false"/>
                                <Property Name="Value" Type="Edm.String" Nullable="false" MaxLength="
                                        Unicode="true" FixedLength="false"/>
                                <Property Name="Expires" Type="Edm.DateTime" Nullable="false"
                                        Precision="3"/>
                        </EntityType>
                </Schema>
        </edmx:DataServices>
</edmx:Edmx>
```

Our model has one defined EntityType called *KeyValuePair* and one EntitySet called *KeyValuePairs* in a container called *MemCache*. The idea behind the model is that each key-value pair is inserted with an expires time, after which it is safe to clean it up.

For simplicity, we'll save this model to a file and load it from the file when our script starts up. Here's the source code:

```
import pyslet.odata2.metadata as edmx

def load_metadata():
        """Loads the metadata file from the current directory."""
        doc=edmx.Document()
        with open('MemCacheSchema.xml','rb') as f:
                doc.Read(f)
        return doc
```

The metadata module contains a Document object and the definitions of the elements in the edmx namespace that enable us to read the XML file.

Step 2: Test the Model

Let's write a simple test function to test our model:

```
def TestData(memCache):
        with memCache.OpenCollection() as collection:
                for i in xrange(26):
                        e=collection.new_entity()
                        e.set_key(str(i))
                        e['Value'].set_from_value(unichr(0x41+i))
                        e['Expires'].set_from_value(iso.TimePoint.from_unix_time(time.time()+10*i))
                        collection.insert_entity(e)

def test_model():
        """Read and write some key value pairs"""
        doc=load_metadata()
        container=InMemoryEntityContainer(doc.root.DataServices['MemCacheSchema.MemCache'])
        memCache=doc.root.DataServices['MemCacheSchema.MemCache.KeyValuePairs']
        TestData(memCache)
        with memCache.OpenCollection() as collection:
                for e in collection.itervalues():
                        print "%s: %s (expires %s)"%(e['Key'].value,e['Value'].value,str(e['Expires'])
```

Our function comes in two parts (for reasons that will become clear later). The first function takes an EntitySet object and creates 26 key-value pairs with increasing expiry times.

The main function loads the metadata model, creates the InMemoryEntityContainer object, calls the first function to create the test data and then opens the *KeyValuePairs* collection itself to check that everything is in order. Here's the output from a sample run:

```
>>> import memcache
>>> memcache.test_model()
24: Y (expires 2014-02-17T22:26:21)
25: Z (expires 2014-02-17T22:26:31)
20: U (expires 2014-02-17T22:25:41)
21: V (expires 2014-02-17T22:25:51)
22: W (expires 2014-02-17T22:26:01)
23: X (expires 2014-02-17T22:26:11)
1: B (expires 2014-02-17T22:22:31)
0: A (expires 2014-02-17T22:22:21)
3: D (expires 2014-02-17T22:22:51)
2: C (expires 2014-02-17T22:22:41)
5: F (expires 2014-02-17T22:23:11)
4: E (expires 2014-02-17T22:23:01)
7: H (expires 2014-02-17T22:23:31)
6: G (expires 2014-02-17T22:23:21)
9: J (expires 2014-02-17T22:23:51)
8: I (expires 2014-02-17T22:23:41)
11: L (expires 2014-02-17T22:24:11)
10: K (expires 2014-02-17T22:24:01)
13: N (expires 2014-02-17T22:24:31)
12: M (expires 2014-02-17T22:24:21)
15: P (expires 2014-02-17T22:24:51)
14: O (expires 2014-02-17T22:24:41)
17: R (expires 2014-02-17T22:25:11)
16: Q (expires 2014-02-17T22:25:01)
19: T (expires 2014-02-17T22:25:31)
18: S (expires 2014-02-17T22:25:21)
```

It is worth pausing briefly here to look at the InMemoryEntityContainer object. When we construct this object we pass in the EntityContainer and it creates all the necessary storage for the EntitySets (and AssociationSets, if required) that it contains. It also binds internal implementations of the EntityCollection object to the model so that, in future, the EntitySet can be opened using the same API described previously in Data Consumers. From this point on we don't

need to refer to the container again as we can just open the EntitySet directly from the model. That object is the heart of our application, blink and you've missed it.

Step 4: Link the Data Source to the OData Server

OData runs over HTTP so we need to assign a service root URL for the server to run on. We define a couple of constants to help with this:

```
SERVICE_PORT=8080
SERVICE_ROOT="http://localhost:%i/"%SERVICE_PORT
```

We're also going to use a separate thread to run the server, a global variable helps here. We're using Pythons wsgi interface for the server which requires a callable object to handle requests. The `Server` object implements callable behaviour to enable this:

```
import logging, threading
from wsgiref.simple_server import make_server

cacheApp=None           #: our Server instance

def runCacheServer():
        """Starts the web server running"""
        server=make_server('',SERVICE_PORT,cacheApp)
        logging.info("Starting HTTP server on port %i..."%SERVICE_PORT)
        # Respond to requests until process is killed
        server.serve_forever()
```

The final part of server implementation involves loading the model, creating the server object and then spawning the server thread:

```
def main():
        """Executed when we are launched"""
        doc=load_metadata()
        container=InMemoryEntityContainer(doc.root.DataServices['MemCacheSchema.MemCache'])
        server=Server(serviceRoot=SERVICE_ROOT)
        server.SetModel(doc)
        # The server is now ready to serve forever
        global cacheApp
        cacheApp=server
        t=threading.Thread(target=runCacheServer)
        t.setDaemon(True)
        t.start()
        logging.info("MemCache starting HTTP server on %s"%SERVICE_ROOT)
```

The Server object just takes the serviceRoot as a parameter on construction and has a `SetModel()` method which is used to assign the metadata document to it. That's all you need to do to create it, it uses the same API described in Data Consumers to consume the data source and expose it via the OData protocol.

At this stage we can test it via the terminal and a browser:

```
>>> import memcache
>>> memcache.main()
>>>
```

At this point the server is running in a separate thread, listening on port 8080. A quick check from the browser shows this to be the case, when I hit http://localhost:8080/KeyValuePairs Firefox recognises that the document is an Atom feed and displays the feed title. The page source shows:

```
<?xml version="1.0" encoding="UTF-8"?>
<feed xmlns="http://www.w3.org/2005/Atom" xmlns:d="http://schemas.microsoft.com/ado/2007/08/dataservi
        <id>http://localhost:8080/KeyValuePairs</id>
        <title type="text">MemCacheSchema.MemCache.KeyValuePairs</title>
        <updated>2014-02-17T22:41:51Z</updated>
        <link href="http://localhost:8080/KeyValuePairs" rel="self"/>
</feed>
```

Looks like it is working!

Step 5: Customise the Server

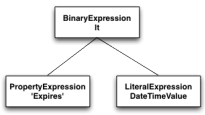
We don't need to do much to customise our server, we'll assume that it is only ever going to be exposed to clients we trust and so authentication is not required or will be handled by some intermediate proxy.

However, we do want to clean up expired entries automatically. Let's add one last function to our code:

```
CLEANUP_SLEEP=10

def CleanupForever(memCache):
        """Runs a loop continuously cleaning up expired items"""
        expires=core.PropertyExpression(u"Expires")
        now=edm.DateTimeValue()
        t=core.LiteralExpression(now)
        filter=core.BinaryExpression(core.Operator.lt)
        filter.operands.append(expires)
        filter.operands.append(t)
        while True:
                now.set_from_value(iso.TimePoint.from_now_utc())
                logging.info("Cleanup thread running at %s",str(now.value))
                with memCache.OpenCollection() as cacheEntries:
                        cacheEntries.set_filter(filter)
                        expiredList=list(cacheEntries)
                        if expiredList:
                                logging.info("Cleaning %i cache entries",len(expiredList))
                                for expired in expiredList:
                                        del cacheEntries[expired]
                        cacheEntries.set_filter(None)
                        logging.info("Cleanup complete, %i cache entries remain",len(cacheEntries))
                time.sleep(CLEANUP_SLEEP)
```

This function starts by building a filter expression manually. Filter expressions are just simple trees of expression objects. We start with a PropertyExpression that references a property named *Expires* and a literal expression with a date-time value. DateTimeValue is just a sub-class of SimpleValue which was introduced in Data Consumers. Previously we've only seen simple values that are part of an entity but in this case we create a standalone value to use in the expression. Finally, the filter expression is created as a BinaryExpression using the less than operator and the operands appended. The resulting expression tree looks like this:



Each time around the loop we can just update the value of the literal expression with the current time.

This function takes an *EntitySet* as a parameter so we can open it to get the collection and then apply the filter. Once filtered, all matching cache entries are loaded into a list before being deleted from the collection, one by one.

Finally, we remove the filter and report the number of remaining entries before sleeping ready for the next run.

We'll call this function right after main, so we've got one thread running the server and the main thread running the cleanup loop.

Now we can test, we start by firing up our server application:

```
$ ./memcache.py
INFO:root:MemCache starting HTTP server on http://localhost:8080/
INFO:root:Cleanup thread running at 2014-02-17T23:03:34
INFO:root:Cleanup complete, 0 cache entries remain
INFO:root:Starting HTTP server on port 8080...
INFO:root:Cleanup thread running at 2014-02-17T23:03:44
INFO:root:Cleanup complete, 0 cache entries remain
```

Unfortunately, we need more than a simple browser to test the application properly. We want to know that the key value pairs are being created properly and for that we need a client capable of writing to the service. Fortunately, Pyslet has an OData consumer, so we open the interpreter in a new terminal and start interacting with our server:

```
>>> from pyslet.odata2.client import Client
>>> c=Client("http://localhost:8080/")
```

As soon as we start the client our server registers hits:

```
INFO:root:Cleanup thread running at 2014-02-17T23:06:34
INFO:root:Cleanup complete, 0 cache entries remain
127.0.0.1 - - [17/Feb/2014 23:06:34] "GET / HTTP/1.1" 200 360
127.0.0.1 - - [17/Feb/2014 23:06:34] "GET /$metadata HTTP/1.1" 200 1040
INFO:root:Cleanup thread running at 2014-02-17T23:06:44
INFO:root:Cleanup complete, 0 cache entries remain
```

Entering the data manually would be tedious but we already wrote a suitable function for adding test data. Because both the data source and the OData client adhere to the same API we can simply pass the EntitySet to our TestData function:

```
>>> import memcache
>>> memcache.TestData(c.feeds['KeyValuePairs'])
```

As we do this, the server window goes crazy as each of the POST requests comes through:

```
INFO:root:Cleanup thread running at 2014-02-17T23:08:14
INFO:root:Cleanup complete, 0 cache entries remain
127.0.0.1 - - [17/Feb/2014 23:08:23] "POST /KeyValuePairs HTTP/1.1" 201 717
... [and so on]
...
127.0.0.1 - - [17/Feb/2014 23:08:24] "POST /KeyValuePairs HTTP/1.1" 201 720
INFO:root:Cleanup thread running at 2014-02-17T23:08:24
INFO:root:Cleaning 1 cache entries
INFO:root:Cleanup complete, 19 cache entries remain
127.0.0.1 - - [17/Feb/2014 23:08:24] "POST /KeyValuePairs HTTP/1.1" 201 720
127.0.0.1 - - [17/Feb/2014 23:08:24] "POST /KeyValuePairs HTTP/1.1" 201 720
127.0.0.1 - - [17/Feb/2014 23:08:24] "POST /KeyValuePairs HTTP/1.1" 201 720
127.0.0.1 - - [17/Feb/2014 23:08:24] "POST /KeyValuePairs HTTP/1.1" 201 720
127.0.0.1 - - [17/Feb/2014 23:08:24] "POST /KeyValuePairs HTTP/1.1" 201 720
127.0.0.1 - - [17/Feb/2014 23:08:24] "POST /KeyValuePairs HTTP/1.1" 201 720
INFO:root:Cleanup thread running at 2014-02-17T23:08:34
INFO:root:Cleaning 1 cache entries
INFO:root:Cleanup complete, 24 cache entries remain
```

We can then watch the data gradually decay as each entry times out in turn. We can easily repopulate the cache, this time let's catch it in a browser by navigating to:

```
http://localhost:8080/KeyValuePairs('25')?$format=json
```

The result is:

```
{"d":{"__metadata":{"uri":"http://localhost:8080/KeyValuePairs('25')
","type":"MemCacheSchema.KeyValuePair"},"Key":"25","Value":"Z","
Expires":"/Date(1392679105162)/"}}
```

We can pick the value our directly with a URL like:

```
http://localhost:8080/KeyValuePairs('25')/Value/$value
```

This returns the simple string 'Z'.

Conclusion

It is easy to write an OData server using Pyslet!

4.2.2 A SQL-Backed Data Service

The sample code for this service is in the samples directory in the Pyslet distribution.

This project demonstrates how to construct a simple OData service based on the *SQLiteEntityContainer* class.

We don't need any customisations, this class does everything we need 'out of the box'. Although we use SQLite by default, an implementation is also provided using the MySQLdb adaptor. If you want to use a database other than these you will need to create a new implementation of the generic *SQLEntityContainer*. See the reference documentation for *sqlds* for details on what is involved. You shouldn't have to change much!

Step 1: Creating the Metadata Model

If you haven't read the Sample Project: InMemory Data Service yet it is a good idea to do that to get a primer on how providers work. The actual differences between writing a SQL-backed service and one backed by the in-memory implementation are minimal. I haven't repeated code here if it is essentially the same as the code shown in the previous example, but remember that the full working source is available in the samples directory.

For this project, I've chosen to write an OData service that exposes weather data for my home town of Cambridge, England. The choice of data set is purely because I have access to over 340,000 data points stretching back to 1995 thanks to the excellent Weather Station website run by the University of Cambridge's Digital Technology Group: http://www.cl.cam.ac.uk/research/dtg/weather/

We start with our metadata model, which we write by hand. There are two entity sets. The first contains the actual data readings from the weather station and the second contains notes relating to known inaccuracies in the data. I've included a navigation property so that it is easy to see which note, if any, applies to a data point.

Here's the model:

```
<?xml version="1.0" encoding="utf-8" standalone="yes" ?>
<edmx:Edmx Version="1.0" xmlns:edmx="http://schemas.microsoft.com/ado/2007/06/edmx"
        xmlns:m="http://schemas.microsoft.com/ado/2007/08/dataservices/metadata">
        <edmx:DataServices m:DataServiceVersion="2.0">
                <Schema Namespace="WeatherSchema" xmlns="http://schemas.microsoft.com/ado/2006/04/edm
                        <EntityContainer Name="CambridgeWeather" m:IsDefaultEntityContainer="true">
                                <EntitySet Name="DataPoints" EntityType="WeatherSchema.DataPoint"/>
                                <EntitySet Name="Notes" EntityType="WeatherSchema.Note"/>
                                <AssociationSet Name="DataPointNotes" Association="WeatherSchema.Data
```

```
                                        <End Role="DataPoint" EntitySet="DataPoints"/>
                                        <End Role="Note" EntitySet="Notes"/>
                                </AssociationSet>
                        </EntityContainer>
                        <EntityType Name="DataPoint">
                                <Key>
                                        <PropertyRef Name="TimePoint"/>
                                </Key>
                                <Property Name="TimePoint" Type="Edm.DateTime" Nullable="false" Preci
                                <Property Name="Temperature" Type="Edm.Single" m:FC_TargetPath="Syndi
                                <Property Name="Humidity" Type="Edm.Byte"/>
                                <Property Name="DewPoint" Type="Edm.Single"/>
                                <Property Name="Pressure" Type="Edm.Int16"/>
                                <Property Name="WindSpeed" Type="Edm.Single"/>
                                <Property Name="WindDirection" Type="Edm.String" MaxLength="3" Unicod
                                <Property Name="WindSpeedMax" Type="Edm.Single"/>
                                <Property Name="SunRainStart" Type="Edm.Time" Precision="0"></Propert
                                <Property Name="Sun" Type="Edm.Single"/>
                                <Property Name="Rain" Type="Edm.Single"/>
                                <NavigationProperty Name="Note" Relationship="WeatherSchema.DataPoint
                                        FromRole="DataPoint" ToRole="Note"/>
                        </EntityType>
                        <EntityType Name="Note">
                                <Key><PropertyRef Name="ID"></PropertyRef></Key>
                                <Property Name="ID" Type="Edm.Int32" Nullable="false"/>
                                <Property Name="StartDate" Type="Edm.DateTime" Nullable="false" Preci
                                <Property Name="EndDate" Type="Edm.DateTime" Nullable="false" Precisi
                                <Property Name="Details" Type="Edm.String" MaxLength="1024" Nullable=
                                <NavigationProperty Name="DataPoints" Relationship="WeatherSchema.Dat
                                        FromRole="Note" ToRole="DataPoint"/>
                        </EntityType>
                        <Association Name="DataPointNote">
                                <End Role="DataPoint" Type="WeatherSchema.DataPoint" Multiplicity="*"
                                <End Role="Note" Type="WeatherSchema.Note" Multiplicity="0..1"/>
                        </Association>
                </Schema>
        </edmx:DataServices>
</edmx:Edmx>
```

I've added two feed customisations to this model. The TimePoint field of the data point will be echoed in the Atom 'updated' field and the Temperature field will become the Atom title. This will make my OData service more interesting to look at in a standard browser.

As before, we'll save the model to a file and load it when our script starts up.

To link the model to a SQLite database back-end we need to create an instance of *SQLiteEntityContainer*:

```
    SAMPLE_DB='weather.db'

def make_container(doc, drop=False, path=SAMPLE_DB):
    if drop and os.path.isfile(path):
        os.remove(path)
    create = not os.path.isfile(path)
    container = SQLiteEntityContainer(
        file_path=path,
        container=doc.root.DataServices['WeatherSchema.CambridgeWeather'])
    if create:
        container.create_all_tables()
    return doc.root.DataServices['WeatherSchema.CambridgeWeather']
```

This function handles the only SQL-specific part of our project. When we create a SQLite container we have to pass *two* keyword arguments: rather than just the container definition as we did for the in-memory implementation. We don't need to return a value because the SQL implementation is bound to the model that was passed in *doc*.

The code above automatically creates the tables if the database doesn't exist yet. This is fine if you are starting from scratch but if you want to expose an existing database you'll need to work backwards from your existing schema when creating the model. Anyway, letting Pyslet create your SQL tables for you neglects your DBA who will almost certainly want to create indexes to optimise performance and tweak the model to get the best out of your platform. The automatically generated SQL script is supposed to be a starting point, not the complete solution.

For example, the data set I used for this project has over 300,000 records in it. At the end of this exercise I had an OData server capable of serving this information from a SQLite database but example URLs were taking 10s or more on my laptop to load. I created an index on the Temperature column using the SQLite command line and the page load times were instantaneous:

```
sqlite> create index TIndex ON DataPoints(Temperature);
```

Modelling an Existing Database

For simple data properties it should be fairly easy to map to the EDM. Here is the way Pyslet maps simple types in the EDM to SQL types:

EDM Type	SQL Equivalent
Edm.Binary	BINARY(MaxLength) if FixedLength specified
Edm.Binary	VARBINARY(MaxLength) if no FixedLength
Edm.Boolean	BOOLEAN
Edm.Byte	SMALLINT
Edm.DateTime	TIMESTAMP
Edm.DateTimeOffset	CHARACTER(20), ISO 8601 string representation is used
Edm.Decimal	DECIMAL(Precision,Scale), defaults 10,0
Edm.Double	FLOAT
Edm.Guid	BINARY(16)
Edm.Int16	SMALLINT
Edm.Int32	INTEGER
Edm.Int64	BIGINT
Edm.SByte	SMALLINT
Edm.Single	REAL
Edm.String	CHAR(MaxLength) or VARCHAR(MaxLength)
Edm.String	NCHAR(MaxLength) or NVARCHAR(MaxLength) if Unicode="true"
Edm.Time	TIME

Navigation properties, and complex properties do not map as easily but they can still be modelled. To start with, look at the way the SQLite implementation turns our model into a SQL CREATE TABLE statement:

```
>>> import weather
>>> doc=weather.load_metadata()
>>> weather.make_container(doc)
>>> dataPoints=doc.root.DataServices['WeatherSchema.CambridgeWeather.DataPoints'].OpenCollection()
>>> print dataPoints.create_table_query()[0]
CREATE TABLE "DataPoints" ("TimePoint" TIMESTAMP NOT NULL,
"Temperature" REAL, "Humidity" SMALLINT, "DewPoint" REAL, "Pressure"
SMALLINT, "WindSpeed" REAL, "WindDirection" TEXT, "WindSpeedMax"
REAL, "SunRainStart" REAL, "Sun" REAL, "Rain" REAL,
"DataPointNotes_ID" INTEGER, PRIMARY KEY ("TimePoint"), CONSTRAINT
"DataPointNotes" FOREIGN KEY ("DataPointNotes_ID") REFERENCES
"Notes"("ID"))
```

After all the data properties there's an additional property called DataPointNotes_ID which is a foreign key into into the Notes table. This was created automatically to model the association set that links the two EntitySets in the container.

Pyslet generates foreign keys for the following types of association:

0..1 to 1	With UNIQUE and NOT NULL constraints
* to 1	With a NOT NULL constraint only
* to 0..1	No additional constraints

When these relationships are reversed the foreign key is of course created in the target table.

What if your foreign key has a different name, say, NoteID? Pyslet gives you the chance to override all name mappings. To fix up this part of the model you need to create a derived class of the base class *SQLEntityContainer* and override the *mangle_name()* method.

In this case, the method would have been called like this:

```
quotedName=container.mangle_name((u"DataPoints",u"DataPointNotes",u"ID"))
```

There is a single argument consisting of a tuple. The first item is the name of the EntitySet (SQL TABLE) and the subsequent items complete a kind of 'path' to the value. Foreign keys have a path comprising of the AssociationSet name followed by the name of the key field in the target EntitySet. The default implementation just joins the path with an underscore character. The method must return a suitably quoted value to use for the column name. To complete the example, here is how our subclass might implement this method to ensure that the foreign key is called 'NoteID' instead of 'DataPointNotes_ID':

```
def mangle_name(self,source_path):
        if source_path==(u"DataPoints",u"DataPointNotes",u"ID"):
                return self.quote_identifier(u'NoteID')
        else:
                return super(MyCustomerContainer,self).mangle_name(source_path)
```

You may be wondering why we don't expose the foreign key field in the model. Some libraries might force you to expose the foreign key in order to expose the navigation property but Pyslet takes the opposite approach. The whole point of navigation properties is to hide away details like foreign keys. If you really want to access the value you can always use an expansion and select the key field in the target entity. Exposing it in the source entity just tempts you in to writing code that 'knows' about your model for example, if we had exposed the foreign key in our example as a simple property we might have been tempted to do something like this:

```
noteID=data_point['DataPointNotes_ID'].value
if noteID is not None:
        note=noteCollection[noteID]
        # do something with the note
```

When we should be doing something like this:

```
note=data_point['Note'].GetEntity()
if note is not None:
        # do something with the note
```

Complex types are handled in the same way as foreign keys, the path being comprised of the name(s) of the complex field(s) terminated by the name of a simple property. For example, if you have a complex type called Address and two properties of type Address called "Home" and "Work" you might end up with SQL that looked like this:

```
CREATE TABLE Employee (
        ...
        Home_Street NVARCHAR(50),
        Home_City NVARCHAR(50),
        Home_Phone NVARCHAR(50),
```

```
        Work_Street NVARCHAR(50),
        Work_City NVARCHAR(50),
        Work_Phone NVARCHAR(50)
        ...
        )
```

You often see SQL written like this anyway so if you want to tweak the mapping to put a Complex type in your model you can.

Finally, we need to deal with the symmetric relationships, 1 to 1 and * to *. These are modelled by separate tables. 1 to 1 relationships are best avoided, the advantages over combining the two entities into a single larger entity are marginal given OData's $select option which allows you to pick a subset of the fields anyway. If you have them in your SQL schema already you might consider creating a view to combine them before attempting to map them to the metadata model.

Either way, both types of symmetric relationships get mapped to a table with the name of the AssociationSet. There are two sets of foreign keys, one for each of the EntitySets being joined. The paths are rather complex and are explained in detail in *SQLAssociationCollection*.

Step 2: Test the Model

Before we add the complication of using our model with a SQL database, let's test it out using the same in-memory implementation we used before:

```
def dry_run():
        doc=load_metadata()
        container=InMemoryEntityContainer(doc.root.DataServices['WeatherSchema.CambridgeWeather'])
        weatherData=doc.root.DataServices['WeatherSchema.CambridgeWeather.DataPoints']
        weather_notes=doc.root.DataServices['WeatherSchema.CambridgeWeather.Notes']
        load_data(weatherData,SAMPLE_DIR)
        load_notes(weather_notes,'weathernotes.txt',weatherData)
        return doc.root.DataServices['WeatherSchema.CambridgeWeather']
```

SAMPLE_DIR here is the name of a directory containing data from the weather station. The implementation of the load_data function is fairly ordinary, parsing the daily text files from the station and adding them to the DataPoints entity set.

The implementation of the load_notes function is more interesting as it demonstrates use of the API for binding entities together using navigation properties:

```
def load_notes(weather_notes,file_name,weatherData):
        with open(file_name,'r') as f:
                id=1
                with weather_notes.OpenCollection() as collection, weatherData.OpenCollection() as da
                        while True:
                                line=f.readline()
                                if len(line)==0:
                                        break
                                elif line[0]=='#':
                                        continue
                                noteWords=line.split()
                                if noteWords:
                                        note=collection.new_entity()
                                        note['ID'].set_from_value(id)
                                        start=iso.TimePoint(
                                                date=iso.Date.from_str(noteWords[0]),
                                                time=iso.Time(hour=0,minute=0,second=0))
                                        note['StartDate'].set_from_value(start)
```

```
                                        end=iso.TimePoint(
                                                date=iso.Date.from_str(noteWords[1]).offset(days=1),
                                                time=iso.Time(hour=0,minute=0,second=0))
                                        note['EndDate'].set_from_value(end)
                                        note['Details'].set_from_value(string.join(noteWords[2:],' '))
                                        collection.insert_entity(note)
                                        # now find the data points that match
                                        data.set_filter(core.CommonExpression.from_str("TimePoint ge
                                        for data_point in data.values():
                                                data_point['Note'].BindEntity(note)
                                                data.update_entity(data_point)
                                        id=id+1
        with weather_notes.OpenCollection() as collection:
                collection.set_orderby(core.CommonExpression.OrderByFromString('StartDate desc'))
                for e in collection.itervalues():
                        with e['DataPoints'].OpenCollection() as affectedData:
                                print "%s-%s: %s (%i data points affected)"%(unicode(e['StartDate'].v
                                unicode(e['EndDate'].value),e['Details'].value,len(affectedDa
```

The function opens collections for both Notes and DataPoints. For each uncommented line in the source file it creates a new Note entity, then, it adds a filter to the collection of data points that narrows down the collection to all the data points affected by the note and then iterates through them binding the note to the data point and updating the entity (to commit the change to the data source). Here's a sample of the output on a dry-run of a small sample of the data from November 2007:

```
2007-12-25T00:00:00-2008-01-03T00:00:00: All sensors inaccurate (0 data points affected)
2007-11-01T00:00:00-2007-11-23T00:00:00: rain sensor over reporting rainfall following malfunction (4
```

You may wonder why we use the values function, rather than itervalues in the loop that updates the data points. itervalues would certainly have been more efficient but, just like native Python dictionaries, it is a bad idea to modify the data source when iterating as unpredictable things may happen. The concept is extended by this API to cover the entire container: a thread should not modify the container while iterating through a collection.

Of course, this API has been designed for parallel use so there is always the chance that another thread or process is modifying the data source outside of your control. Behaviour in that case is left to be implementation dependent - storage engines have widely differing policies on what to do in these cases.

If you have large amounts of data to iterate through you should consider using list(collection.iterpage(True)) instead. For a SQL data souurce this has the disadvantage of executing a new query for each page rather than spooling data from a single SELECT but it provides control over page size (and hence memory usage in your client) and is robust to modifications.

> As an aside, if you change the call from values to itervalues in the sample you may well discover a bug in the SQLite driver in Python 2.7. The bug means that a commit on a database connection while you are fetching data on another cursor causes subsequent data access commands to fail. It's a bit technical, but the details are here: http://bugs.python.org/issue10513

Having tested the model using the in-memory provider we can implement a full test using the SQL back-end we created in make_container above. This test function prints the 30 strongest wind gusts in the database, along with any linked note:

```
def test_model(drop=False):
        doc=load_metadata()
        container=make_container(doc,drop)
        weatherData=doc.root.DataServices['WeatherSchema.CambridgeWeather.DataPoints']
        weather_notes=doc.root.DataServices['WeatherSchema.CambridgeWeather.Notes']
        if drop:
                load_data(weatherData,SAMPLE_DIR)
                load_notes(weather_notes,'weathernotes.txt',weatherData)
```

```
        with weatherData.OpenCollection() as collection:
                collection.set_orderby(core.CommonExpression.OrderByFromString('WindSpeedMax desc'))
                collection.set_page(30)
                for e in collection.iterpage():
                        note=e['Note'].GetEntity()
                        if e['WindSpeedMax'] and e['Pressure']:
                                print "%s: Pressure %imb, max wind speed %0.1f knots (%0.1f mph); %s
                                        e['Pressure'].value,e['WindSpeedMax'].value,e['WindSpeedMax']
                                        note['Details'] if note is not None else "")
```

Here's some sample output:

```
>>> weather.test_model()
2002-10-27T10:30:00: Pressure 988mb, max wind speed 74.0 knots (85.2 mph);
2004-03-20T15:30:00: Pressure 993mb, max wind speed 72.0 knots (82.9 mph);
2007-01-18T14:30:00: Pressure 984mb, max wind speed 70.0 knots (80.6 mph);
... [ and so on ]
...
2007-01-11T10:30:00: Pressure 998mb, max wind speed 58.0 knots (66.7 mph);
2007-01-18T07:30:00: Pressure 980mb, max wind speed 58.0 knots (66.7 mph);
1996-02-18T04:30:00: Pressure 998mb, max wind speed 56.0 knots (64.4 mph); humidity and dewpoint reac
2000-12-13T01:30:00: Pressure 991mb, max wind speed 56.0 knots (64.4 mph);
2002-10-27T13:00:00: Pressure 996mb, max wind speed 56.0 knots (64.4 mph);
2004-01-31T17:30:00: Pressure 983mb, max wind speed 56.0 knots (64.4 mph);
```

Notice that the reading from 1996 has a related note.

Step 4: Link the Data Source to the OData Server

This data set is designed to be updated by some offline process that polls the weather station for the latest readings and adds them to the database behind the scenes. Unlike the memory-cache example, the OData interface should be read-only so we use the `ReadOnlyServer` sub-class of the OData server:

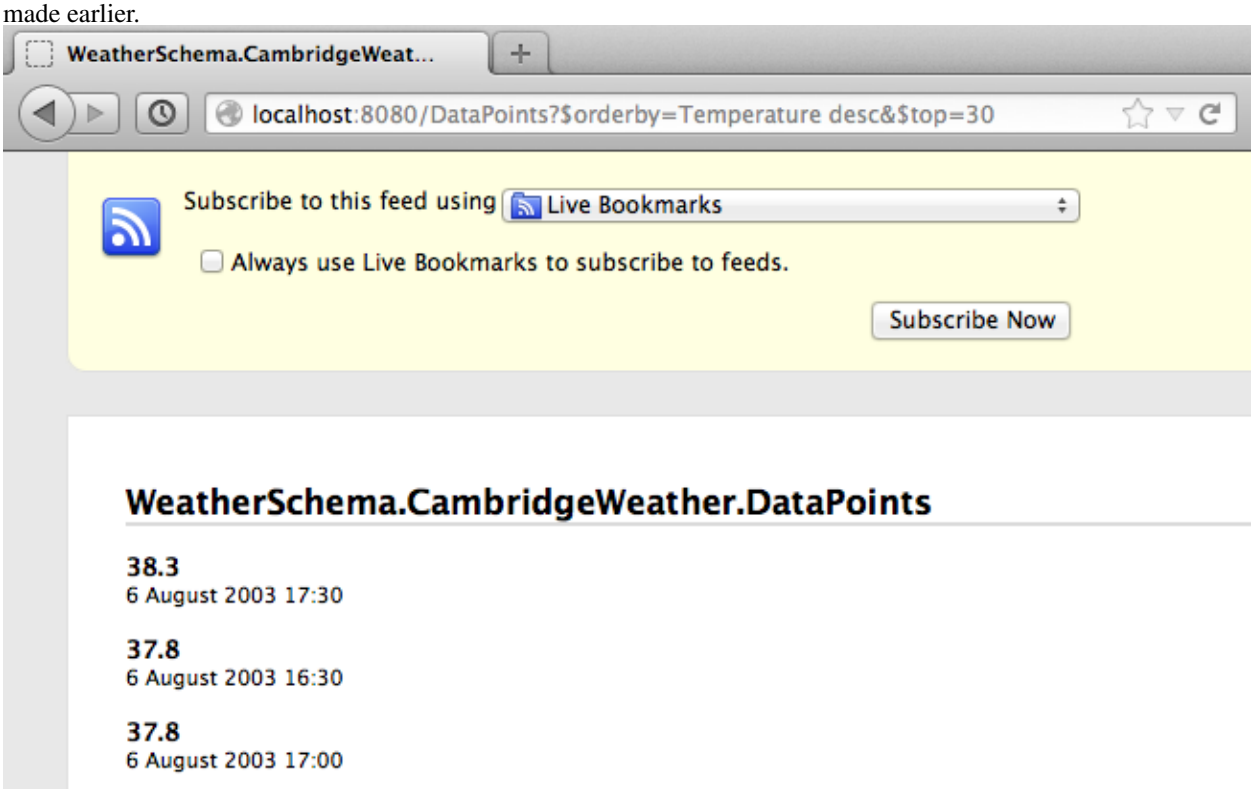
```
def run_weather_server(weather_app=None):
        """Starts the web server running"""
        server=make_server('',SERVICE_PORT,weather_app)
        logging.info("HTTP server on port %i running"%SERVICE_PORT)
        # Respond to requests until process is killed
        server.serve_forever()

def main():
        """Executed when we are launched"""
        doc=load_metadata()
        container=make_container(doc)
        server=ReadOnlyServer(serviceRoot=SERVICE_ROOT)
        server.SetModel(doc)
        t=threading.Thread(target=run_weather_server,kwargs={'weather_app':server})
        t.setDaemon(True)
        t.start()
        logging.info("Starting HTTP server on %s"%SERVICE_ROOT)
        t.join()
```

Once the script is running we test in a browser. I've loaded the full data set into the server, how many data points? Here's how we can find out, in our browser we go to:

```
http://localhost:8080/DataPoints/$count
```

The result is 325213. Firefox recognises that the feeds are in Atom format and renders the feed customisations we made earlier.



When we access this page with logging turned up to INFO we get the following output on the console, interspersed with the simple HTTP server output:

```
INFO:root:SELECT COUNT(*) FROM "DataPoints"; []
127.0.0.1 - - [21/Feb/2014 22:57:01] "GET /DataPoints/$count HTTP/1.1" 200 6
INFO:root:SELECT "TimePoint", "Temperature", "Humidity", "DewPoint", "Pressure", "WindSpeed", "WindDi
127.0.0.1 - - [21/Feb/2014 22:57:18] "GET /DataPoints?$orderby=Temperature%20desc&$top=30 HTTP/1.1" 2
```

You may wonder what those square brackets are doing at the end of the SQL statements. They're actually used for logging the parameter values when the query has been parameterised. If we add a filter you'll see what they do:

```
http://localhost:8080/DataPoints?$filter=Temperature%20gt%20-100&$orderby=Temperature%20asc&$top=30
```

And here's the output on the console:

```
INFO:root:SELECT "TimePoint", "Temperature", "Humidity", "DewPoint", "Pressure", "WindSpeed", "WindDi
127.0.0.1 - - [21/Feb/2014 16:35:09] "GET /DataPoints?$filter=Temperature%20gt%20-100&$orderby=Tempe
```

Yes, all Pyslet queries are fully parameterized for security and performance!

4.2.3 Sample Project: Custom Data Service

The sample code for this service is in the samples directory in the Pyslet distribution: fsodata.py

This project demonstrates how to construct a simple OData service based on a custom EntityContainer class. It also demonstrates how to handle media streams in your own data sources.

Although OData is often talked about as the ODBC of the web there is no reason why your data has to be in a database format to be exposed by OData...

Step 0: Create the DAL implementation

If your data source is in a general form then you will want to create general classes dervied from *pyslet.odata2.core.EntityCollection* and *pyslet.odata2.core.NavigationCollection*. For example, suppose you want to expose data stored in a 'Unix' database accessed using one of Python's dbm modules. You could write a general implementation that maps this DAL API to the dbm interface. This is similar to the approach taken with the SQL classes, they are written using Python's DB API enabling a wide variety of SQL databases to be exposed through OData with little or no extra work required for a specific data set.

On the other hand, if your datasource is fairly specific to a particular application you might create specific implementations of these classes that are tied to the entities in your model.

In this project, we'll take the latter approach and so defer discussion of the implementation details until we've constructed the model.

Step 1: Creating the Metadata Model

For small amounts of data, the basic OData classes already supplied do almost everything you need. In this example we'll expose information about the files and directories in a designated part of the file system for an application like a blog or a simple file sharing site. We'll assume that there aren't too many files and that walking the tree is a relatively painless operation to perform.

As before, we start with our metadata model, which we write by hand. There is just one entity set: Files. It has two navigation properties that are defined by a single parent/child association.

Here's the model:

```
<?xml version="1.0" encoding="utf-8" standalone="yes" ?>
<edmx:Edmx Version="1.0"
    xmlns:edmx="http://schemas.microsoft.com/ado/2007/06/edmx"
    xmlns:m="http://schemas.microsoft.com/ado/2007/08/dataservices/metadata">
    <edmx:DataServices m:DataServiceVersion="2.0">
        <Schema Namespace="FSSchema"
            xmlns="http://schemas.microsoft.com/ado/2006/04/edm">
            <EntityContainer Name="FS" m:IsDefaultEntityContainer="true">
                <EntitySet Name="Files" EntityType="FSSchema.File"/>
                <AssociationSet Name="Directories"
                    Association="FSSchema.Directory">
                    <End Role="Parent" EntitySet="Files"/>
                    <End Role="Child" EntitySet="Files"/>
                </AssociationSet>
            </EntityContainer>
            <EntityType Name="File" m:HasStream="true">
                <Key>
                    <PropertyRef Name="path"/>
                </Key>
                <Property Name="path" Type="Edm.String" Nullable="false"
                    MaxLength="1024" Unicode="false" FixedLength="false"/>
                <Property Name="name" Type="Edm.String" Nullable="false"
                    MaxLength="255" Unicode="true" FixedLength="false"
                    m:FC_TargetPath="SyndicationTitle"
                    m:FC_KeepInContent="true"/>
                <Property Name="isDirectory" Type="Edm.Boolean"
                    Nullable="false"/>
                <Property Name="size" Type="Edm.Int32" Nullable="true"/>
                <Property Name="lastAccess" Type="Edm.DateTime"
                    Nullable="false" Precision="3"/>
                <Property Name="lastModified" Type="Edm.DateTime"
```

```
                    Nullable="false" Precision="3"
                    m:FC_TargetPath="SyndicationUpdated"
                    m:FC_KeepInContent="true"/>
                <NavigationProperty Name="Files"
                    Relationship="FSSchema.Directory" FromRole="Parent"
                    ToRole="Child"/>
                <NavigationProperty Name="Parent"
                    Relationship="FSSchema.Directory" FromRole="Child"
                    ToRole="Parent"/>
            </EntityType>
            <Association Name="Directory">
                <End Role="Parent" Type="FSSchema.File"
                    Multiplicity="0..1"/>
                <End Role="Child" Type="FSSchema.File" Multiplicity="*"/>
            </Association>
        </Schema>
    </edmx:DataServices>
</edmx:Edmx>
```

I've added two feed customisations to this model. The last modified date of the file will be echoed in the Atom 'updated' field and the file's name will become the Atom title. This will make my OData service more interesting to look at in a standard browser.

Finally, we want to actually download these files so I've added the HasStream attribute to the EntityType declaration. The idea is that using the $value path option in the URL will allow you to download the contents of the file.

As before, we'll save the model to a file and load it when our script starts up. This model is fsschema.xml in the samples directory.

Step 0: Revisited

Now we have our metadata model specified we can start implementing the classes that will enable it. The keys in our entities are pseudo-paths to the files within a special directory using '/' as a separator, for example '/dirA/dirB/file.txt'.

We start with a constant to specify the BASE_PATH and two functions, one that turns our path 'keys' into file-system absolute paths and one that reverses the transformation. I won't repeat the code for these functions here as they can be found in the sample code under the names fspath_to_path and path_to_fspath, but their main job is to ensure that symbolic links and all files and directories with names starting '.' are hidden from the service and that no nefarious OData queries can circumvent the restrictions on the exposed directory.

Given an absolute file system path we can now write a function that will fill in the details for an entity. Notice the last thing it does is set the entity's `exists` flag to True indicating that the entity represents a real object in our exposed directory:

```
def fspath_to_entity(fspath, e):
    path = fspath_to_path(fspath)
    e['path'].set_from_value(path)
    if path == '/':
        e['name'].set_from_value('/')
    else:
        e['name'].set_from_value(path.split('/')[-1])
    if os.path.isfile(fspath):
        e['isDirectory'].set_from_value(False)
        try:
            info = os.lstat(fspath)
            e['size'].set_from_value(info.st_size)
            e['lastAccess'].set_from_value(info.st_atime)
            e['lastModified'].set_from_value(info.st_mtime)
```

```
        except IOError:
            # just leave the information as NULLs
            pass
    elif os.path.isdir(fspath):
        e['isDirectory'].set_from_value(True)
    else:
        raise ValueError
    e.exists = True
```

Armed with this utility function we derive a class from *pyslet.odata2.core.EntityCollection* and bind it to our metadata model when the script starts up. We'll look at the details of this class later but let's start with the declaration:

```
import pyslet.odata2.core as odata

class FSCollection(odata.EntityCollection):
    """ this is our custom collection class
        ... more details below"""
```

Let's look at the first part of the load_metadata function which is called on script start-up:

```
import pyslet.odata2.metadata as edmx

def load_metadata(
        path=os.path.join(os.path.split(__file__)[0], 'fsschema.xml')):
    """Loads the metadata file from the script directory."""
    doc = edmx.Document()
    with open(path, 'rb') as f:
        doc.Read(f)
    # next step is to bind our model to it
    container = doc.root.DataServices['FSSchema.FS']
    container['Files'].bind(FSCollection)
    # ... more initialisation stuff here
```

The critical step here is the last line where we *bind* our custom collection class to the 'Files' entity set. From this point on, calls to the DAL API for the File entity set will be routed to our collection class, not the default implementation. What do we need to do to handle them?

Writing our Custom Entity Collection

The basic *pyslet.odata2.csdl.EntityCollection* class documents the key methods we must override. Our implementation is made a little simpler because we don't need to override the __init__ method. In fact, it is enough to override just a single method to get our custom provider working: itervalues. There's a catch though, itervalues must iterate through all the entities in the collection honouring any filter, ordering and expand rules that are in effect. This sounds like a lot of work but the basic implementation has helper methods that can be used to wrap a simpler implementation.

We start by defining a generator function that yields all the entities in the collection, in no particular order:

```
def generate_entities(self):
    """List all the files in our file system

    The first item yielded is a dummy value with path /"""
    e = self.new_entity()
    e['path'].set_from_value('/')
    e['name'].set_from_value('/')
    e['isDirectory'].set_from_value(True)
    e.exists = True
```

```
    yield e
    for dirpath, dirnames, filenames in os.walk(BASE_PATH):
        for d in dirnames:
            fspath = os.path.join(dirpath, d)
            e = self.new_entity()
            try:
                fspath_to_entity(fspath, e)
                yield e
            except ValueError:
                # unexpected but ignore
                continue
        for f in filenames:
            fspath = os.path.join(dirpath, f)
            e = self.new_entity()
            try:
                fspath_to_entity(fspath, e)
                yield e
            except ValueError:
                # unexpected but ignore
                continue
```

We use the builtin os.walk generator and the helper function fspath_to_entity that we defined earlier. Notice how we use the *new_entity()* method to create an instance and then pass it to fspath_to_entity to get it filled in with the details. The first entity, corresponding to the root of our exposed directory, is created by hand for simplicity.

We can now use this generator, combined with the wrapper methods defined by the base class for itervalues:

```
def itervalues(self):
    return self.order_entities(
        self.expand_entities(self.filter_entities(
            self.generate_entities())))
```

Our generator function is passed to filter_entities which iterates through our generator yielding only the entities that *match* the filter. Similarly, this filtered iterable is then iterated by the expand_entities method to implement the expand and select rules. Finally, the resulting generator is wrapped by the order_entities method which sorts them according to the orderby rules. This last step does nothing if there is no orderby option in effect but if there is it is a bit wasteful because the iterator will be turned into a list before it is sorted, causing all entities to be loaded into memory. See *Big vs Small Data* for advice on dealing with this issue.

With itervalues defined our provider should now be working. The navigation properties are not bound yet so they'll yield nothing but the basic Files feed should be returning all the eligible files in the BASE_PATH directory.

Before we pack up and commit our changes though we need to revisit the advice in the base class. Although functional, our collection is very inefficient when someone uses direct key lookup. Essentially, we're iterating through the entire collection every time, just to find a matching key. We SHOULD override `__getitem__()` to improve our code:

```
def __getitem__(self, path):
    """Get just a single file, by path"""
    try:
        fspath = path_to_fspath(path)
        e = self.new_entity()
        fspath_to_entity(fspath, e)
        if self.check_filter(e):
            if self.expand or self.select:
                e.Expand(self.expand, self.select)
            return e
        else:
            raise KeyError("Filtered path: %s" % path)
    except ValueError:
```

```
        raise KeyError("No such path: %s" % path)
```

The code is pretty simple, we convert the path 'key' into a full file system path and then return just that entity. Our path_to_fspath method takes care of raising KeyError for us if the path doesn't correspond to an object that exists in the directory we're exposing. fspath_to_entity raises ValueError if the file system path turns out not to belong to a regular file or directory so we catch this and raise KeyError there too.

Notice that the value returned by key lookup must still honour any filter in place. We use the base class method *check_filter* to help us implement this requirement. Similarly for *set_expand*.

The final suggestion for improvement is to override the __len__ method in order to provide a more efficient implementation for determining the number of entities in the collection. Unfortunately, in this case we don't really have a better method than iterating through them all so we skip that part.

Dealing With Navigation

To make our example more interesting, I've defined two navigation properties that enable you to use OData to traverse the file system by navigating up to a File's parent directory or down to the files and sub-directories it contains. The implementations are similar but we have to define two separate classes derived from *pyslet.odata2.core.NavigationCollection* and we have to use the attribute from_entity which contains the entity we are navigating from:

```
class FSChildren(odata.NavigationCollection):

    # itervalues defined as before

    def generate_entities(self):
        """List all the children of an entity"""
        path = self.from_entity['path'].value
        fspath = path_to_fspath(path)
        if os.path.isdir(fspath):
            for filename in os.listdir(fspath):
                child_fspath = os.path.join(fspath, filename)
                try:
                    e = self.new_entity()
                    fspath_to_entity(child_fspath, e)
                    yield e
                except ValueError:
                    # skip this one
                    continue

    # __getitem__ omitted for brevity...


class FSParent(odata.NavigationCollection):

    # itervalues defined as before

    def generate_entities(self):
        """List the single parent of an entity"""
        path = self.from_entity['path'].value
        if path == '/':
            # special case, no parent
            return
        parent_path = string.join(path.split('/')[:-1], '/')
        if not parent_path:
            # special case!
```

```
            parent_path = '/'
        parent_fspath = path_to_fspath(parent_path)
        try:
            e = self.new_entity()
            fspath_to_entity(parent_fspath, e)
            yield e
        except ValueError:
            # really unexpected, every path should have a parent
            # except for the root
            raise ValueError("Unexpected path error: %s" % parent_path)

    # __getitem__ omitted for brevity...
```

Notice in the second class that navigation properties are always defined in terms of collections, even if they are only supposed to yield a maximum of one item as is the case here with navigation to the parent directory.

To make these navigation classes active we have to bind them in a similar way to the way we bound the main collection class, here's the rest of the load_metadata function we defined earlier:

```
container['Files'].BindNavigation('Files', FSChildren)
container['Files'].BindNavigation('Parent', FSParent)
```

Adding Support for Streams

To access the contents of the file we need to implement support for the stream methods on the base collection. These methods are only supported (and needed) on base collections, not on navigation collections. As a result, we'll add them to our FSCollection class.

To support reading streams you need to support two new methods, read_stream and read_stream_close. These methods are very similar, they just provide different approaches to obtaining the data. read_stream pushes the data by writing it to a file you pass in as a parameter and read_stream_close pulls the stream, returning a generator that iterates over the data and closing the collection when the iteration terminates. This second form is used by the OData server as it is more compatible with the way the WSGI framework expects to consume data.

The stream methods use a very simple class *StreamInfo* to return some basic information about the stream such as the content type, the size and modification time. The content type is required, everything else is optional:

```
def _get_path_info(self, path):
    try:
        e = self[path]
        fspath = path_to_fspath(path)
        if os.path.isdir(fspath):
            # directories return zero-length data
            sinfo = odata.StreamInfo(type=params.PLAIN_TEXT, size=0)
        else:
            root, ext = os.path.splitext(fspath)
            type = map_extension(ext)
            modified = e['lastModified'].value
            if modified:
                modified = modified.with_zone(0)
            sinfo = odata.StreamInfo(
                type=type,
                modified=modified,
                size=e['size'].value)
        return fspath, sinfo
    except ValueError:
        raise KeyError("No such path: %s" % path)
```

This method returns a tuple of the native file system path and the basic information about the stream. For directories, we return a zero-length text/plain stream, for files we use an internally defined map_extension function to look up the file extension in a simple dictionary.

The type is an instance of *pyslet.http.params.MediaType* which is a class wrapper for content types, you can create you own very simply by passing the type and subtype as strings:

```
type = params.MediaType('image','gif')
```

or, if you have untrusted input, by creating an instance from a string:

```
type = params.MediaType.from_str(
    'text/html; name=index.htm; charset="utf-8"')
print type
# prints: text/html; charset=utf-8; name=index.htm
```

To generate the data we use another private method:

```
def _generate_file(self, fspath, close_it=False):
    try:
        with open(fspath,'rb') as f:
            data = ''
            while True:
                data = f.read(io.DEFAULT_BUFFER_SIZE)
                if not data:
                    # EOF
                    break
                else:
                    yield data
    finally:
        if close_it:
            self.close()
```

This is a generator method that yields the data in chunks. When the iteration is complete (or destroyed) the collection can be closed and cleaned up automatically by passing True for close_it.

Armed with these two methods we can finish our implementation by providing implementations of the two required methods for media stream support:

```
def read_stream(self, path, out=None):
    fspath, sinfo = self._get_path_info(path)
    if out is not None and sinfo.size:
        for data in self._generate_file(fspath):
            out.write(data)
    return sinfo

def read_stream_close(self, path):
    fspath, sinfo = self._get_path_info(path)
    if sinfo.size:
        return sinfo, self._generate_file(fspath,True)
    else:
        self.close()
        return sinfo, []
```

Step 2: Test the Model

Testing our model is fairly easy, I loaded a couple of files and a directory into the BASE_PATH and then ran this session from the interpreter:

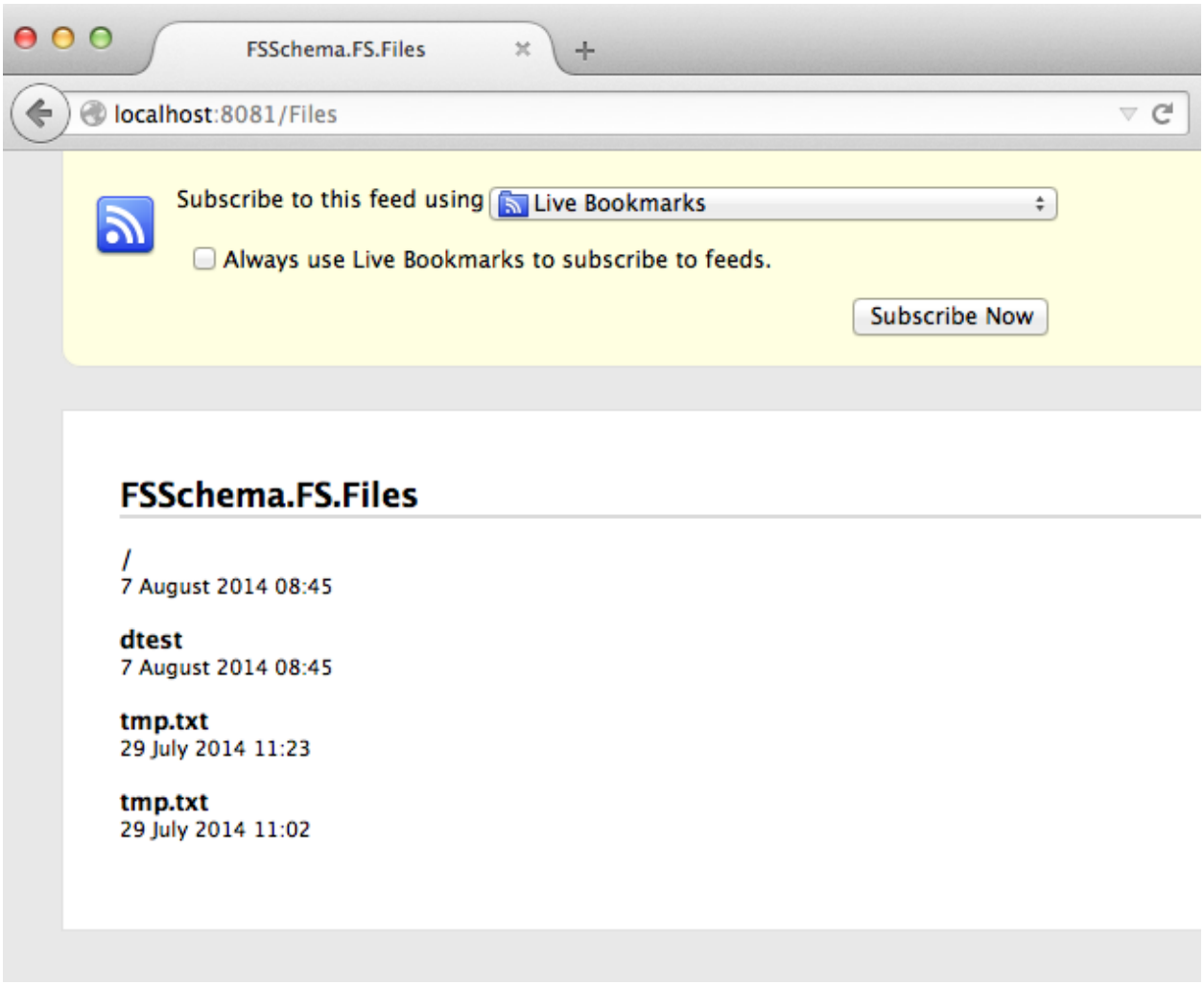
```
>>> import fsodata
>>> doc = fsodata.load_metadata()
>>> container = doc.root.DataServices['FSSchema.FS']
>>> collection = container['Files'].OpenCollection()
>>> for path in collection: print path
...
/
/dtest
/tmp.txt
/dtest/tmp.txt
>>> for f in collection.itervalues():
...     print f['path'].value, str(f['lastModified'].value)
...
/ None
/dtest None
/tmp.txt 2014-07-29T10:02:21
/dtest/tmp.txt 2014-07-29T10:23:18
>>> info, gen = collection.read_stream_close('/tmp.txt')
>>> info.size
6
>>> str(info.type)
'text/plain'
>>> for data in gen: print data
...
Hello

>>>
```

Step 3: Link the Data Source to the OData Server

This step is almost identical to previous examples.

Once the script is running we can test in a browser:



Note: Sharp eyed readers might notice the difference in the time values displayed by the browser and those displayed by the interpreter session above. It is is worth drilling down a little into EDM's DateTime type to explain. This type has fallen out of favour in OData version 4 but the idea of storing a date time value in an unspecified local time can be meaningful, even if the UTC time it represents varies depending on the location, daylight savings and so on. Indeed, this abstract concept is the one we use in day-to-day life all the time!

In this case, the dates returned by os.stat are elapsed seconds from the epoch, they are not really expressed in any particular time zone but bear in mind that their meaning doesn't change when the clocks change. This elapsed time is passed directly to the `DateTime` class where it is treated as a 'unix' time, in effect ensuring that our *lastModified* dates are always stored in UTC (but with no explicit UTC offset).

The catch comes when we publish our information as an Atom feed using OData. There's a slight oversight in the OData specification here because Atom insists that the updated time of an entry has a date *with* a timezone. When serialising the entity in Atom format Pyslet assumes that DateTime values are in UTC (which is correct in this case). Firefox, when it renders the feed, is smart enough to convert these updated times into local times for my system (which at the time was running in UTC+01:00).

Big vs Small Data

Real applications will probably want to expose more data than our simple example. How you do this depends on your data source. The worst case scenario for the implementation shown here is the use of orderby. When orderby is in effect all entities are iterated over and cached in memory before being sorted. A close second is a filter that misses all or most entities in a collection as, again, these filters will cause our method to iterate through all the entities even if iterpage is used to implement restrictions on the amount of data returned.

If your data source has its own query language then you should consider writing something that translates the OData query into the query language of your data source. This is the approach taken by the SQL-based examples.

If, on the other hand, your data source doesn't have a good query language then you could expose it using a minimal OData implementation (such as the one given here) and then use the same schema to create a SQL-backed service. Pulling the data from your data source through the API and pushing it into the SQL-backed service would be fairly trivial and could be done as a periodic synchronization process. This works even better if you have a last modified field on your entities that you can use to filter out the unchanged ones, as our simple implementation of itervalues won't cause the collection to be loaded into memory for a filter alone.

Finally, if periodic synchronization is not good enough to reflect the dynamic nature or your (unqueryable) data source then you will want to think about some type of intelligent caching to reduce the impact of worst case OData queries. You might think about simply disabling $orderby and $filter options (which is perfectly OK in OData). You can do that by overriding the *set_orderby()* and *set_filter()* methods, raising NotImplementedError.

4.2.4 Which DAL Implementation?

Transient Data

If your data is relatively small and transient then you could use the in memory implementation of the DAL API directly. This is the easiest route to creating a new OData provider as you won't need to override any of of the implementations.

Look at the example project Sample Project: InMemory Data Service to see how easy it is to create a useful in-memory key-value store.

SQL

If your data is currently in a SQL database, or if you intend to write a read-only data source and you could easily put your data into a SQL database, then you should use the Python DB ABI-based implementation as a starting point.

If your data is in a database other than a SQLite database you will have to provide a few tweaks by deriving a new class from *SQLEntityContainer*. This can't be helped, the DB API does a good job at dealing with most issues, such as variation in parameterization conventions and expected data types, but SQL connection parameters and the occasional differences in the SQL syntax mean there is likely to be a small amount of work to do.

A look at the customisations required for *SQLiteEntityContainer* where a handful of methods have had to be overridden should point the way. You may want to override the default *SQLEntityCollection* object too where functions and operators from the the expression language can be mapped on to parameterized SQL queries.

Once you have a class that can connect to your chosen database move on to A SQL-Backed Data Service.

Customer Provider

Writing a customer provider isn't as hard as you might think, provided your data set is of a mangeable size then you can use the built-in behaviour of the base classes to take care of almost all the API's needs. You just need to expose the entity values themselves by implementing a couple of methods!

Look at the example project Sample Project: Custom Data Service to see how you can write a simple application that exposes a download-directory to the web using OData (providing a little more metadata than is easily obtainable from plain HTTP.)

An OData Proxy

Finally, the OData client implementation of the DAL API opens the possibility of writing an OData proxy server. Why would you do this?

One of the big challenges for the OData protocol is web-security in the end user's browser. By supporting JSON over the wire OData sends out a clear signal that using it directly from a Javascript on a web page should be possible. But in practice, this only works well for unauthenticated (and hence read-only) OData services. If you want to write more exciting applications you leave yourself open to all manner of browser-based attacks that could expose your data to unauthorised bad guys. To mitigate these risks browsers are increasingly locking down the browser to make it harder for cross-site exploits to happen, which is a good thing. The downside is that it makes it harder for your web-application to talk to an OData server unless they are both hosted on the same domain.

An OData proxy can be co-located with your application to overcome this problem. A dumb proxy is probably best implemented by the web-server, rather than a full-blown web application but the classes defined in this package are a good starting point for writing a more intelligent proxy such as one that checks for a valid session with your application before proxying the request.

The implementation isn't trivial because the identities of the entities created by the client (as reported by `get_location()`) are the URLs of the entities as they appear in the remote data service whereas the OData proxy needs to serve up entities with identities with URLs that appear under its service root. As a result, you need to create a copy of the client's model and implement proxy classes that implement the API by pulling and pushing entities into the client. This isn't as much work as it sounds and you probably want to do it anyway so that your proxy can add value, such as hiding parts of the model that shouldn't be proxied, adding constraints for authorisation, etc.

I'm the process of developing a set of proxy classes to act as a good starting point for this type of application. Watch this space, or reach out to me via the Pyslet home page.

4.3 OData Reference

The basic API for the DAL is defined by the Entity Data Model (EDM) defined in *pyslet.odata2.csdl*, which is extended by some core OData-specific features defined in *pyslet.odata2.core* and *pyslet.odata2.metadata*. With these three modules it is possible to create derived classes that implement the Data Access Layer API in a variety of different storage scenarios.

4.3.1 Entity Data Model (EDM)

This module defines functions and classes for working with data based on Microsoft's Entity Data Model (EDM) as documented by the Conceptual Schema Definition Language and associated file format: http://msdn.microsoft.com/en-us/library/dd541474.aspx

The classes in this model fall in to two categories. The data classes represent the actual data objects, like simple and complex values, entities and collections. The metadata classes represent the elements of the metadata model like entity types, property definitions, associations, entity sets and so on. The metadata elements have direct XML representations, the data classes do not.

Data Model

class pyslet.odata2.csdl.**EntityCollection**(*entity_set*, ***kwargs*)

Bases: *pyslet.odata2.csdl.DictionaryLike*, pyslet.pep8.PEP8Compatibility

Represents a collection of entities from an *EntitySet*.

To use a database analogy, EntitySet's are like tables whereas EntityCollections are more like the database cursors that you use to execute data access commands. An entity collection may consume physical resources (like a database connection) and so should be closed with the `close()` method when you're done.

Entity collections support the context manager protocol in python so you can use them in with statements to make clean-up easier:

```
with entity_set.OpenCollection() as collection:
        if 42 in collection:
                print "Found it!"
```

The close method is called automatically when the with statement exits.

Entity collections also behave like a python dictionary of *Entity* instances keyed on a value representing the Entity's key property or properties. The keys are either single values (as in the above code example) or tuples in the case of compound keys. The order of the values in the tuple is taken from the order of the *PropertyRef* definitions in the metadata model. You can obtain an entity's key from the *Entity.key()* method.

When an EntityCollection represents an entire entity set you cannot use dictionary assignment to modify the collection. You must use *insert_entity()* instead where the reasons for this restriction are expanded on.

For consistency with python dictionaries the following statement is permitted, though it is effectively a no-operation:

```
etColl[key]=entity
```

The above statement raises KeyError if *entity* is *not* a member of the entity set. If *key* does not match the entity's key then ValueError is raised.

Although you can't add an entity with assignment you can delete an entity with the delete operator:

```
del etColl[key]
```

Deletes the entity with *key* from the entity set.

These two operations have a different meaning when a collection represents the subset of entities obtained through navigation. See *NavigationCollection* for details.

Notes for data providers

Derived classes MUST call super in their __init__ method to ensure the proper construction of the parent collection class. The proper way to do this is:

```
class MyCollection(EntityCollection):

        def __init__(self,paramA,paramsB,**kwargs):
                # paramA and paramB are examples of how to consume
                # private keyword arguments in this method so that they
                # aren't passed on to the next __init__
                super(MyCollection,self).__init__(**kwargs)
```

All collections require a named entity_set argument, an *EntitySet* instance from which all entities in the collection are drawn.

Derived classes MUST also override *itervalues()*. The implementation of itervalues must return an iterable object that honours the value of the expand query option, the current filter and the orderby rules.

Derived classes SHOULD also override `__getitem__()` and `__len__()` as the default implementations are very inefficient, particularly for non-trivial entity sets.

Writeable data sources must override py:meth:*__delitem__*.

If a particular operation is not supported for some data-service specific reason then NotImplementedError must be raised.

Writeable entity collections SHOULD override `clear()` as the default implementation is very inefficient.

entity_set = None
the entity set from which the entities are drawn

expand = None
the expand query option in effect

select = None
the select query option in effect

filter = None
a filter or None for no filter (see *check_filter()*)

orderby = None
a list of orderby rules or None for no ordering

skip = None
the skip query option in effect

top = None
the top query option in effect

topmax = None
the provider-enforced maximum page size in effect

inlinecount = None
True if inlinecount option is in effect

The inlinecount option is used to alter the representation of the collection and, if set, indicates that the __len__ method will be called before iterating through the collection itself.

get_location()
Returns the location of this collection as a *URI* instance.

By default, the location is given as the location of the *entity_set* from which the entities are drawn.

get_title()
Returns a user recognisable title for the collection.

By default this is the fully qualified name of the entity set in the metadata model.

set_expand(*expand*, *select=None*)
Sets the expand and select query options for this collection.

The expand query option causes the named navigation properties to be expanded and the associated entities to be loaded in to the entity instances before they are returned by this collection.

expand is a dictionary of expand rules. Expansions can be chained, represented by the dictionary entry also being a dictionary:

```
# expand the Customer navigation property...
{ 'Customer': None }
# expand the Customer and Invoice navigation properties
{ 'Customer':None, 'Invoice':None }
# expand the Customer property and then the Orders property within Customer
{ 'Customer': {'Orders':None} }
```

The select query option restricts the properties that are set in returned entities. The *select* option is a similar dictionary structure, the main difference being that it can contain the single key '*' indicating that all *data* properties are selected.

SelectKeys()
Sets the select rule to select the key property/properties only.

Any expand rule is removed.

expand_entities(*entityIterable*)
Utility method for data providers.

Given an object that iterates over all entities in the collection, returns a generator function that returns expanded entities with select rules applied according to *expand* and *select* rules.

Data providers should use a better method of expanded entities if possible as this implementation simply iterates through the entities and calls *Entity.Expand()* on each one.

set_filter(*filter*)
Sets the filter object for this collection, see *check_filter()*.

filter_entities(*entityIterable*)
Utility method for data providers.

Given an object that iterates over all entities in the collection, returns a generator function that returns only those entities that pass through the current *filter* object.

Data providers should use a better method of filtering entities if possible as this implementation simply iterates through the entities and calls *check_filter()* on each one.

check_filter(*entity*)
Checks *entity* against the current filter object and returns True if it passes.

This method is really a placeholder. Filtering is not covered in the CSDL model itself but is a feature of the OData *pyslet.odata2.core* module.

See `pyslet.odata2.core.EntityCollectionMixin.check_filter()` for more. The implementation in the case class simply raises NotImplementedError if a filter has been set.

set_orderby(*orderby*)
Sets the orderby rules for this collection.

orderby is a list of tuples, each consisting of:

```
( an order object as used by :py:meth:`calculate_order_key` , 1 | -1 )
```

calculate_order_key(*entity*, *orderObject*)
Given an entity and an order object returns the key used to sort the entity.

This method is really a placeholder. Ordering is not covered in the CSDL model itself but is a feature of the OData *pyslet.odata2.core* module.

See `pyslet.odata2.core.EntityCollectionMixin.calculate_order_key()` for more. The implementation in the case class simply raises NotImplementedError.

order_entities(*entityIterable*)
Utility method for data providers.

Given an object that iterates over the entities in random order, returns a generator function that returns the same entities in sorted order (according to the *orderby* object).

This implementation simply creates a list and then sorts it based on the output of *calculate_order_key()* so is not suitable for use with long lists of entities. However, if no ordering is required then no list is created.

SetInlineCount(*inlinecount*)
Sets the inline count flag for this collection.

new_entity()
Returns a new py:class:*Entity* instance suitable for adding to this collection.

The properties of the entity are set to their defaults, or to null if no default is defined (even if the property is marked as not nullable).

The entity is not considered to exist until it is actually added to the collection. At this point we deviate from dictionary-like behaviour, Instead of using assignment you must call *insert_entity()*.:

```
e=collection.new_entity()
e["ID"]=1000
e["Name"]="Fred"
assert 1000 not in collection
collection[1000]=e          # raises KeyError
```

The correct way to add the entity is:

```
collection.insert_entity(e)
```

The first block of code is prone to problems as the key 1000 may violate the collection's key allocation policy so we raise KeyError when assignment is used to insert a new entity to the collection. This is consistent with the concept behind OData and Atom where new entities are POSTed to collections and the ID and resulting entity are returned to the caller on success because the service may have modified them to satisfy service-specific constraints.

CopyEntity(*entity*)
Creates a new *entity* copying the value from *entity*

The key is not copied and is initially set to NULL.

insert_entity(*entity*)
Inserts *entity* into this entity set.

After a successful call to insert_entity:

1. ***entity* is updated with any auto-generated values such as** an autoincrement correct key.
2. `exists` is set to True for *entity*

Data providers must override this method if the collection is writable.

If the call is unsuccessful then *entity* should be discarded as its associated bindings may be in a misleading state (when compared to the state of the data source itself).

A general *ConstraintError* will be raised when the insertion violates model constraints (including an attempt to create two entities with duplicate keys).

update_entity(*entity*)
Updates *entity* which must already be in the entity set.

Data providers must override this method if the collection is writable.

update_bindings(*entity*)
Iterates through the *Entity.NavigationItems()* and generates appropriate calls to create/update any pending bindings.

Unlike the `commit()` method, which updates all data and navigation values simultaneously, this method can be used to selectively update just the navigation properties.

set_page(*top*, *skip=0*, *skiptoken=None*)
Sets the page parameters that determine the next page returned by *iterpage()*.

The skip and top query options are integers which determine the number of entities returned (top) and the number of entities skipped (skip).

skiptoken is an opaque token previously obtained from a call to *next_skiptoken()* on a similar collection which provides an index into collection prior to any additional *skip* being applied.

TopMax(*topmax*)
Sets the maximum page size for this collection.

Data consumers should use *set_page()* to control paging, however data providers can use this method to force the collection to limit the size of a page to at most topmax entities. When topmax is in force and is less than the top value set in *set_page()*, *next_skiptoken()* will return a suitable value for identifying the next page in the collection immediately after a complete iteration of *iterpage()*.

Provider enforced paging is optional, if it is not supported NotImplementedError must be raised.

iterpage(*set_next=False*)
Returns an iterable subset of the values returned by *itervalues()*

The subset is defined by the top, skip and skiptoken values set with *set_page()*

If *set_next* is True then the page is automatically advanced so that the next call to iterpage iterates over the next page.

Data providers should override this implementation for a more efficient implementation. The default implementation simply wraps *itervalues()*.

next_skiptoken()
Following a complete iteration of the generator returned by *iterpage()*, this method returns the skiptoken which will generate the next page or None if all requested entities were returned.

itervalues()
Iterates over the collection.

The collection is filtered as defined by *set_filter()* and sorted according to any rules defined by *set_orderby()*.

Entities are also expanded and selected according to the rules defined by *set_expand*.

Data providers must override this implementation which, by default, returns no entities (simulating an empty collection).

class pyslet.odata2.csdl.**Entity**(*entity_set*)
Bases: *pyslet.odata2.csdl.TypeInstance*

Represents a single instance of an *EntityType*.

Entity instance must only be created by data providers, a child class may be used with data provider-specific functionality. Data consumers should use the *EntityCollection.new_entity()* or *EntityCollection.CopyEntity* methods to create instances.

- entity_set is the entity set this entity belongs to

Entity instances extend *TypeInstance*'s dictionary-like behaviour to include all properties. As a result the dictionary values are one of *SimpleValue*, *Complex* or py:class:*DeferredValue* instances.

Property values are created on construction and cannot be assigned directly. To update a simple value use the value's *SimpleValue.set_from_value()* method:

```
e['Name'].set_from_value("Steve")
        # update simple property Name
e['Address']['City'].set_from_value("Cambridge")
        # update City in complex property Address
```

A simple valued property that is NULL is still a *SimpleValue* instance, though it will behave as 0 in tests:

```
e['Name'].set_from_value(None)    # set to NULL
if e['Name']:
        print "Will not print!"
```

Navigation properties are represented as *DeferredValue* instances. A deferred value can be opened in a similar way to an entity set:

```
# open the collection obtained from navigation property Friends
with e['Friends'].OpenCollection() as friends:
        # iterate through all the friends of entity e
        for friend in friends:
                print friend['Name']
```

A convenience method is provided when the navigation property points to a single entity (or None) by definition:

```
mum=e['Mother'].GetEntity()     # may return None
```

In the EDM one or more properties are marked as forming the entity's key. The entity key is unique within the entity set. On construction, an Entity instance is marked as being 'non-existent', *exists* is set to False. This is consistent with the fact that the data properties of an entity are initialised to their default values, or NULL if there is no default specified in the model. Entity instances returned as values in collection objects have exists set to True.

Entities from the same entity set can be compared (unlike *Complex* instances), comparison is done by *key()*. Therefore, two instances that represent that same entity will compare equal.

If an entity does not exist, OpenCollection will fail if called on one of its navigation properties with *NonExistentEntity*.

You can use *IsEntityCollection()* to determine if a property will return an *EntityCollection* without the cost of accessing the data source itself.

exists = None
whether or not the instance exists in the entity set

selected = None
the set of selected property names or None if all properties are selected

__iter__()
Iterates over the property names, including the navigation properties.

Unlike native Python dictionaries, the order in which the properties are iterated over is defined. The regular property names are yielded first, followed by the navigation properties. Within these groups properties are yielded in the order they were declared in the metadata model.

DataKeys()
Iterates through the names of this entity's data properties only

The order of the names is always the order they are defined in the metadata model.

data_items()
Iterator that yields tuples of (key,value) for this entity's data properties only.

The order of the items is always the order they are defined in the metadata model.

merge(*fromvalue*)
Sets this entity's value from *fromvalue* which must be a *TypeInstance* instance. In other words, it may be either an Entity or a Complex value.

There is no requirement that *fromvalue* be of the same type, but it must be broadly compatible, which is defined as:

Any named property present in both the current value and *fromvalue* must be of compatible types.

Any named property in the current value which is not present in *fromvalue* is left unchanged by this method.

Null values in fromvalue are not copied.

NavigationKeys()
Iterates through the names of this entity's navigation properties only.

The order of the names is always the order they are defined in the metadata model.

NavigationItems()
Iterator that yields tuples of (key,deferred value) for this entity's navigation properties only.

The order of the items is always the order they are defined in the metadata model.

CheckNavigationConstraints(*ignoreEnd=None*)
For entities that do not yet exist, checks that each of the required navigation properties has been bound (with *DeferredValue.BindEntity()*).

If a required navigation property has not been bound then `NavigationConstraintError` is raised.

If the entity already exists, *EntityExists* is raised.

For data providers, *ignoreEnd* may be set to an association set end bound to this entity's entity set. Any violation of the related association is ignored.

IsNavigationProperty(*name*)
Returns true if name is the name of a navigation property, False otherwise.

IsEntityCollection(*name*)
Returns True if *name* is the name of a navigation property that points to an entity collection, False otherwise.

commit()
Updates this entity following modification.

You can use select rules to provide a hint about which fields have been updated. By the same logic, you cannot update a property that is not selected!

The default implementation opens a collection object from the parent entity set and calls *EntityCollection.update_entity()*.

Delete()
Deletes this entity from the parent entity set.

The default implementation opens a collection object from the parent entity set and uses the del operator.

Data providers must ensure that the entity's *exists* flag is set to False after deletion.

key()
Returns the entity key as a single python value or a tuple of python values for compound keys.

The order of the values is always the order of the PropertyRef definitions in the associated EntityType's *key*.

set_key(*key*)
Sets this entity's key from a single python value or tuple.

The entity must be non-existent or *EntityExists* is raised.

auto_key(*base=None*)
Sets the key to a random value

base An optional key suggestion which can be used to influence the choice of automatically generated key.

KeyDict()
Returns the entity key as a dictionary mapping key property names onto *SimpleValue* instances.

Expand(*expand*, *select=None*)
Expands and selects properties of the entity according to the given *expand* and *select* rules (if any).

Data consumers will usually apply expand rules to a collection which will then automatically ensure that all entities returned by the collection have been expanded.

If, as a result of *select*, a non-key property is unselected then its value is set to NULL. (Properties that comprise the key are never NULL.)

If a property that is being expanded is also subject to one or more selection rules these are passed along with any chained Expand method call.

The selection rules in effect are saved in the `select` member and can be tested using *Selected()*.

Selected(*name*)
Returns true if the property *name* is selected in this entity.

You should not rely on the value of a unselected property, in most cases it will be set to NULL.

ETag()
Returns a list of EDMValue instance values to use for optimistic concurrency control or None if the entity does not support it (or if all concurrency tokens are NULL or unselected).

ETagValues()
Returns a list of EDMValue instance values that may be used for optimistic concurrency control. The difference between this method and *ETag()* is that this method returns all values even if they are NULL or unselected. If there are no concurrency tokens then an empty list is returned.

generate_ctoken()
Returns a hash object representing this entity's value.

The hash is a SHA256 obtained by concatenating the literal representations of all data properties (strings are UTF-8 encoded) except the keys and properties which have Fixed concurrency mode.

SetConcurrencyTokens()
A utility method for data providers.

Sets all *ETagValues()* using the following algorithm:

1. **Binary values are set directly from the output of** *generate_ctoken()*
2. **String values are set from the hexdigest of the output** *generate_ctoken()*
3. Integer values are incremented.
4. **DateTime and DateTimeOffset values are set to the current** time in UTC (and nudged by 1s if necessary)
5. Guid values are set to a new random (type 4) UUID.

Any other type will generate a ValueError.

ETagIsStrong()
Returns True if this entity's etag is a strong entity tag as defined by RFC2616:

```
A "strong entity tag" MAY be shared by two entities of a
resource only if they are equivalent by octet equality.
```

The default implementation returns False which is consistent with the implementation of *generate_ctoken()* as that does not include the key fields.

class pyslet.odata2.csdl.**SimpleValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.EDMValue*

An abstract class that represents a value of a simple type in the EDMModel.

This class is not designed to be instantiated directly, use one of the factory methods in EdmValue to construct one of the specific child classes.

typeCode = None
the *SimpleType* code

mtype = None
an optional *pyslet.http.params.MediaType* representing this value

value = None
The actual value or None if this instance represents a NULL value

The python type used for *value* depends on typeCode as follows:

- Edm.Boolean: one of the Python constants True or False
- Edm.Byte, Edm.SByte, Edm.Int16, Edm.Int32: int
- Edm.Int64: long
- Edm.Double, Edm.Single: python float
- Edm.Decimal: python Decimal instance (from decimal module)
- Edm.DateTime, Edm.DateTimeOffset: py:class:*pyslet.iso8601.TimePoint* instance
- Edm.Time: py:class:*pyslet.iso8601.Time* instance (not a Duration, note corrected v2 specification of OData)
- Edm.Binary: raw string
- Edm.String: unicode string
- Edm.Guid: python UUID instance (from uuid module)

For future compatibility, this attribute should only be updated using *set_from_value()* or one of the other related methods.

SimpleCast(*typeCode*)
Returns a new *SimpleValue* instance created from *typeCode*

The value of the new instance is set using *Cast()*

Cast(*targetValue*)
Updates and returns *targetValue* a *SimpleValue* instance.

The value of targetValue is replaced with a value cast from this instance's value.

If the types are incompatible a TypeError is raised, if the values are incompatible then ValueError is raised.

NULL values can be cast to any value type.

SetFromSimpleValue(*new_value*)
The reverse of the *Cast()* method, sets this value to the value of *new_value* casting as appropriate.

__eq__(*other*)
Instances compare equal only if they are of the same type and have values that compare equal.

__unicode__()
Formats this value into its literal form.

NULL values cannot be represented in literal form and will raise ValueError.

SetFromLiteral(*value*)
Decodes a value from the value's literal form.

You can get the literal form of a value using the unicode function.

set_null()
Sets the value to NULL

set_from_value(*new_value*)
Sets the value from a python variable coercing *new_value* if necessary to ensure it is of the correct type for the value's *typeCode*.

set_random_value(*base=None*)
Sets a random value based

base a *SimpleValue* instance of the same type that may be used as a base or stem or the random value generated or may be ignored, depending on the value type.

classmethod Copy(*value*)
Constructs a new SimpleValue instance by copying *value*

class pyslet.odata2.csdl.**NumericValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.SimpleValue*

An abstract class that represents all numeric simple values.

The literal forms of numeric values are parsed in a two-stage process. Firstly the utility class *Parser* is used to obtain a numeric tuple and then the value is set using *SetFromNumericLiteral()*

All numeric types may have their value set directly from int, long, float or Decimal.

Integer representations are rounded towards zero using the python *int* or *long* functions when necessary.

SetToZero()
Set this value to the default representation of zero

SetFromNumericLiteral(*numericValue*)
Decodes a value from a numeric tuple as returned by *Parser.ParseNumericLiteral()*.

class pyslet.odata2.csdl.**FloatValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.NumericValue*

Abstract class that represents one of Edm.Double or Edm.Single.

Values can be set from int, long, float or Decimal.

There is no hard-and-fast rule about the representation of float in Python and we may refuse to accept values that fall within the accepted ranges defined by the CSDL if float cannot hold them. That said, you won't have this problem in practice.

The derived classes *SingleValue* and *DoubleValue* only differ in the Max value used when range checking.

Values are formatted using Python's default unicode conversion.

Primitive SimpleTypes

Simple values can be created directly using one of the type-specific classes below.

class pyslet.odata2.csdl.**BinaryValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.SimpleValue*

Represents a *SimpleValue* of type Edm.Binary.

Binary literals allow content in the following form:

```
[A-Fa-f0-9][A-Fa-f0-9]*
```

Binary values can be set from any Python type, though anything other than a binary string is set to its pickled representation. There is no reverse facility for reading an object from the pickled value.

class pyslet.odata2.csdl.**BooleanValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.SimpleValue*

Represents a simple value of type Edm.Boolean

Boolean literals are one of:

```
true | false
```

Boolean values can be set from their Python equivalents and from any int, long, float or Decimal where the non-zero test is used to set the value.

class pyslet.odata2.csdl.**ByteValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.NumericValue*

Represents a simple value of type Edm.Byte

Byte literals must not have a sign, decimal point or exponent.

Byte values can be set from an int, long, float or Decimal

class pyslet.odata2.csdl.**DateTimeValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.SimpleValue*

Represents a simple value of type Edm.DateTime

DateTime literals allow content in the following form:

```
yyyy-mm-ddThh:mm[:ss[.ffffff]]
```

DateTime values can be set from an instance of `iso8601.TimePoint` or type int, long, float or Decimal.

Any zone specifier is ignored. There is *no* conversion to UTC, the value simply becomes a local time in an unspecified zone. This is a weakness of the EDM, it is good practice to limit use of the DateTime type to UTC times.

When set from a numeric value, the value must be non-negative. Unix time is assumed. See the *from_unix_time()* factory method of TimePoint for information.

If a property definition was set on construction then the defined precision is used when representing the value as a unicode string. For example, if the property has precision 3 then the output of the unicode conversion will appear in the following form:

```
1969-07-20T20:17:40.000
```

class pyslet.odata2.csdl.**DateTimeOffsetValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.SimpleValue*

Represents a simple value of type Edm.DateTimeOffset

DateTimeOffset literals are defined in terms of the XMLSchema lexical representation.

DateTimeOffset values can be set from an instance of `iso8601.TimePoint` or type int, long, float or Decimal.

TimePoint instances must have a zone specifier. There is *no* automatic assumption of UTC.

When set from a numeric value, the value must be non-negative. Unix time *in UTC* assumed. See the *from_unix_time()* factory method of TimePoint for information.

If a property definition was set on construction then the defined precision is used when representing the value as a unicode string. For example, if the property has precision 3 then the output of the unicode conversion will appear in the following form:

```
1969-07-20T15:17:40.000-05:00
```

It isn't completely clear if the canonical representation of UTC using 'Z' instead of an offset is intended or widely supported so we always use an offset:

```
1969-07-20T20:17:40.000+00:00
```

class pyslet.odata2.csdl.**DecimalValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.NumericValue*

Represents a simple value of type Edm.Decimal

Decimal literals must not use exponent notation and there must be no more than 29 digits to the left and right of the decimal point.

Decimal values can be set from int, long, float or Decimal values.

class pyslet.odata2.csdl.**DoubleValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.FloatValue*

Represents a simple value of type Edm.Double

Max = 1.7976931348623157e+308
the largest positive double value

This value is set dynamically on module load, theoretically it may be set lower than the maximum allowed by the specification if Python's native float is of insufficient precision but this is unlikely to be an issue.

MaxD = Decimal('1.79769313486E+308')
the largest positive double value converted to decimal form

class pyslet.odata2.csdl.**GuidValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.SimpleValue*

Represents a simple value of type Edm.Guid

Guid literals allow content in the following form: ddddddd-dddd-dddd-dddd-dddddddddddd where each d represents [A-Fa-f0-9].

Guid values can also be set directly from either binary or hex strings. Binary strings must be of length 16 and are passed as raw bytes to the UUID constructor, hexadecimal strings can be string or unicode strings and must be of length 32 characters.

class pyslet.odata2.csdl.**Int16Value**(*pDef=None*)
Bases: *pyslet.odata2.csdl.NumericValue*

Represents a simple value of type Edm.Int16

class pyslet.odata2.csdl.**Int32Value**(*pDef=None*)
Bases: *pyslet.odata2.csdl.NumericValue*

Represents a simple value of type Edm.Int32

class pyslet.odata2.csdl.**Int64Value**(*pDef=None*)
Bases: *pyslet.odata2.csdl.NumericValue*

Represents a simple value of type Edm.Int64

class pyslet.odata2.csdl.**SByteValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.NumericValue*

Represents a simple value of type Edm.SByte

class pyslet.odata2.csdl.**SingleValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.FloatValue*

Represents a simple value of type Edm.Single

Max = 3.4028234663852886e+38
the largest positive single value

This value is set dynamically on module load, theoretically it may be set lower than the maximum allowed by the specification if Python's native float is of insufficient precision but this is very unlikely to be an issue unless you've compiled Python on in a very unusual environment.

MaxD = Decimal('3.40282346639E+38')
the largest positive single value converted to Decimal

SetFromNumericLiteral(*numericValue*)
Decodes a Single value from a `Numeric` literal.

class pyslet.odata2.csdl.**StringValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.SimpleValue*

Represents a simple value of type Edm.String"

The literal form of a string is the string itself.

Values may be set from any string or object which supports the native unicode function.

class pyslet.odata2.csdl.**TimeValue**(*pDef=None*)
Bases: *pyslet.odata2.csdl.SimpleValue*

Represents a simple value of type Edm.Time

Time literals allow content in the form:

hh:mm:ss.sss

Time values can be set from an instance of *pyslet.iso8601.Time*, int, long, float or Decimal and from datetime.timedelta values.

When set from a numeric value the value must be in the range 0..86399.9 and is treated as an elapsed time in seconds since midnight.

If a property definition was set on construction then the defined precision is used when representing the value as a unicode string. For example, if the property has precision 3 then the output of the unicode conversion will appear in the following form:

```
20:17:40.000
```

Complex Types

class pyslet.odata2.csdl.**Complex**(*pDef=None*)
Bases: *pyslet.odata2.csdl.EDMValue*, *pyslet.odata2.csdl.TypeInstance*

Represents a single instance of a *ComplexType*.

IsNull()
Complex values are never NULL

set_null()
Sets all simple property values to NULL recursively

merge(*new_value*)
Sets this value from *new_value* which must be a *Complex* instance.

There is no requirement that *new_value* is of the same type, but it must be broadly compatible, which is defined as:

> Any named property present in both the current value and *new_value* must be of compatible types.

Any named property in the current value which is not present in *new_value* is left unchanged by this method.

Null values are not merged.

Navigation: Deferred Values

class pyslet.odata2.csdl.**DeferredValue**(*name*, *from_entity*)
Bases: object

Represents the value of a navigation property.

name = None
the name of the associated navigation property

from_entity = None
the entity that contains this value

pDef = None
the definition of the navigation property

isRequired = None
True if this deferred value represents a (single) required entity

isCollection = None
True if this deferred value represents a collection

isExpanded = None
True if this deferred value has been expanded.

An expanded navigation property will return a read-only *ExpandedEntityCollection* when *OpenCollection()* is called.

bindings = None
The list of entity instances or keys to bind to *from_entity* when it is inserted or next updated.

Target()
Returns the target entity set of this navigation (without opening the collection).

GetEntity()
Returns a single entity instance or None.

If this deferred value represents an entity collection then NavigationError is raised.

OpenCollection()
Opens the collection associated with this navigation property.

Returns an *EntityCollection* instance which must be closed when it is no longer needed. This is best achieved with the Python with statement using the collection's context-manager behaviour. For example:

```
with customer['Orders'].OpenCollection() as orders:
        # do something with the orders
```

set_expansion_values(*values*)
Sets the expansion of this deferred value

values A list of *Entity* instances.

No call to the underlying data-layer is made, it is assumed that values is an appropriate representation of the data that would be obtained by executing:

```
with self.OpenCollection() as coll:
    return coll.values()
```

The purpose of this method is to allow the re-use of a value list that has been obtained previously without having to consult the data source again.

SetExpansion(*expandedCollection*)
Sets the expansion for this deferred value to the *ExpandedEntityCollection* given.

If *expandedCollection* is None then the expansion is removed and future calls to `OpenColection()` will yield a (dynamically created) entity collection.

expand_collection(*expand*, *select*)
A convenience function of use to data providers.

Expands this navigation property, further expanding the resulting collection of entities using the given *expand* and *select* options (see *EntityCollection.set_expand()* for details).

BindEntity(*target*)
Binds a *target* entity to this navigation property.

target is either the entity you're binding or its key in the target entity set. For example:

```
customer['Orders'].bind(1)
```

binds the entity represented by 'customer' to the Order entity with key 1.

Just as for updates to data property values, the binding information is saved and acted upon when the entity is next updated or, for non-existent entities, inserted into the entity set.

If you attempt to bind to a target entity that doesn't exist the target entity will be created automatically when the source entity is updated or inserted.

CheckNavigationConstraint()
Checks if this navigation property *isRequired* and raises `NavigationConstraintError` if it has not been bound with *BindEntity()*.

This method is only intended to be called on non-existent entities.

update_bindings()
Iterates through *bindings* and generates appropriate calls to update the collection.

Unlike the parent Entity's *Entity.commit()* method, which updates all data and navigation values simultaneously, this method can be used to selectively update a single navigation property.

ClearBindings()
Removes any (unsaved) entity bindings from this navigation property.

class pyslet.odata2.csdl.**NavigationCollection**(*from_entity*, *name*, ***kwargs*)
Bases: *pyslet.odata2.csdl.EntityCollection*

Represents the collection of entities returned by a *navigation* property.

These collections behave in the same way as entity collections opened from the base *EntitySet* with the following exceptions:

```
etColl[key]=entity
```

Adds a link to *entity* from the source entity used to open the navigation collection. If *key* does not match *entity*'s key then ValueError is raised. The entity must already exist and be a member of the base entity set, otherwise KeyError is raised.

This class is used even if the navigation property is declared to return a single entity, rather than a collection. In this case assignment will only work if the collection is currently empty. To *replace* an existing link use *replace()*.

del etColl[key]

Deletes the link from the source entity to the entity with *key*. If no such link exists, KeyError is raised.

Thie behaviour differs from the base *EntityCollection* behaviour where the del operator removes the entity completely from the entity container. In this case the entity still exists in the parent entity set, only the link is removed.

Notes for data providers

On construction:

- ***entity_set* is the entity set containing the target entities,** the collection behaves like a subset of this entity set. It is passed to super

Named arguments specific to this class:

- *from_entity* is the source entity being navigated
- *name* is the name of the navigation property being navigated

Writeable collections must override the `__setitem__()` method.

name = None
the name of the navigation property

from_entity = None
the source entity

from_end = None
the *AssociationSetEnd* that represents the source of this association

pDef = None
the navigation property's definition in the metadata model

insert_entity(*entity*)
Inserts a new *entity* into the target entity set *and* simultaneously creates a link to it from the source entity.

replace(*entity*)
This method replaces all links with a link to the single item, *entity*. If the collection was empty then this is equivalent to __setitem__(entity.key(),entity).

Although for some collections this is equivalent to `clear()` followed by __setitem__, this method must be used to combine these operations into a single call when the collection is required to contain exactly one link at all times.

class pyslet.odata2.csdl.**ExpandedEntityCollection**(*entityList*, ***kwargs*)
Bases: *pyslet.odata2.csdl.NavigationCollection*

A special sub-class of *NavigationCollection* used when a navigation property has been expanded.

An expanded entity collection is a read-only, cached view of the entities linked from the source entity.

Warning: although you may apply a filter and orderby rules to an expanded collection these are evaluated on the local copy and are not passed to the data source. As a result, there may be differences in the way these options behave due to different expression semantics.

Note for data providers:

The named argument *entityList* passed to this constructor is a simple python list of the entities the expanded collection contains. Internally a dictionary of the entities is built to speed up access by key.

Supporting Classes

class pyslet.odata2.csdl.**EDMValue**(*pDef=None*)
Bases: pyslet.pep8.PEP8Compatibility

Abstract class to represent a value in the EDMModel.

This class is used to wrap or 'box' instances of a value. In particular, it can be used in a context where that value can have either a simple or complex type.

pDef = None
An optional *Property* instance from the metadata model defining this value's type

__nonzero__()
EDMValue instances are treated as being non-zero if *IsNull()* returns False.

IsNull()
Returns True if this object is Null.

classmethod NewValue(*pDef*)
Constructs an instance of the correct child class of *EDMValue* to represent a value defined by *Property* instance *pDef*.

We support a special case for creating a type-less NULL. If you pass None for pDef then a type-less SipmleValue is instantiated.

classmethod NewSimpleValue(*typeCode*)
Constructs an instance of the correct child class of *EDMValue* to represent an (undeclared) simple value of *SimpleType* *typeCode*.

classmethod NewSimpleValueFromValue(*value*)
Constructs an instance of the correct child class of *EDMValue* to hold *value*.

value may be any of the types listed in *SimpleValue*.

class pyslet.odata2.csdl.**TypeInstance**(*type_def=None*)
Bases: *pyslet.odata2.csdl.DictionaryLike*, pyslet.pep8.PEP8Compatibility

Abstract class to represents a single instance of a *ComplexType* or *EntityType*.

Behaves like a read-only dictionary mapping property names onto *EDMValue* instances. (You can change the value of a property using the methods of *EDMValue* and its descendants.)

Unlike regular Python dictionaries, iteration over the of keys in the dictionary (the names of the properties) is always done in the order in which they are declared in the type definition.

type_def = None
the definition of this type

Metadata Model

class pyslet.odata2.csdl.**CSDLElement**(*parent*, *name=None*)
Bases: pyslet.xmlnames20091208.XMLNSElement

All elements in the metadata model inherit from this class.

class pyslet.odata2.csdl.**Schema**(*parent*)
Bases: *pyslet.odata2.csdl.NameTableMixin*, *pyslet.odata2.csdl.CSDLElement*

Represents the Edm root element.

Schema instances are based on *NameTableMixin* allowing you to look up the names of declared Associations, ComplexTypes, EntityTypes, EntityContainers and Functions using dictionary-like methods.

name = None
the declared name of this schema

Association = None
a list of *Association* instances

ComplexType = None
a list of *ComplexType* instances

EntityType = None
a list of *EntityType* instances

class pyslet.odata2.csdl.**EntityContainer**(*parent*)
Bases: *pyslet.odata2.csdl.NameTableMixin*, *pyslet.odata2.csdl.CSDLElement*

Models an entity container in the metadata model.

An EntityContainer inherits from *NameTableMixin* to enable it to behave like a scope. The *EntitySet* instances and *AssociationSet* instances it contains are declared within the scope.

name = None
the declared name of the container

Documentation = None
the optional *Documentation*

EntitySet = None
a list of *EntitySet* instances

AssociationSet = None
a list of *AssociationSet* instances

find_entitysets(*entity_type*)
Returns a list of all entity sets with a given type

entity_type An *EntityType* instance.

Returns an empty list if no declared EntitySets have this type.

class pyslet.odata2.csdl.**EntitySet**(*parent*)
Bases: *pyslet.odata2.csdl.CSDLElement*

Represents an EntitySet in the metadata model.

name = None
the declared name of the entity set

entityTypeName = None
the name of the entity type of this set's elements

entityType = None
the *EntityType* of this set's elements

keys = None
a list of the names of this entity set's keys in their declared order

navigation = None
a mapping from navigation property names to *AssociationSetEnd* instances

linkEnds = None
A mapping from *AssociationSetEnd* instances that reference this entity set to navigation property names (or None if this end of the association is not bound to a named navigation property)

unboundPrincipal = None
An *AssociationSetEnd* that represents our end of an association with an unbound principal or None if all principals are bound.

What does that mean? It means that there is an association set bound to us where the other role has a multiplicity of 1 (required) but our entity type does not have a navigation property bound to the association. As a result, our entities can only be created by a deep insert from the principal (the entity set at the other end of the association).

Clear as mud? An example may help. Suppose that each Order entity must have an associated Customer but (perhaps perversely) there is no navigation link from Order to Customer, only from Customer to Order. For the Order entity, the Customer is the principal as Orders can only be exist when they are associated with a Customer.

Attempting to create an Order in the base collection of Orders will always fail:

```
with Orders.OpenCollection() as collection:
    order=collection.new_entity()
    # set order fields here
    collection.insert_entity(order)
    # raises ConstraintError as order is not bound to a customer
```

Instead, you have to create new orders from a Customer entity:

```
with Customers.OpenCollection() as collectionCustomers:
    # get the existing customer
    customer=collectionCustomers['ALFKI']
    with customer['Orders'].OpenCollection() as collectionOrders:
        # create a new order
        order=collectionOrders.new_entity()
        # ... set order details here
        collectionOrders.insert_entity(order)
```

You can also use a deep insert:

```
with Customers.OpenCollection() as collectionCustomers,
        Orders.OpenCollection() as collectionOrders:
    customer=collectionCustomers.new_entity()
    # set customer details here
    order=collectionOrders.new_entity()
    # set order details here
    customer['Orders'].BindEntity(order)
    collectionCustomers.insert_entity(customer)
```

For the avoidance of doubt, an entity set can't have two unbound principals because if it did you would never be able to create entities in it!

Documentation = None
the optional *Documentation*

GetFQName()
Returns the fully qualified name of this entity set.

get_location()
Returns a *pyslet.rfc2396.URI* instance representing the location for this entity set.

set_location()
Sets the location of this entity set by resolving a relative path consisting of:

```
[ EntityContainer.name '.' ] name
```

The resolution of URIs is done in accordance with the XML specification, so is affected by any xml:base attributes set on parent elements or by the original base URI used to load the metadata model. If no base URI can be found then the location remains expressed in relative terms.

GetKey(*keylike*)
Extracts a key value suitable for using as a key in an *EntityCollection* based on this entity set.

Keys are represented as python values (as described in *SimpleValue*) or as tuples of python values in the case of compound keys. The order of the values in a compound key is the order in which the Key properties are defined in the corresponding EntityType definition.

If *keylike* is already in the correct format for this entity type then it is returned unchanged.

If the key is single-valued and *keylike* is a tuple containing a single value then the single value is returned without the tuple wrapper.

If *keylike* is a dictionary, or an *Entity* instance, which maps property names to values (or to *SimpleValue* instances) the key is calculated from it by extracting the key properties. As a special case, a value mapped with a dictionary key of the empty string is assumed to be the value of the key property for an entity type with a single-valued key, but only if the key property's name is not itself in the dictionary.

If *keylike* cannot be turned in to a valid key the KeyError is raised.

extract_key(*keyvalue*)
Extracts a key value from *keylike*.

Unlike GetKey, this method attempts to convert the data in *keyvalue* into the correct format for the key. For compound keys *keyvalue* must be a suitable list or tuple or compatible iterable supporting the len method. Dictionaries are not supported.

If keyvalue cannot be converted into a suitable representation of the key then None is returned.

key_dict(*key*)
Given a key from this entity set, returns a key dictionary.

The result is a mapping from named properties to *SimpleValue* instances. The property name is always used as the key in the mapping, even if the key refers to a single property. This contrasts with *GetKeyDict()*.

GetKeyDict(*key*)
Given a key from this entity set, returns a key dictionary.

The result is a mapping from named properties to *SimpleValue* instances. As a special case, if a single property defines the entity key it is represented using the empty string, *not* the property name.

bind(*entityCollectionBinding*, ***extraArgs*)
Binds this entity set to a specific class or callable used by *OpenCollection()*

entityCollectionBinding must be a class (or other callable) that returns an *EntityCollection* instance, by default we are bound to the default EntityCollection class which behaves like an empty collection.

extraArgs is a python dict of named arguments to pass to the binding callable

OpenCollection()
Returns an *EntityCollection* instance suitable for accessing the entities themselves.

BindNavigation(*name*, *entityCollectionBinding*, ***extraArgs*)
Binds the navigation property *name* to a class or callable used by *OpenNavigation()*

entityCollectionBinding must be a class (or other callable) that returns a *NavigationCollection* instance. By default we are bound to the default NavigationCollection class which behaves like an empty collection.

extraArgs is a python dict of named arguments to pass to the binding callable

OpenNavigation(*name*, *sourceEntity*)
Returns a *NavigationCollection* instance suitable for accessing the entities obtained by navigating from *sourceEntity*, an *Entity* instance, via the navigation property with *name*.

NavigationTarget(*name*)
Returns the target entity set of navigation property *name*

NavigationMultiplicity(*name*)
Returns the *Multiplicity* of both the source and the target of the named navigation property, as a tuple, for example, if *customers* is an entity set from the sample OData service:

```
customers.NavigationMultiplicity['Orders']==(Multiplicity.ZeroToOne,Multiplicity.Many)
```

IsEntityCollection(*name*)
Returns True if more than one entity is possible when navigating the named property.

class pyslet.odata2.csdl.**AssociationSet**(*parent*)
Bases: *pyslet.odata2.csdl.CSDLElement*

Represents an association set in the metadata model.

The purpose of the association set is to bind the ends of an association to entity sets in the container.

Contrast this with the association element which merely describes the association between entity types.

At first sight this part of the entity data model can be confusing but imagine an entity container that contains two entity sets that have the same entity type. Any navigation properties that reference this type will need to be explicitly bound to one or other of the entity sets in the container.

> As an aside, it isn't really clear if the model was intended to be used this way. It may have been intended that the entity type in the definition of an entity set should be unique within the scope of the entity container.

name = None
the declared name of this association set

associationName = None
the name of the association definition

association = None
the *Association* definition

Documentation = None
the optional *Documentation*

class pyslet.odata2.csdl.**AssociationSetEnd**(*parent*)
Bases: *pyslet.odata2.csdl.CSDLElement*

Represents the links between two actual sets of entities in the metadata model.

The *GetQualifiedName()* method defines the identity of this element. The built-in Python hash function returns a hash based on this value and the associated comparison functions are also implemented enabling these elements to be added to ordinary Python dictionaries.

Oddly, role names are sometimes treated as optional but it can make it a challenge to work out which end of the association is which when we are actually using the model if one or both are missing. The algorithm we use is to use role names if either are given, otherwise we match the entity types. If these are also identical then the choice is arbitrary. To prevent confusion missing role names are filled in when the metadata model is loaded.

name = None
the role-name given to this end of the link

entitySetName = None
name of the entity set this end links to

entity_set = None
EntitySet this end links to

associationEnd = None
AssociationEnd that defines this end of the link

otherEnd = None
the other *AssociationSetEnd* of this link

Documentation = None
the optional *Documentation*

GetQualifiedName()
A utility function to return a qualified name.

The qualified name comprises the name of the parent *AssociationSet* and the role name.

class pyslet.odata2.csdl.**Type**(*parent*)
Bases: *pyslet.odata2.csdl.NameTableMixin*, *pyslet.odata2.csdl.CSDLElement*

An abstract class for both Entity and Complex types.

Types inherit from *NameTableMixin* to allow them to behave as scopes in their own right. The named properties are declared in the type's scope enabling you so use them as dictionaries to look up property definitions.

Because of the way nested scopes work, this means that you can concatenate names to do a deep look up, for example, if Person is a defined type:

```
Person['Address']['City'] is Person['Address.City']
```

name = None
the declared name of this type

baseType = None
the name of the base-type for this type

Property = None
a list of *Property*

GetFQName()
Returns the full name of this type, including the schema namespace prefix.

class pyslet.odata2.csdl.**EntityType**(*parent*)
Bases: *pyslet.odata2.csdl.Type*

Models the key and the collection of properties that define a set of *Entity*

Key = None
the *Key*

ValidateExpansion(*expand*, *select*)
A utility method for data providers.

Checks the expand and select options, as described in *EntityCollection.set_expand()* for validity raising ValueError if they violate the OData specification.

Specifically the following are checked:

1. **That "*" only ever appears as the last item in a select** path
2. **That nothing appears after a simple property in a select** path
3. That all names are valid property names
4. That all expanded names are those of navigation properties

class pyslet.odata2.csdl.**Key**(*parent*)
Bases: *pyslet.odata2.csdl.CSDLElement*

Models the key fields of an *EntityType*

PropertyRef = None
a list of *PropertyRef*

class pyslet.odata2.csdl.**PropertyRef**(*parent*)
Bases: *pyslet.odata2.csdl.CSDLElement*

Models a reference to a single property within a *Key*.

name = None
the name of this (key) property

property = None
the *Property* instance of this (key) property

UpdateTypeRefs(*scope*, *stopOnErrors=False*)
Sets *property*

class pyslet.odata2.csdl.**Property**(*parent*)
Bases: *pyslet.odata2.csdl.CSDLElement*

Models a property of an *EntityType* or *ComplexType*.

Instances of this class are callable, taking an optional string literal. They return a new *EDMValue* instance with a value set from the optional literal or NULL if no literal was supplied. Complex values can't be created from a literal.

name = None
the declared name of the property

type = None
the name of the property's type

simpleTypeCode = None
one of the *SimpleType* constants if the property has a simple type

complexType = None
the associated *ComplexType* if the property has a complex type

nullable = None
if the property may have a null value

defaultValue = None
a string containing the default value for the property or None if no default is defined

maxLength = None
the maximum length permitted for property values

fixedLength = None
a boolean indicating that the property must be of length *maxLength*

precision = None
a positive integer indicating the maximum number of decimal digits (decimal values)

scale = None
a non-negative integer indicating the maximum number of decimal digits to the right of the point

unicode = None
a boolean indicating that a string property contains unicode data

Documentation = None
the optional *Documentation*

class pyslet.odata2.csdl.**ComplexType**(*parent*)
Bases: *pyslet.odata2.csdl.Type*

Models the collection of properties that define a *Complex* value.

This class is a trivial sub-class of *Type*

class pyslet.odata2.csdl.**NavigationProperty**(*parent*)
Bases: *pyslet.odata2.csdl.CSDLElement*

Models a navigation property of an *EntityType*.

name = None
the declared name of the navigation property

fromRole = None
the name of this link's source role

toRole = None
the name of this link's target role

from_end = None
the *AssociationEnd* instance representing this link's source

to_end = None
the *AssociationEnd* instance representing this link's target

ambiguous = None
flag set if *Association* is ambiguous within the parent EntityType, *backLink* will never be set!

backLink = None
the *NavigationProperty* that provides the back link (or None, if this link is one-way)

class pyslet.odata2.csdl.**Association**(*parent*)
Bases: *pyslet.odata2.csdl.NameTableMixin*, *pyslet.odata2.csdl.CSDLElement*

Models an association.

This class inherits from *NameTableMixin* to enable it to behave like a scope in its own right. The contained *AssociationEnd* instances are declared in the association scope by role name.

name = None
the name declared for this association

Documentation = None
the optional *Documentation*

AssociationEnd = None
a list of *AssociationEnd* instances

GetFQName()
Returns the full name of this association, including the schema namespace prefix.

class pyslet.odata2.csdl.**AssociationEnd**(*parent*)
Bases: *pyslet.odata2.csdl.CSDLElement*

Models one end of an *Association*.

We define a hash method to allow AssociationEnds to be used as keys in a dictionary.

name = None
the role-name given to this end of the link

type = None
name of the entity type this end links to

entityType = None
EntityType this end links to

multiplicity = None
a *Multiplicity* constant

otherEnd = None
the other *AssociationEnd* of this link

GetQualifiedName()
A utility function to return a qualified name.

The qualified name comprises the name of the parent *Association* and the role name.

class pyslet.odata2.csdl.**Documentation**(*parent*)
Bases: *pyslet.odata2.csdl.CSDLElement*

Used to document elements in the metadata model

Misc Definitions

pyslet.odata2.csdl.**ValidateSimpleIdentifier**(*identifier*)
Validates a simple identifier, returning the identifier unchanged or raising ValueError.

class pyslet.odata2.csdl.**SimpleType**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

SimpleType defines constants for the core data types defined by CSDL

```
SimpleType.Boolean
SimpleType.DEFAULT == None
```

For more methods see *Enumeration*

The canonical names for these constants uses the Edm prefix, for example, "Edm.String". As a result, the class has attributes of the form "SimpleType.Edm.Binary" which are inaccessible to python unless getattr is used. To workaround this problem (and because the Edm. prefix seems to be optional) we also define aliases without the Edm. prefix. As a result you can use, e.g., SimpleType.Int32 as the symbolic representation in code but the following are all True:

```
SimpleType.DecodeValue(u"Edm.Int32")==SimpleType.Int32
SimpleType.DecodeValue(u"Int32")==SimpleType.Int32
SimpleType.EncodeValue(SimpleType.Int32)==u"Edm.Int32"
```

PythonType = {<type 'long'>: 7, <type 'float'>: 8, <type 'str'>: 14, <type 'int'>: 13, <type 'unicode'>: 14, <type 'bool'>
A python dictionary that maps a type code (defined by the types module) to a constant from this class indicating a safe representation in the EDM. For example:

```
SimpleType.PythonType[types.IntType]==SimpleType.Int64
```

class pyslet.odata2.csdl.**ConcurrencyMode**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

ConcurrencyMode defines constants for the concurrency modes defined by CSDL

```
ConcurrencyMode.Fixed
ConcurrencyMode.DEFAULT == ConcurrencyMode.none
```

Note that although 'Fixed' and 'None' are the correct values lower-case aliases are also defined to allow the value 'none' to be accessible through normal attribute access. In most cases you won't need to worry as a test such as the following is sufficient:

if property.concurrencyMode==ConcurrencyMode.Fixed: # do something with concurrency tokens

For more methods see *Enumeration*

pyslet.odata2.csdl.**DecodeMaxLength**(*value*)
Decodes a maxLength value from a unicode string.

"The maxLength facet accepts a value of the literal string "max" or a positive integer with value ranging from 1 to 2^31"

The value 'max' is returned as the value *MAX*

pyslet.odata2.csdl.**EncodeMaxLength**(*value*)
Encodes a maxLength value as a unicode string.

pyslet.odata2.csdl.**MAX = -1**
we define the constant MAX to represent the special 'max' value of maxLength

class pyslet.odata2.csdl.**Multiplicity**
Defines constants for representing association end multiplicities.

pyslet.odata2.csdl.**DecodeMultiplicity**(*src*)
Decodes a *Multiplicity* value from a unicode string.

The valid strings are "0..1", "1" and "*"

pyslet.odata2.csdl.**EncodeMultiplicity**(*value*)
Encodes a *Multiplicity* value as a unicode string.

class pyslet.odata2.csdl.**Parser**(*source*)
Bases: *pyslet.unicode5.BasicParser*

A CSDL-specific parser, mainly for decoding literal values of simple types.

The individual parsing methods may raise ValueError in cases where parsed value has a value that is out of range.

ParseBinaryLiteral()
Parses a binary literal, returning a binary string

ParseBooleanLiteral()
Parses a boolean literal returning True, False or None if no boolean literal was found.

ParseByteLiteral()
Parses a byteLiteral, returning a python integer.

We are generous in what we accept, ignoring leading zeros. Values outside the range for byte return None.

ParseDateTimeLiteral()
Parses a DateTime literal, returning a *pyslet.iso8601.TimePoint* instance.

Returns None if no DateTime literal can be parsed. This is a generous way of parsing iso8601-like values, it accepts omitted zeros in the date, such as 4-7-2001.

ParseGuidLiteral()
Parses a Guid literal, returning a UUID instance from the uuid module.

Returns None if no Guid can be parsed.

ParseNumericLiteral()
Parses a numeric literal returning a named tuple of strings:

```
( sign, lDigits, rDigits, expSign, eDigits )
```

An empty string indicates a component that was not present except that rDigits will be None if no decimal point was present. Likewise, eDigits may be None indicating that no exponent was found.

Although both lDigits and rDigits can be empty they will never *both* be empty strings. If there are no digits present then the method returns None, rather than a tuple. Therefore, forms like "E+3" are not treated as being numeric literals whereas, perhaps oddly, 1E+ is parsed as a numeric literal (even though it will raise ValueError later when setting any of the numeric value types).

Representations of infinity and not-a-number result in lDigits being set to 'inf' and 'nan' respectively. They always result in rDigits and eDigits being None.

ParseTimeLiteral()
Parses a Time literal, returning a *pyslet.iso8601.Time* instance.

Returns None if no Time literal can be parsed. This is a generous way of parsing iso8601-like values, it accepts omitted zeros in the leading field, such as 7:45:00.

Utility Classes

These classes are not specific to the EDM but are used to support the implementation. They are documented to allow them to be reused in other modules.

class pyslet.odata2.csdl.**NameTableMixin**
Bases: *pyslet.odata2.csdl.DictionaryLike*

A mix-in class to help other objects become named scopes.

Using this mix-in the class behaves like a read-only named dictionary with string keys and object values. If the dictionary contains a value that is itself a NameTableMixin then keys can be compounded to look-up items in sub-scopes.

For example, if the name table contains a value with key "X" that is itself a name table containing a value with key "Y" then both "X" and "X.Y" are valid keys, the latter performing a 'deep lookup' in the nested scope.

name = None
the name of this name table (in the context of its parent)

nameTable = None
a dictionary mapping names to child objects

__getitem__(*key*)
Looks up *key* in *nameTable* and, if not found, in each child scope with a name that is a valid scope prefix of key. For example, if key is "My.Scope.Name" then a child scope with name "My.Scope" would be searched for "Name" or a child scope with name "My" would be searched for "Scope.Name".

__iter__()
Yields all keys defined in this scope and all compounded keys from nested scopes. For example, a child scope with name "My.Scope" which itself has a child "Name" would generate two keys: "My.Scope" and "My.Scope.Name".

__len__()
Returns the number of keys in this scope including all compounded keys from nested scopes.

Declare(*value*)
Declares a value in this named scope.

value must have a name attribute which is used to declare it in the scope; duplicate keys are not allowed and will raise DuplicateKey.

Values are always declared in the top-level scope, even if they contain the compounding character '.', however, you cannot declare "X" if you have already declared "X.Y" and vice versa.

Undeclare(*value*)
Removes a value from the named scope.

Values can only be removed from the top-level scope.

class pyslet.odata2.csdl.**DictionaryLike**
Bases: object

An abstract class for behaving like a dictionary.

Derived classes must override *__iter__()* and *__getitem__()* and if the dictionary is writable *__setitem__()* and probably *__delitem__()* too. These methods all raise NotImplementedError by default.

Dervied classes should also override *__len__()* and *clear()* as the default implementations are inefficient.

A note on thread safety. Unlike native Python dictionaries, DictionaryLike objects can not be treated as thread safe for updates. The implementations of the read-only methods (including the iterators) are designed to be thread safe so, once populated, they can be safely shared. Derived classes should honour this contract when implementing *__iter__()*, *__getitem__()* and *__len__()* or clearly document that the object is not thread-safe at all.

Finally, one other difference worth noting is touched on in a comment from the following question on Stack Overflow: http://stackoverflow.com/questions/3358770/python-dictionary-is-thread-safe

This question is about whether a dictionary can be modified during iteration. Although not typically a thread-safety issue the commenter says:

> I think they are related. What if one thread iterates and the other modifies the dict?

To recap, native Python dictionaries limit the modifications you can make during iteration, quoting from the docs:

> The dictionary p should not be mutated during iteration. It is safe (since Python 2.1) to modify the values of the keys as you iterate over the dictionary, but only so long as the set of keys does not change

You should treat DictionaryLike objects with the same respect but the behaviour is not defined at this abstract class level and will vary depending on the implementation. Derived classes are only dictionary-like, they are not actually Python dictionaries!

__getitem__(*key*)
Implements self[key]

This method must be overridden to make a concrete implementation

__setitem__(*key*, *value*)
Implements assignment to self[key]

This method must be overridden if you want your dictionary-like object to be writable.

__delitem__(*key*)
Implements del self[key]

This method should be overridden if you want your dictionary-like object to be writable.

__iter__()
Returns an object that implements the iterable protocol on the keys

This method must be overridden to make a concrete implementation

__len__()
Implements len(self)

The default implementation simply counts the keys returned by __iter__ and should be overridden with a more efficient implementation if available.

__contains__(*key*)
Implements: key in self

The default implementation uses __getitem__ and returns False if it raises a KeyError.

iterkeys()
Returns an iterable of the keys, simple calls __iter__

itervalues()
Returns an iterable of the values.

The default implementation is a generator function that iterates over the keys and uses __getitem__ to yield each value.

keys()
Returns a list of keys.

This is a copy of the keys in no specific order. Modifications to this list do not affect the object. The default implementation uses *iterkeys()*

values()
Returns a list of values.

This is a copy of the values in no specific order. Modifications to this list do not affect the object. The default implementation uses *itervalues()*.

iteritems()
Returns an iterable of the key,value pairs.

The default implementation is a generator function that uses *__iter__()* and __getitem__ to yield the pairs.

items()
Returns a list of key,value pair tuples.

This is a copy of the items in no specific order. Modifications to this list do not affect the object. The default implementation uses *iteritems*.

has_key(*key*)
Equivalent to: key in self

get(*key*, *default=None*)
Equivalent to: self[key] if key in self else default.

Implemented using __getitem__

setdefault(*key*, *value=None*)
Equivalent to: self[key] if key in self else value; ensuring self[key]=value

Implemented using __getitem__ and __setitem__.

pop(*key*, *value=None*)
Equivalent to: self[key] if key in self else value; ensuring key not in self.

Implemented using __getitem__ and __delitem__.

clear()
Removes all items from the object.

The default implementation uses *keys()* and deletes the items one-by-one with __delitem__. It does this to avoid deleting objects while iterating as the results are generally undefined. A more efficient implementation is recommended.

popitem()
Equivalent to: self[key] for some random key; removing key.

This is a rather odd implementation but to avoid iterating over the whole object we create an iterator with __iter__, use __getitem__ once and then discard it. If an object is found we use __delitem__ to delete it, otherwise KeyError is raised.

bigclear()
Removes all the items from the object (alternative for large dictionary-like objects).

This is an alternative implementation more suited to objects with very large numbers of keys. It uses *popitem()* repeatedly until KeyError is raised. The downside is that popitem creates (and discards) one iterator object for each item it removes. The upside is that we never load the list of keys into memory.

copy()
Makes a shallow copy of this object.

This method must be overridden if you want your dictionary-like object to support the copy operation.

update(*items*)
Iterates through *items* using __setitem__ to add them to the set.

__weakref__
list of weak references to the object (if defined)

Exceptions

class pyslet.odata2.csdl.**NonExistentEntity**
Bases: *pyslet.odata2.csdl.EDMError*

Raised when attempting to perform a restricted operation on an entity that doesn't exist yet. For example, getting the value of a navigation property.

class pyslet.odata2.csdl.**EntityExists**
Bases: *pyslet.odata2.csdl.EDMError*

Raised when attempting to perform a restricted operation on an entity that already exists. For example, inserting it into the base collection.

class pyslet.odata2.csdl.**ConstraintError**
Bases: *pyslet.odata2.csdl.EDMError*

General error raised when a constraint has been violated.

class pyslet.odata2.csdl.**NavigationError**
Bases: *pyslet.odata2.csdl.ConstraintError*

Raised when attempting to perform an operation on an entity and a violation of a navigation property's relationship is encountered. For example, adding multiple links when only one is allowed or failing to add a link when one is required.

class pyslet.odata2.csdl.**ConcurrencyError**
Bases: *pyslet.odata2.csdl.ConstraintError*

Raised when attempting to perform an update on an entity and a violation of a concurrency control constraint is encountered.

class pyslet.odata2.csdl.**ModelIncomplete**
Bases: pyslet.odata2.csdl.ModelError

Raised when a model element has a missing reference.

For example, an *EntitySet* that is bound to an undeclared :*EntityType*.

class pyslet.odata2.csdl.**ModelConstraintError**
Bases: pyslet.odata2.csdl.ModelError

Raised when an issue in the model other than completeness prevents an action being performed.

For example, an entity type that is dependent on two unbound principals (so can never be inserted).

class pyslet.odata2.csdl.**DuplicateName**
Bases: pyslet.odata2.csdl.ModelError

Raised by *NameTableMixin* when attempting to declare a name in a context where the name is already declared.

This might be raised if your metadata document incorrectly defines two objects with the same name in the same scope, for example

class pyslet.odata2.csdl.**IncompatibleNames**
Bases: *pyslet.odata2.csdl.DuplicateName*

A special type of *DuplicateName* exception raised by *NameTableMixin* when attempting to declare a name which might hide, or be hidden by, another name already declared.

CSDL's definition of SimpleIdentifier allows '.' to be used in names but also uses it for qualifying names. As a result, it is possible to define a scope with a name like "My.Scope" which precludes the later definition of a scope called simply "My" (and vice versa).

class pyslet.odata2.csdl.**InvalidMetadataDocument**
Bases: pyslet.odata2.csdl.ModelError

Raised by general CSDL model violations.

class pyslet.odata2.csdl.**EDMError**
Bases: exceptions.Exception

General exception for all CSDL model errors.

Constants

pyslet.odata2.csdl.**EDM_NAMESPACE = 'http://schemas.microsoft.com/ado/2009/11/edm'**
Namespace to use for CSDL elements

4.3.2 OData Core Classes

This module extends the definitions in *pyslet.odata2.csdl* with OData-specific functions and classes. In most cases you won't need to worry about which layer of the model a definition belongs to. Where a class is derived from one in the parent EDM the same name is used, therefore most of the time you should look to include items from the core module rather than from the base csdl module.

Data Model

class pyslet.odata2.core.**EntityCollection**(*entity_set*, ***kwargs*)
Bases: *pyslet.odata2.csdl.EntityCollection*

EntityCollections that provide OData-specific options

Our definition of EntityCollection is designed for use with Python's diamond inheritance model. We inherit directly from the basic *pyslet.odata2.csdl.EntityCollection* object, providing additional methods that support the expression model defined by OData, media link entries and JSON encoding.

get_next_page_location()
Returns the location of this page of the collection

The result is a rfc2396.URI instance.

new_entity()
Returns an OData aware instance

is_medialink_collection()
Returns True if this is a collection of Media-Link Entries

new_stream(*src*, *sinfo=None*, *key=None*)
Creates a media resource.

src A file-like object from which the stream's data will be read.

sinfo A *StreamInfo* object containing metadata about the stream. If the size field of sinfo is set then *at most* sinfo.size bytes are read from src. Otherwise src is read until the end of the file.

key The key associated with the stream being written. This value is taken as a suggestion for the key to use, its use is not guaranteed. The key actually used to store the stream can be obtained from the resulting entity.

Returns the media-link entry *Entity*

update_stream(*src*, *key*, *sinfo=None*)
Updates an existing media resource.

The parameters are the same as *new_stream()* except that the key must be present and must be an existing key in the collection.

read_stream(*key*, *out=None*)
Reads a media resource.

key The key associated with the stream being read.

out An optional file like object to which the stream's data will be written. If no output file is provided then no data is written.

The return result is the *StreamInfo* class describing the stream.

read_stream_close(*key*)
Creates a generator for a media resource.

key The key associated with the stream being read.

The return result is a tuple of the *StreamInfo* class describing the stream and a generator that yields the stream's data.

The collection is closed by the generator when the iteration is complete (or when the generator is destroyed).

check_filter(*entity*)
Checks *entity* against any filter and returns True if it passes.

The *filter* object must be an instance of py:class:*CommonExpression* that returns a Boolean value.

boolExpression is a `CommonExpression`.

calculate_order_key(*entity*, *orderObject*)
Evaluates orderObject as an instance of py:class:*CommonExpression*.

generate_entity_set_in_json(*version=2*)
Generates JSON serialised form of this collection.

generate_link_coll_json(*version=2*)
Generates JSON serialised collection of links

class `pyslet.odata2.core.`**Entity**(*entity_set*)
Bases: *pyslet.odata2.csdl.Entity*

We override Entity in order to provide OData serialisation.

set_from_json_object(*obj*, *entity_resolver=None*, *for_update=False*)
Sets the value from a JSON representation.

obj A python dictionary parsed from a JSON representation

entity_resolver An optional callable that takes a URI object and returns the entity object it points to. This is used for resolving links when creating or updating entities from a JSON source.

for_update An optional boolean (defaults to False) that indicates if an *existing* entity is being deserialised for update or just for read access. When True, new bindings are added to the entity for links provided in the obj. If the entity doesn't exist then this argument is ignored.

generate_entity_type_in_json(*for_update=False*, *version=2*)
Returns a JSON-encoded string representing this entity

for_update A boolean, defaults to False, indicating that the output JSON should include any unsaved bindings

version Defaults to version 2 output

link_json()
Returns a JSON-serialised link to this entity

class `pyslet.odata2.core.`**StreamInfo**(*type=MediaType('application', 'octet-stream', {})*, *created=None*, *modified=None*, *size=None*)
Bases: `object`

Represents information about a media resource stream.

type = None
the media type, a *MediaType* instance

created = None
the optional creation time, a fully specified *TimePoint* instance that includes a zone

modified = None
the optional modification time, a fully specified *TimePoint* instance that includes a zone

size = None
the size of the stream (in bytes), None if not known

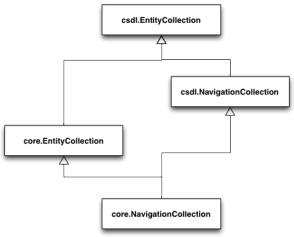
md5 = None
the 16 byte binary MD5 checksum of the stream, None if not known

Navigation: Deferred Values

class pyslet.odata2.core.**NavigationCollection**(*from_entity*, *name*, ***kwargs*)
Bases: *pyslet.odata2.core.EntityCollection*, *pyslet.odata2.csdl.NavigationCollection*

NavigationCollections that provide OData-specific options.

This class uses Python's diamond inheritance model



This allows us to inherit from both the OData-specific form of EntityCollection and NavigationCollection. This is illustrated in the above diagram which shows the method resolution order reading from the bottom of the diagram. The default object is omitted.

This technique is repeated in specific implementations of the API where common collection behaviour is implemented in a class that inherits from *EntityCollection* and then mixed in to a new class derived from *NavigationCollection*.

expand_collection()
Return an expanded version of this collection

Returns an instance of an OData-specific *ExpandedEntityCollection*.

get_location()
Returns the location of this collection as a rfc2396.URI instance.

We override the location based on the source entity set + the fromKey.

class pyslet.odata2.core.**ExpandedEntityCollection**(*entityList*, ***kwargs*)
Bases: *pyslet.odata2.core.EntityCollection*, *pyslet.odata2.csdl.ExpandedEntityCollection*

Expanded collections with OData-specific behaviour.

This class uses diamond inheritance in a similar way to *NavigationCollection*

4.3.3 OData Metadata Classes

This module defines sub-classes of those defined in the EDM that include special handling of the OData defined metadata attributes.

EDM Elements

Feed Customisation

class pyslet.odata2.metadata.**EntityType**(*parent*)
Bases: *pyslet.odata2.csdl.EntityType*, *pyslet.odata2.metadata.FeedCustomisationMixin*

Supports feed customisation behaviour of EntityTypes

get_source_path()
Returns the source path

This result is read from the FC_SourcePath attribute. It is a *list* of property names that represents a path into the entity or None if there is no source path set.

has_stream()
Returns true if this is a media link resource.

Read from the HasStream attribute. The default is False.

class pyslet.odata2.metadata.**Property**(*parent*)
Bases: *pyslet.odata2.csdl.Property*, *pyslet.odata2.metadata.FeedCustomisationMixin*

Supports feed customisation behaviour of Properties

get_mime_type()
Returns the media type of a property

The result is read from the MimeType attribute. It is a *MediaType* instance or None if the attribute is not defined.

class pyslet.odata2.metadata.**FeedCustomisationMixin**
Bases: object

Utility class used to add common feed customisation attributes

get_target_path()
Returns the target path for an element

The result is a list of qualified element names, that is, tuples of (namespace,name). The last name may start with '@' indicating an attribute rather than an element.

Feed customisations are declared using the FC_TargetPath attribute. Returns None if there is no target path declared.

keep_in_content()
Returns true if a property value should be kept in the content

This is indicated with the FC_KeepInContent attribute. If the attribute is missing then False is returned, so properties with custom paths default to being omitted from the properties list.

get_fc_ns_prefix()
Returns the custom namespace mapping to use.

The value is read from the FC_NsPrefix attribute. The result is a tuple of: (prefix, namespace uri).

If no mapping is specified then (None,None) is returned.

Entity Containers

class pyslet.odata2.metadata.**EntityContainer**(*parent*)
Bases: *pyslet.odata2.csdl.EntityContainer*

Supports OData's concept of the default container.

is_default_entity_container()
Returns True if this is the default entity container

The value is read from the IsDefaultEntityContainer attribute. The default is False.

class pyslet.odata2.metadata.**EntitySet**(*parent*)
Bases: *pyslet.odata2.csdl.EntitySet*

set_location()
Overridden to add support for the default entity container

By default, the path to an EntitySet includes the name of the container it belongs to, e.g., MyDatabase.MyTable. This implementation checks to see if we in the default container and, if so, omits the container name prefix before setting the location URI.

EDMX Elements

class pyslet.odata2.metadata.**Document**(***args*)
Bases: pyslet.odata2.edmx.Document

Class for working with OData-specific metadata documents.

Adds namespace prefix declarations for the OData metadata and OData dataservices namespaces.

classmethod get_element_class(*name*)
Returns the class used to represent an element.

Overrides get_element_class() to use the OData-specific implementations of the edmx/csdl classes defined in this module.

validate()
Validates any declared OData extensions

Checks many of the requirements given in the specification and raises *InvalidMetadataDocument* if the tests fail.

Returns the data service version required to process the service or None if no data service version is specified.

class pyslet.odata2.metadata.**DataServices**(*parent*)
Bases: pyslet.odata2.edmx.DataServices

Adds OData specific behaviour

defaultContainer = None
the default entity container

data_services_version()
Returns the data service version

Read from the DataServiceVersion attribute. Defaults to None.

search_containers(*name*)
Returns an entity set or service operation with *name*

name must be of the form:

```
[<entity container>.]<entity set, function or operation name>
```

The entity container must be present unless the target is in the default container in which case it *must not* be present.

If *name* can't be found KeyError is raised.

4.3.4 OData Client

Overview

Warning: this client doesn't support certificate validation when accessing servers through https URLs. This feature is coming soon...

Using the Client

The client implementation uses Python's logging module to provide logging, when learning about the client it may help to turn logging up to "INFO" as it makes it clearer what the client is doing. "DEBUG" would show exactly what is passing over the wire.:

```
>>> import logging
>>> logging.basicConfig(level=logging.INFO)
```

To create a new client simply instantiate a Client object. You can pass the URL of the service root you wish to connect to directly to the constructor which will then call the service to download the list of feeds and the metadata document from which it will set the *Client.model*.

```
>>> from pyslet.odata2.client import Client
>>> c=Client("http://services.odata.org/V2/Northwind/Northwind.svc/")
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/ HTTP/1.1
INFO:root:Finished Response, status 200
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/$metadata HTTP/1.1
INFO:root:Finished Response, status 200
>>>
```

The *Client.feeds* attribute is a dictionary mapping the exposed feeds (by name) onto *EntitySet* instances. This makes it easy to open the feeds as EDM collections. In your code you'd typically use the with statement when opening the collection but for clarity we'll continue on the python command line:

```
>>> products=c.feeds['Products'].OpenCollection()
>>> for p in products: print p
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products HTTP/1.1
INFO:root:Finished Response, status 200
1
2
3
... [and so on]
...
20
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$skiptoken=20 HTTP/1.1
INFO:root:Finished Response, status 200
```

```
21
22
23
... [and so on]
...
76
77
>>>
```

Note that products behaves like a dictionary, iterating through it iterates through the keys in the dictionary. In this case these are the keys of the entities in the collection of products. Notice that the client logs several requests to the server interspersed with the printed output. Subsequent requests use $skiptoken because the server is limiting the maximum page size. These calls are made as you iterate through the collection allowing you to iterate through very large collections.

The keys alone are of limited interest, let's try a similar loop but this time we'll print the product names as well:

```
>>> for k,p in products.iteritems(): print k,p['ProductName'].value
...
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products HTTP/1.1
INFO:root:Finished Response, status 200
1 Chai
2 Chang
3 Aniseed Syrup
...
...
20 Sir Rodney's Marmalade
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products?$skiptoken=20 HTTP/1.1
INFO:root:Finished Response, status 200
21 Sir Rodney's Scones
22 Gustaf's Knäckebröd
23 Tunnbröd
...
...
76 Lakkalikööri
77 Original Frankfurter grüne Soße
>>>
```

Sir Rodney's Scones sound interesting, we can grab an individual record in the usual way:

```
>>> scones=products[21]
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21) HTTP/1.1
INFO:root:Finished Response, status 200
>>> for k,v in scones.data_items(): print k,v.value
...
ProductID 21
ProductName Sir Rodney's Scones
SupplierID 8
CategoryID 3
QuantityPerUnit 24 pkgs. x 4 pieces
UnitPrice 10.0000
UnitsInStock 3
UnitsOnOrder 40
ReorderLevel 5
Discontinued False
>>>
```

Well, I've simply got to have some of these, let's use one of the navigation properties to load information about the supplier:

```
>>> supplier=scones['Supplier'].GetEntity()
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(21)/Supplier HTTP/1.1
INFO:root:Finished Response, status 200
>>> for k,v in supplier.data_items(): print k,v.value
...
SupplierID 8
CompanyName Specialty Biscuits, Ltd.
ContactName Peter Wilson
ContactTitle Sales Representative
Address 29 King's Way
City Manchester
Region None
PostalCode M14 GSD
Country UK
Phone (161) 555-4448
Fax None
HomePage None
```

Attempting to load a non existent entity results in a KeyError of course:

```
>>> p=products[211]
INFO:root:Sending request to services.odata.org
INFO:root:GET /V2/Northwind/Northwind.svc/Products(211) HTTP/1.1
INFO:root:Finished Response, status 404
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "/Library/Python/2.7/site-packages/pyslet/odata2/client.py", line 165, in __getitem__
       raise KeyError(key)
KeyError: 211
```

Finally, when we're done, it is a good idea to close the open collection:

```
>>> products.close()
```

Reference

class pyslet.odata2.client.**Client**(*serviceRoot=None*, ***kwargs*)

Bases: pyslet.rfc5023.Client

An OData client.

Can be constructed with an optional URL specifying the service root of an OData service. The URL is passed directly to *LoadService()*.

service = None

a *pyslet.rfc5023.Service* instance describing this service

feeds = None

a dictionary of feed titles, mapped to csdl.EntitySet instances

model = None

a metadata.Edmx instance containing the model for the service

LoadService(*serviceRoot*, *metadata=None*)

Configures this client to use the service at *serviceRoot*

serviceRoot A string or *pyslet.rfc2396.URI* instance. The URI may now point to a local file though this must have an xml:base attribute to point to the true location of the service as calls to the feeds themselves require the use of http(s).

metadata (None) A *pyslet.rfc2396.URI* instance pointing to the metadata file. This is usually derived automatically by adding $metadata to the service root but some services have inconsistent metadata models. You can download a copy, modify the model and use a local copy this way instead, e.g., by passing something like:

```
URI.from_path('metadata.xml')
```

If you use a local copy you must add an xml:base attribute to the root element indicating the true location of the $metadata file as the client uses this information to match feeds with the metadata model.

Exceptions

class pyslet.odata2.client.**ClientException**
Bases: exceptions.Exception

Base class for all client-specific exceptions.

class pyslet.odata2.client.**AuthorizationRequired**
Bases: *pyslet.odata2.client.ClientException*

The server returned a response code of 401 to the request.

class pyslet.odata2.client.**UnexpectedHTTPResponse**
Bases: *pyslet.odata2.client.ClientException*

The server returned an unexpected response code, typically a 500 internal server error. The error message contains details of the error response returned.

4.3.5 An In-Memory Data Service

4.3.6 SQL Database-based Data Services

This module defines a general (but abstract) implementation of the EDM-based data-access-layer (DAL) using Python's DB API: http://www.python.org/dev/peps/pep-0249/

It also contains a concrete implementation derived from the above that uses the standard SQLite module for storage. For more information about SQLite see: http://www.sqlite.org/

Data Access Layer API

Entity Containers

There are primarily two use cases here:

1. Create a derived class of *SQLEntityContainer* to provide platform specific modifications to the way SQL queries are constructed and database connections are created and managed.
2. Create a derived class of *SQLEntityContainer* to provide modified name mappings for a specific database and metadata model.

These two use cases can be supported through multiple (diamond) inheritance. This makes it easier for you to separate the code required. In practice, implementations for different database platforms are likely to be shared (perhaps as part of future releases of Pyslet itself) whereas modifications to the name mangler to map this API to an existing database will be project specific.

For example, to achieve platform specific modifications you'll override SQLEntityContainer and provide new implementations for methods such as *SQLEntityContainer.get_collection_class()*:

```
class MyDBContainer(SQLEntityContainer):

        def get_collection_class(self):
                return MyDBEntityCollection
```

To achieve modified property name mappings you'll override SQLEntityContainer and provide new implementations for methods such as *SQLEntityContainer.mangle_name()*:

```
class SouthwindDBContainer(SQLEntityContainer):

        def mangle_name(self,source_path):
                # do some custom name mangling here....
```

Normally, you'll want to achieve both use cases, so to actually instantiate your database you'll select the container class that represents the database platform and then combine it with the class that contains your data-specific modifications:

```
import MyDB, Southwind

# easy to configure constants at the top of your script
DBCONTAINER_CLASS=MyDB.MyDBContainer
DBCONTAINER_ARGS={
        'username':"southwind",
        'password':"password"
        }

MAX_CONNECTIONS=100

class SouthwindDB(Southwind.SouthwindDBContainer,DBCONTAINER_CLASS):
        pass

# .... load the metadata from disk and then do something like this
db=SouthwindDB(container=SouthwindMetadata,max_connections=MAX_CONNECTIONS,**DBCONTAINER_ARGS)
```

class pyslet.odata2.sqlds.**SQLEntityContainer**(*container*, *dbapi*, *streamstore=None*, *max_connections=10*, *field_name_joiner=u'_'*, *max_idle=None*, ***kwargs*)

Bases: object

Object used to represent an Entity Container (aka Database).

Keyword arguments on construction:

container The *EntityContainer* that defines this database.

streamstore An optional StreamStore that will be used to store media resources in the container. If absent, media resources actions will generate NotImplementedError.

dbapi The DB API v2 compatible module to use to connect to the database.

This implementation is compatible with modules regardless of their thread-safety level (provided they declare it correctly!).

max_connections (optional) The maximum number of connections to open to the database. If your program attempts to open more than this number (defaults to 10) then it will block until a connection becomes free. Connections are always shared within the same thread so this argument should be set to the expected maximum number of threads that will access the database.

If using a module with thread-safety level 0 max_connections is ignored and is effectively 1, so use of the API is then best confined to single-threaded programs. Multi-threaded programs can still use the API but it will block when there is contention for access to the module and context switches will force the database connection to be closed and reopened.

field_name_joiner (optional) The character used by the name mangler to join compound names, for example, to obtain the column name of a complex property like "Address/City". The default is "_", resulting in names like "Address_City" but it can be changed here. Note: all names are quoted using *quote_identifier()* before appearing in SQL statements.

max_idle (optional) The maximum number of seconds idle database connections should be kept open before they are cleaned by the *pool_cleaner()*. The default is None which means that the pool_cleaner never runs. Any other value causes a separate thread to be created to run the pool cleaner passing the value of the parameter each time. The frequency of calling the pool_cleaner method is calculated by dividing max_idle by 5, but it never runs more than once per minute. For example, a setting of 3600 (1 hour) will result in a pool cleaner call every 12 minutes.

This class is designed to work with diamond inheritance and super. All derived classes must call __init__ through super and pass all unused keyword arguments. For example:

```
class MyDBContainer:
        def __init__(self,myDBConfig,**kwargs):
                super(MyDBContainer,self).__init__(**kwargs)
                # do something with myDBConfig....
```

streamstore = None
the *EntityContainer*

dbapi = None
the optional `StreamStore`

module_lock = None
the DB API compatible module

fk_table = None
A mapping from an entity set name to a FK mapping of the form:

```
{<association set end>: (<nullable flag>, <unique keys flag>),...}
```

The outer mapping has one entry for each entity set (even if the corresponding foreign key mapping is empty).

Each foreign key mapping has one entry for each foreign key reference that must appear in that entity set's table. The key is an `AssociationSetEnd` that is bound to the entity set (the other end will be bound to the target entity set). This allows us to distinguish between the two ends of a recursive association.

aux_table = None
A mapping from the names of symmetric association sets to a tuple of:

```
(<entity set A>, <name prefix A>, <entity set B>,
<name prefix B>, <unique keys>)
```

mangled_names = None
A mapping from source path tuples to mangled and quoted names to use in SQL queries. For example:

```
        (u'Customer'):u'"Customer"'
        (u'Customer', u'Address', u'City') : u"Address_City"
        (u'Customer', u'Orders') : u"Customer_Orders"
```

Note that the first element of the tuple is the entity set name but the default implementation does not use this in the mangled name for primitive fields as they are qualified in contexts where a name clash is possible. However, mangled navigation property names do include the table name prefix as they used as pseudo-table names.

field_name_joiner = None
Default string used to join complex field names in SQL queries, e.g. Address_City

ro_names = None
The set of names that should be considered read only by the SQL insert and update generation code. The items in the set are source paths, as per *mangled_names*. The set is populated on construction using the *ro_name()* method.

mangle_name(*source_path*)
Mangles a source path into a quoted SQL name

This is a key extension point to use when you are wrapping an existing database with the API. It allows you to control the names used for entity sets (tables) and properties (columns) in SQL queries.

source_path A tuple or list of strings describing the path to a property in the metadata model.

For entity sets, this is a tuple with a single entry in it, the entity set name.

For data properties this is a tuple containing the path, including the entity set name e.g., ("Customers","Address","City") for the City property in a complex property 'Address' in entity set "Customers".

For navigation properties the tuple is the navigation property name prefixed with the entity set name, e.g., ("Customers","Orders"). This name is only used as a SQL alias for the target table, to remove ambiguity from certain queries that include a join across the navigation property. The mangled name must be distinct from the entity set name itself. from other such aliases and from other column names in this table.

Foreign key properties contain paths starting with both the entity set and the association set names (see *SQLForeignKeyCollection* for details) unless the association is symmetric, in which case they also contain the navigation property name (see *SQLAssociationCollection* for details of these more complex cases).

The default implementation strips the entity set name away and uses the default joining character to create a compound name before calling *quote_identifier()* to obtain the SQL string. All names are mangled once, on construction, and from then on looked up in the dictionary of mangled names.

If you need to override this method to modify the names used in your database you should ensure all other names (including any unrecognized by your program) are passed to the default implementation for mangling.

ro_name(*source_path*)
Test if a source_path identifies a read-only property

This is a an additional extension point to use when you are wrapping an existing database with the API. It allows you to manage situations where an entity property has an implied value and should be treated read only.

There are two key use cases, auto-generated primary keys (such as auto-increment integer keys) and foreign keys which are exposed explicitly as foreign keys and should only be updated through an associated navigation property.

source_path A tuple or list of strings describing the path to a property in the metadata model. See *mangle_name()* for more information.

The default implementation returns False.

If you override this method you must ensure all other names (including any unrecognized by your program) are passed to the default implementation using super.

source_path_generator(*entity_set*)
Utility generator for source path *tuples* for *entity_set*

get_collection_class()
Returns the collection class used to represent a generic entity set.

Override this method to provide a class derived from *SQLEntityCollection* when you are customising this implementation for a specific database engine.

get_symmetric_navigation_class()
Returns the collection class used to represent a symmetric relation.

Override this method to provide a class derived from *SQLAssociationCollection* when you are customising this implementation for a specific database engine.

get_fk_class()
Returns the class used when the FK is in the source table.

Override this method to provide a class derived from *SQLForeignKeyCollection* when you are customising this implementation for a specific database engine.

get_rk_class()
Returns the class used when the FK is in the target table.

Override this method to provide a class derived from *SQLReverseKeyCollection* when you are customising this implementation for a specific database engine.

create_all_tables(*out=None*)
Creates all tables in this container.

out An optional file-like object. If given, the tables are not actually created, the SQL statements are written to this file instead.

Tables are created in a sensible order to ensure that foreign key constraints do not fail but this method is not compatible with databases that contain circular references though, e.g., Table A -> Table B with a foreign key and Table B -> Table A with a foreign key. Such databases will have to be created by hand. You can use the create_table_query methods to act as a starting point for your script.

drop_all_tables(*out=None*)
Drops all tables in this container.

Tables are dropped in a sensible order to ensure that foreign key constraints do not fail, the order is essentially the reverse of the order used by *create_all_tables()*.

connection_stats()
Return information about the connection pool

Returns a triple of:

nlocked the number of connections in use by all threads.

nunlocked the number of connections waiting

nidle the number of dead connections

Connections are placed in the 'dead pool' when unexpected lock failures occur or if they are locked and the owning thread is detected to have terminated without releasing them.

pool_cleaner(*max_idle=900.0*)
Cleans up the connection pool

max_idle (float) Optional number of seconds beyond which an idle connection is closed. Defaults to 10 times the *SQL_TIMEOUT*.

open()
Creates and returns a new connection object.

Must be overridden by database specific implementations because the underlying DB ABI does not provide a standard method of connecting.

close_connection(*connection*)
Calls the underlying close method.

break_connection(*connection*)
Called when closing or cleaning up locked connections.

This method is called when the connection is locked (by a different thread) and the caller wants to force that thread to relinquish control.

The assumption is that the database is stuck in some lengthy transaction and that break_connection can be used to terminate the transaction and force an exception in the thread that initiated it - resulting in a subsequent call to `release_connection()` and a state which enables this thread to acquire the connection's lock so that it can close it.

The default implementation does nothing, which might cause the close method to stall until the other thread relinquishes control normally.

close(*timeout=5*)
Closes this database.

This method goes through each open connection and attempts to acquire it and then close it. The object is put into a mode that disables `acquire_connection()` (it returns None from now on).

timeout Defaults to 5 seconds. If connections are locked by other *running* threads we wait for those threads to release them, calling *break_connection()* to speed up termination if possible.

If None (not recommended!) this method will block indefinitely until all threads properly call `release_connection()`.

Any locks we fail to acquire in the timeout are ignored and the connections are left open for the python garbage collector to dispose of.

quote_identifier(*identifier*)
Given an *identifier* returns a safely quoted form of it.

By default we strip double quote and then use them to enclose it. E.g., if the string u'Employee_Name' is passed then the string u'"Employee_Name"' is returned.

prepare_sql_type(*simple_value*, *params*, *nullable=None*)
Given a simple value, returns a SQL-formatted name of its type.

Used to construct CREATE TABLE queries.

simple_value A *pyslet.odata2.csdl.SimpleValue* instance which should have been created from a suitable *pyslet.odata2.csdl.Property* definition.

params A *SQLParams* object. If simple_value is non-NULL, a DEFAULT value is added as part of the type definition.

nullable Optional Boolean that can be used to override the nullable status of the associated property definition.

For example, if the value was created from an Int32 non-nullable property and has value 0 then this might return the string u'INTEGER NOT NULL DEFAULT ?' with 0 being added to *params*

You should override this implementation if your database platform requires special handling of certain datatypes. The default mappings are given below.

EDM Type	SQL Equivalent
Edm.Binary	BINARY(MaxLength) if FixedLength specified
Edm.Binary	VARBINARY(MaxLength) if no FixedLength
Edm.Boolean	BOOLEAN
Edm.Byte	SMALLINT
Edm.DateTime	TIMESTAMP
Edm.DateTimeOffset	CHARACTER(27), ISO 8601 string representation is used with micro second precision
Edm.Decimal	DECIMAL(Precision,Scale), defaults 10,0
Edm.Double	FLOAT
Edm.Guid	BINARY(16)
Edm.Int16	SMALLINT
Edm.Int32	INTEGER
Edm.Int64	BIGINT
Edm.SByte	SMALLINT
Edm.Single	REAL
Edm.String	CHAR(MaxLength) or VARCHAR(MaxLength)
Edm.String	NCHAR(MaxLength) or NVARCHAR(MaxLength) if Unicode="true"
Edm.Time	TIME

Parameterized CREATE TABLE queries are unreliable in my experience so the current implementation of the native create_table methods ignore default values when calling this method.

prepare_sql_value(*simple_value*)

Returns a python object suitable for passing as a parameter

simple_value A *pyslet.odata2.csdl.SimpleValue* instance.

You should override this method if your database requires special handling of parameter values. The default implementation performs the following conversions

EDM Type	Python value added as parameter
NULL	None
Edm.Binary	(byte) string
Edm.Boolean	True or False
Edm.Byte	int
Edm.DateTime	Timestamp instance from DB API module
Edm.DateTimeOffset	string (ISO 8601 basic format)
Edm.Decimal	Decimal instance
Edm.Double	float
Edm.Guid	(byte) string
Edm.Int16	int
Edm.Int32	int
Edm.Int64	long
Edm.SByte	int
Edm.Single	float
Edm.String	(unicode) string
Edm.Time	Time instance from DB API module

read_sql_value(*simple_value*, *new_value*)

Updates *simple_value* from *new_value*.

simple_value A *pyslet.odata2.csdl.SimpleValue* instance.

new_value A value returned by the underlying DB API, e.g., from a cursor fetch operation

This method performs the reverse transformation to *prepare_sql_value()* and may need to be overridden to convert *new_value* into a form suitable for passing to the underlying *set_from_value()* method.

new_from_sql_value(*sql_value*)
Returns a new simple value with value *sql_value*

The return value is a *pyslet.odata2.csdl.SimpleValue* instance.

sql_value A value returned by the underlying DB API, e.g., from a cursor fetch operation

This method creates a new instance, selecting the most appropriate type to represent sql_value. By default *pyslet.odata2.csdl.EDMValue.NewSimpleValueFromValue()* is used.

You may need to override this method to identify the appropriate value type.

select_limit_clause(*skip*, *top*)
Returns a SELECT modifier to limit a query

See *limit_clause()* for details of the parameters.

Returns a tuple of:

skip 0 if the modifier implements this functionality. If it does not implement this function then the value passed in for skip *must* be returned.

modifier A string modifier to insert immediately after the SELECT statement (must be empty or end with a space).

For example, if your database supports the TOP keyword you might return:

```
(skip, 'TOP %i' % top)
```

This will result in queries such as:

```
SELECT TOP 10 FROM ....
```

More modern syntax tends to use a special limit clause at the end of the query, rather than a SELECT modifier. The default implementation returns:

```
(skip, '')
```

...essentially doing nothing.

limit_clause(*skip*, *top*)
Returns a limit clause to limit a query

skip An integer number of entities to skip

top An integer number of entities to limit the result set of a query or None is no limit is desired.

Returns a tuple of:

skip 0 if the limit clause implements this functionality. If it does not implement this function then the value passed in for skip *must* be returned.

clause A limit clause to append to the query. Must be empty or end with a space.

For example, if your database supports the MySQL-style LIMIT and OFFSET keywords you would return (for non-None values of top):

```
        (0, 'LIMIT %i OFFSET %i' % (top, skip))
```

This will result in queries such as:

```
        SELECT * FROM Customers LIMIT 10 OFFSET 20
```

More modern syntax tends to use a special limit clause at the end of the query, rather than a SELECT modifier. Such as:

```
        (skip, 'FETCH FIRST %i ROWS ONLY ' % top)
```

This syntax is part of SQL 2008 standard but is not widely adopted and, for compatibility with existing external database implementation, the default implementation remains blank.

For an example of how to create a platform-specific implementation see *SQLite* below.

Entity Collections

These classes are documented primarily to facilitate the creation of alternative implementations designed to run over other DB API based data layers. The documentation goes a bit further than is necessary to help promote an understanding of the way the API is implemented.

class pyslet.odata2.sqlds.**SQLEntityCollection**(*container*, ***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLCollectionBase*

Represents a collection of entities from an `EntitySet`.

This class is the heart of the SQL implementation of the API, constructing and executing queries to implement the core methods from *pyslet.odata2.csdl.EntityCollection*.

insert_entity(*entity*)
Inserts *entity* into the collection.

We override this method, rerouting it to a SQL-specific implementation that takes additional arguments.

insert_entity_sql(*entity*, *from_end=None*, *fk_values=None*, *transaction=None*)
Inserts *entity* into the collection.

This method is not designed to be overridden by other implementations but it does extend the default functionality for a more efficient implementation and to enable better transactional processing. The additional parameters are documented here.

from_end An optional *pyslet.odata2.csdl.AssociationSetEnd* bound to this entity set. If present, indicates that this entity is being inserted as part of a single transaction involving an insert or update to the other end of the association.

This suppresses any check for a required link via this association (as it is assumed that the link is present, or will be, in the same transaction).

fk_values If the association referred to by *from_end* is represented by a set of foreign keys stored in this entity set's table (see *SQLReverseKeyCollection*) then fk_values is the list of (mangled column name, value) tuples that must be inserted in order to create the link.

transaction An optional transaction. If present, the connection is left uncommitted.

The method functions in three phases.

1. Process all bindings for which we hold the foreign key. This includes inserting new entities where deep inserts are being used or calculating foreign key values where links to existing entities have been specified on creation.

   In addition, all required links are checked and raise errors if no binding is present.

2. A simple SQL INSERT statement is executed to add the record to the database along with any foreign keys generated in (1) or passed in *fk_values*.

3. Process all remaining bindings. Although we could do this using the *update_bindings()* method of DeferredValue we handle this directly to retain transactional integrity (where supported).

   Links to existing entities are created using the insert_link method available on the SQL-specific *SQLNavigationCollection*.

   Deep inserts are handled by a recursive call to this method. After step 1, the only bindings that remain are (a) those that are stored at the other end of the link and so can be created by passing values for *from_end* and *fk_values* in a recursive call or (b) those that are stored in a separate table which are created by combining a recursive call and a call to insert_link.

Required links are always created in step 1 because the overarching mapping to SQL forces such links to be represented as foreign keys in the source table (i.e., this table) unless the relationship is 1-1, in which case the link is created in step 3 and our database is briefly in violation of the model. If the underlying database API does not support transactions then it is possible for this state to persist resulting in an orphan entity or entities, i.e., entities with missing required links. A failed `rollback()` call will log this condition along with the error that caused it.

update_entity(*entity*)
Updates *entity*

This method follows a very similar pattern to `InsertMethod()`, using a three-phase process.

1. **Process all bindings for which we hold the foreign key.** This includes inserting new entities where deep inserts are being used or calculating foreign key values where links to existing entities have been specified on update.

2. **A simple SQL UPDATE statement is executed to update the** record in the database along with any updated foreign keys generated in (1).

3. **Process all remaining bindings while retaining transactional** integrity (where supported).

   Links to existing entities are created using the insert_link or replace methods available on the SQL-specific *SQLNavigationCollection*. The replace method is used when a navigation property that links to a single entity has been bound. Deep inserts are handled by calling insert_entity_sql before the link is created.

The same transactional behaviour as *insert_entity_sql()* is exhibited.

update_link(*entity*, *link_end*, *target_entity*, *no_replace=False*, *transaction=None*)
Updates a link when this table contains the foreign key

entity The entity being linked from (must already exist)

link_end The *AssociationSetEnd* bound to this entity set that represents this entity set's end of the assocation being modified.

target_entity The entity to link to or None if the link is to be removed.

no_replace If True, existing links will not be replaced. The affect is to force the underlying SQL query to include a constraint that the foreign key is currently NULL. By default this argument is False and any existing link will be replaced.

transaction An optional transaction. If present, the connection is left uncommitted.

delete_entity(*entity*, *from_end=None*, *transaction=None*)
Deletes an entity

Called by the dictionary-like del operator, provided as a separate method to enable it to be called recursively when doing cascade deletes and to support transactions.

from_end An optional *AssociationSetEnd* bound to this entity set that represents the link from which we are being deleted during a cascade delete.

The purpose of this parameter is prevent cascade deletes from doubling back on themselves and causing an infinite loop.

transaction An optional transaction. If present, the connection is left uncommitted.

delete_link(*entity*, *link_end*, *target_entity*, *transaction=None*)
Deletes the link between *entity* and *target_entity*

The foreign key for this link must be held in this entity set's table.

entity The entity in this entity set that the link is from.

link_end The *AssociationSetEnd* bound to this entity set that represents this entity set's end of the assocation being modified.

target_entity The target entity that defines the link to be removed.

transaction An optional transaction. If present, the connection is left uncommitted.

clear_links(*link_end*, *target_entity*, *transaction=None*)
Deletes all links to *target_entity*

The foreign key for this link must be held in this entity set's table.

link_end The *AssociationSetEnd* bound to this entity set that represents this entity set's end of the assocation being modified.

target_entity The target entity that defines the link(s) to be removed.

transaction An optional transaction. If present, the connection is left uncommitted.

create_table_query()
Returns a SQL statement and params for creating the table.

create_table()
Executes the SQL statement *create_table_query()*

drop_table_query()
Returns a SQL statement for dropping the table.

drop_table()
Executes the SQL statement *drop_table_query()*

class pyslet.odata2.sqlds.**SQLCollectionBase**(*container*, ***kwargs*)
Bases: *pyslet.odata2.core.EntityCollection*

A base class to provide core SQL functionality.

Additional keyword arguments:

container A *SQLEntityContainer* instance.

On construction a data connection is acquired from *container*, this may prevent other threads from using the database until the lock is released by the *close()* method.

container = None
the parent container (database) for this collection

connection = None
a connection to the database acquired with SQLEntityContainer.acquire_connection()

close()
Closes the cursor and database connection if they are open.

set_page(*top*, *skip=0*, *skiptoken=None*)
Sets the values for paging.

Our implementation uses a special format for *skiptoken*. It is a comma-separated list of simple literal values corresponding to the values required by the ordering augmented with the key values to ensure uniqueness.

For example, if $orderby=A,B on an entity set with key K then the skiptoken will typically have three values comprising the last values returned for A,B and K in that order. In cases where the resulting skiptoken would be unreasonably large an additional integer (representing a further skip) may be appended and the whole token expressed relative to an earlier skip point.

reset_joins()
Sets the base join information for this collection

add_join(*name*)
Adds a join to this collection

name The name of the navigation property to traverse.

The return result is the alias name to use for the target table.

As per the specification, the target must have multiplicity 1 or 0..1.

join_clause()
A utility method to return the JOIN clause.

Defaults to an empty expression.

where_clause(*entity*, *params*, *use_filter=True*, *use_skip=False*, *null_cols=()*)
A utility method that generates the WHERE clause for a query

entity An optional entity within this collection that is the focus of this query. If not None the resulting WHERE clause will restrict the query to this entity only.

params The *SQLParams* object to add parameters to.

use_filter Defaults to True, indicates if this collection's filter should be added to the WHERE clause.

use_skip Defaults to False, indicates if the skiptoken should be used in the where clause. If True then the query is limited to entities appearing after the skiptoken's value (see below).

null_cols An iterable of mangled column names that must be NULL (defaults to an empty tuple). This argument is used during updates to prevent the replacement of non-NULL foreign keys.

The operation of the skiptoken deserves some explanation. When in play the skiptoken contains the last value of the order expression returned. The order expression always uses the keys to ensure unambiguous ordering. The clause added is best served with an example. If an entity has key K and an order expression such as "tolower(Name) desc" then the query will contain something like:

```
SELECT K, Nname, DOB, LOWER(Name) AS o_1, K ....
        WHERE (o_1 < ? OR (o_1 = ? AND K > ?))
```

The values from the skiptoken will be passed as parameters.

where_entity_clause(*where*, *entity*, *params*)
Adds the entity constraint expression to a list of SQL expressions.

where The list to append the entity expression to.

entity An expression is added to restrict the query to this entity

where_skiptoken_clause(*where*, *params*)
Adds the entity constraint expression to a list of SQL expressions.

where The list to append the skiptoken expression to.

set_orderby(*orderby*)
Sets the orderby rules for this collection.

We override the default implementation to calculate a list of field name aliases to use in ordered queries. For example, if the orderby expression is "tolower(Name) desc" then each SELECT query will be generated with an additional expression, e.g.:

```
SELECT ID, Name, DOB, LOWER(Name) AS o_1 ...
    ORDER BY o_1 DESC, ID ASC
```

The name "o_1" is obtained from the name mangler using the tuple:

```
(entity_set.name,'o_1')
```

Subsequent order expressions have names 'o_2', 'o_3', etc.

Notice that regardless of the ordering expression supplied the keys are always added to ensure that, when an ordering is required, a defined order results even at the expense of some redundancy.

orderby_clause()
A utility method to return the orderby clause.

params The *SQLParams* object to add parameters to.

orderby_cols(*column_names*, *params*, *force_order=False*)
A utility to add the column names and aliases for the ordering.

column_names A list of SQL column name/alias expressions

params The *SQLParams* object to add parameters to.

force_order Forces the addition of an ordering by key if an orderby expression has not been set.

insert_fields(*entity*)
A generator for inserting mangled property names and values.

entity Any instance of *Entity*

The yielded values are tuples of (mangled field name, *SimpleValue* instance).

Read only fields are never generated, even if they are keys. This allows automatically generated keys to be used and also covers the more esoteric use case where a foreign key constraint exists on the primary key (or part thereof) - in the latter case the relationship should be marked as required to prevent unexpected constraint violations.

Otherwise, only selected fields are yielded so if you attempt to insert a value without selecting the key fields you can expect a constraint violation unless the key is read only.

auto_fields(*entity*)
A generator for selecting auto mangled property names and values.

entity Any instance of *Entity*

The yielded values are tuples of (mangled field name, *SimpleValue* instance).

Only fields that are read only are yielded with the caveat that they must also be either selected or keys. The purpose of this method is to assist with reading back automatically generated field values after an insert or update.

key_fields(*entity*)
A generator for selecting mangled key names and values.

entity Any instance of *Entity*

The yielded values are tuples of (mangled field name, *SimpleValue* instance). Only the keys fields are yielded.

select_fields(*entity*, *prefix=True*)
A generator for selecting mangled property names and values.

entity Any instance of *Entity*

The yielded values are tuples of (mangled field name, *SimpleValue* instance). Only selected fields are yielded with the caveat that the keys are always selected.

update_fields(*entity*)
A generator for updating mangled property names and values.

entity Any instance of *Entity*

The yielded values are tuples of (mangled field name, *SimpleValue* instance).

Neither read only fields nor key are generated. All other fields are yielded but unselected fields are set to NULL before being yielded. This implements OData's PUT semantics. See *merge_fields()* for an alternative.

merge_fields(*entity*)
A generator for merging mangled property names and values.

entity Any instance of *Entity*

The yielded values are tuples of (mangled field name, *SimpleValue* instance).

Neither read only fields, keys nor unselected fields are generated. All other fields are yielded implementing OData's MERGE semantics. See *update_fields()* for an alternative.

stream_field(*entity*, *prefix=True*)
Returns information for selecting the stream ID.

entity Any instance of *Entity*

Returns a tuples of (mangled field name, *SimpleValue* instance).

sql_expression(*expression*, *params*, *context='AND'*)
Converts an expression into a SQL expression string.

expression A `pyslet.odata2.core.CommonExpression` instance.

params A *SQLParams* object of the appropriate type for this database connection.

context A string containing the SQL operator that provides the context in which the expression is being converted, defaults to 'AND'. This is used to determine if the resulting expression must be bracketed or not. See *sql_bracket()* for a useful utility function to illustrate this.

This method is basically a grand dispatcher that sends calls to other node-specific methods with similar signatures. The effect is to traverse the entire tree rooted at *expression*.

The result is a string containing the parameterized expression with appropriate values added to the *params* object *in the same sequence* that they appear in the returned SQL expression.

When creating derived classes to implement database-specific behaviour you should override the individual evaluation methods rather than this method. All related methods have the same signature.

Where methods are documented as having no default implementation, NotImplementedError is raised.

sql_bracket(*query*, *context*, *operator*)
A utility method for bracketing a SQL query.

query The query string

context A string representing the SQL operator that defines the context in which the query is to placed. E.g., 'AND'

operator The dominant operator in the query.

This method is used by operator-specific conversion methods. The query is not parsed, it is merely passed in as a string to be bracketed (or not) depending on the values of *context* and *operator*.

The implementation is very simple, it checks the precedence of *operator* in *context* and returns *query* bracketed if necessary:

```
collection.sql_bracket("Age+3","*","+")=="(Age+3)"
collection.sql_bracket("Age*3","+","*")=="Age*3"
```

sql_expression_member(*expression*, *params*, *context*)
Converts a member expression, e.g., Address/City

This implementation does not support the use of navigation properties but does support references to complex properties.

It outputs the mangled name of the property, qualified by the table name.

sql_expression_cast(*expression*, *params*, *context*)
Converts the cast expression: no default implementation

sql_expression_generic_binary(*expression*, *params*, *context*, *operator*)
A utility method for implementing binary operator conversion.

The signature of the basic *sql_expression()* is extended to include an *operator* argument, a string representing the (binary) SQL operator corresponding to the expression object.

sql_expression_mul(*expression*, *params*, *context*)
Converts the mul expression: maps to SQL "*"

sql_expression_div(*expression*, *params*, *context*)
Converts the div expression: maps to SQL "/"

sql_expression_mod(*expression*, *params*, *context*)
Converts the mod expression: no default implementation

sql_expression_add(*expression*, *params*, *context*)
Converts the add expression: maps to SQL "+"

sql_expression_sub(*expression*, *params*, *context*)
Converts the sub expression: maps to SQL "-"

sql_expression_lt(*expression*, *params*, *context*)
Converts the lt expression: maps to SQL "<"

sql_expression_gt(*expression*, *params*, *context*)
Converts the gt expression: maps to SQL ">"

sql_expression_le(*expression*, *params*, *context*)
Converts the le expression: maps to SQL "<="

sql_expression_ge(*expression*, *params*, *context*)
Converts the ge expression: maps to SQL ">="

sql_expression_isof(*expression*, *params*, *context*)
Converts the isof expression: no default implementation

sql_expression_eq(*expression*, *params*, *context*)
Converts the eq expression: maps to SQL "="

sql_expression_ne(*expression*, *params*, *context*)
Converts the ne expression: maps to SQL "<>"

sql_expression_and(*expression*, *params*, *context*)
Converts the and expression: maps to SQL "AND"

sql_expression_or(*expression*, *params*, *context*)
Converts the or expression: maps to SQL "OR"

sql_expression_endswith(*expression*, *params*, *context*)
Converts the endswith function: maps to "op[0] LIKE '%'+op[1]"

This is implemented using the concatenation operator

sql_expression_indexof(*expression*, *params*, *context*)
Converts the indexof method: maps to POSITION(op[0] IN op[1])

sql_expression_replace(*expression*, *params*, *context*)
Converts the replace method: no default implementation

sql_expression_startswith(*expression*, *params*, *context*)
Converts the startswith function: maps to "op[0] LIKE op[1]+'%"'

This is implemented using the concatenation operator

sql_expression_tolower(*expression*, *params*, *context*)
Converts the tolower method: maps to LOWER function

sql_expression_toupper(*expression*, *params*, *context*)
Converts the toupper method: maps to UCASE function

sql_expression_trim(*expression*, *params*, *context*)
Converts the trim method: maps to TRIM function

sql_expression_substring(*expression*, *params*, *context*)
Converts the substring method

maps to SUBSTRING(op[0] FROM op[1] [FOR op[2]]

sql_expression_substringof(*expression*, *params*, *context*)
Converts the substringof function

maps to "op[1] LIKE '%'+op[0]+'%"'

To do this we need to invoke the concatenation operator.

This method has been poorly defined in OData with the parameters being switched between versions 2 and 3. It is being withdrawn as a result and replaced with contains in OData version 4. We follow the version 3 convention here of "first parameter in the second parameter" which fits better with the examples and with the intuitive meaning:

```
substringof(A,B) == A in B
```

sql_expression_concat(*expression*, *params*, *context*)
Converts the concat method: maps to ||

sql_expression_length(*expression*, *params*, *context*)
Converts the length method: maps to CHAR_LENGTH(op[0])

sql_expression_year(*expression*, *params*, *context*)
Converts the year method: maps to EXTRACT(YEAR FROM op[0])

sql_expression_month(*expression*, *params*, *context*)
Converts the month method: maps to EXTRACT(MONTH FROM op[0])

sql_expression_day(*expression*, *params*, *context*)
Converts the day method: maps to EXTRACT(DAY FROM op[0])

sql_expression_hour(*expression*, *params*, *context*)
Converts the hour method: maps to EXTRACT(HOUR FROM op[0])

sql_expression_minute(*expression*, *params*, *context*)
Converts the minute method: maps to EXTRACT(MINUTE FROM op[0])

sql_expression_second(*expression*, *params*, *context*)
Converts the second method: maps to EXTRACT(SECOND FROM op[0])

sql_expression_round(*expression*, *params*, *context*)
Converts the round method: no default implementation

sql_expression_floor(*expression*, *params*, *context*)
Converts the floor method: no default implementation

sql_expression_ceiling(*expression*, *params*, *context*)
Converts the ceiling method: no default implementation

class pyslet.odata2.sqlds.**SQLNavigationCollection**(*aset_name*, ***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLCollectionBase*, *pyslet.odata2.core.NavigationCollection*

Abstract class representing all navigation collections.

Additional keyword arguments:

aset_name The name of the association set that defines this relationship. This additional parameter is used by the name mangler to obtain the field name (or table name) used for the foreign keys.

insert_link(*entity*, *transaction=None*)
Inserts a link to *entity* into this collection.

transaction An optional transaction. If present, the connection is left uncommitted.

replace_link(*entity*, *transaction=None*)
Replaces all links with a single link to *entity*.

transaction An optional transaction. If present, the connection is left uncommitted.

delete_link(*entity*, *transaction=None*)
A utility method that deletes the link to *entity* in this collection.

This method is called during cascaded deletes to force-remove a link prior to the deletion of the entity itself.

transaction An optional transaction. If present, the connection is left uncommitted.

class pyslet.odata2.sqlds.**SQLForeignKeyCollection**(***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLNavigationCollection*

The collection of entities obtained by navigation via a foreign key

This object is used when the foreign key is stored in the same table as *from_entity*. This occurs when the relationship is one of:

```
0..1 to 1
Many to 1
Many to 0..1
```

The name mangler looks for the foreign key in the field obtained by mangling:

```
(entity set name, association set name, key name)
```

For example, suppose that a link exists from entity set Orders[*] to entity set Customers[0..1] and that the key field of Customer is "CustomerID". If the association set that binds Orders to Customers with this link is called OrdersToCustomers then the foreign key would be obtained by looking up:

```
('Orders','OrdersToCustomers','CustomerID')
```

By default this would result in the field name:

```
'OrdersToCustomers_CustomerID'
```

This field would be looked up in the 'Orders' table. The operation of the name mangler can be customised by overriding the *SQLEntityContainer.mangle_name()* method in the container.

reset_joins()
Overridden to provide an inner join to *from_entity*'s table.

The join clause introduces an alias for the table containing *from_entity*. The resulting join looks something like this:

```
SELECT ... FROM Customers
INNER JOIN Orders AS nav1 ON
    Customers.CustomerID=nav1.OrdersToCustomers_CustomerID
...
WHERE nav1.OrderID = ?;
```

The value of the OrderID key property in from_entity is passed as a parameter when executing the expression.

In most cases, there will be a navigation properly bound to this association in the reverse direction. For example, to continue the above example, Orders to Customers might be bound to a navigation property in the reverse direction called, say, 'AllOrders' *in the target entity set*.

If this navigation property is used in an expression then the existing INNER JOIN defined here is used instead of a new LEFT JOIN as would normally be the case.

where_clause(*entity*, *params*, *use_filter=True*, *use_skip=False*)
Adds the constraint for entities linked from *from_entity* only.

We continue to use the alias set in the `join_clause()` where an example WHERE clause is illustrated.

class pyslet.odata2.sqlds.**SQLReverseKeyCollection**(***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLNavigationCollection*

The collection of entities obtained by navigation to a foreign key

This object is used when the foreign key is stored in the target table. This occurs in the reverse of the cases where *SQLReverseKeyCollection* is used, i.e:

1 to 0..1 1 to Many 0..1 to Many

The implementation is actually simpler in this direction as no JOIN clause is required.

where_clause(*entity*, *params*, *use_filter=True*, *use_skip=False*)
Adds the constraint to entities linked from *from_entity* only.

delete_link(*entity*, *transaction=None*)
Called during cascaded deletes.

This is actually a no-operation as the foreign key for this association is in the entity's record itself and will be removed automatically when entity is deleted.

clear_links(*transaction=None*)
Deletes all links from this collection's *from_entity*

transaction An optional transaction. If present, the connection is left uncommitted.

class pyslet.odata2.sqlds.**SQLAssociationCollection**(***kwargs*)

Bases: *pyslet.odata2.sqlds.SQLNavigationCollection*

The collection obtained by navigation using an auxiliary table

This object is used when the relationship is described by two sets of foreign keys stored in an auxiliary table. This occurs mainly when the link is Many to Many but it is also used for 1 to 1 relationships. This last use may seem odd but it is used to represent the symmetry of the relationship. In practice, a single set of foreign keys is likely to exist in one table or the other and so the relationship is best modelled by a 0..1 to 1 relationship even if the intention is that the records will always exist in pairs.

The name of the auxiliary table is obtained from the name mangler using the association set's name. The keys use a more complex mangled form to cover cases where there is a recursive Many to Many relation (such as a social network of friends between User entities). The names of the keys are obtained by mangling:

```
( association set name, target entity set name,
    navigation property name, key name )
```

An example should help. Suppose we have entities representing sports Teams(TeamID) and sports Players(PlayerID) and that you can navigate from Player to Team using the "PlayedFor" navigation property and from Team to Player using the "Players" navigation property. Both navigation properties are collections so the relationship is Many to Many. If the association set that binds the two entity sets is called PlayersAndTeams then the the auxiliary table name will be mangled from:

```
('PlayersAndTeams')
```

and the fields will be mangled from:

```
('PlayersAndTeams','Teams','PlayedFor','TeamID')
('PlayersAndTeams','Players','Players','PlayerID')
```

By default this results in column names 'Teams_PlayedFor_TeamID' and 'Players_Players_PlayerID'. If you are modelling an existing database then 'TeamID' and 'PlayerID' on their own are more likely choices. You would need to override the *SQLEntityContainer.mangle_name()* method in the container to catch these cases and return the shorter column names.

Finally, to ensure the uniqueness of foreign key constraints, the following names are mangled:

```
( association set name, association set name, 'fkA')
( association set name, association set name, 'fkB')
```

Notice that the association set name is used twice as it is not only defines the scope of the name but must also be incorporated into the constraint name to ensure uniqueness across the entire databas.

reset_joins()

Overridden to provide an inner join to the aux table.

If the Customer and Group entities are related with a Many-Many relationship called Customers_Groups, the resulting join looks something like this (when the from_entity is a Customer):

```
SELECT ... FROM Groups
INNER JOIN Customers_Groups ON
    Groups.GroupID = Customers_Groups.Groups_MemberOf_GroupID
...
WHERE Customers_Groups.Customers_Members_CustomerID = ?;
```

The value of the CustomerID key property in from_entity is passed as a parameter when executing the expression.

add_join(*name*)
Overridden to provide special handling of navigation

In most cases, there will be a navigation property bound to this association in the reverse direction. For Many-Many relations this can't be used in an expression but if the relationship is actually 1-1 then we would augment the default INNER JOIN with an additional INNER JOIN to include the whole of the from_entity. (Normally we'd think of these expressions as LEFT joins but we're navigating back across a link that points to a single entity so there is no difference.)

To illustrate, if Customers have a 1-1 relationship with PrimaryContacts through a Customers_PrimaryContacts association set then the expression grows an additional join:

```
SELECT ... FROM PrimaryContacts
INNER JOIN Customers_PrimaryContacts ON
    PrimaryContacts.ContactID =
        Customers_PrimaryContacts.PrimaryContacts_Contact_ContactID
INNER JOIN Customers AS nav1 ON
    Customers_PrimaryContacts.Customers_Customer_CustmerID =
        Customers.CustomerID
...
WHERE Customers_PrimaryContacts.Customers_Customer_CustomerID = ?;
```

This is a cumbersome query to join two entities that are supposed to have a 1-1 relationship, which is one of the reasons why it is generally better to pick on side of the relationship or other and make it 0..1 to 1 as this would obviate the auxiliary table completely and just put a non-NULL, unique foreign key in the table that represents the 0..1 side of the relationship.

where_clause(*entity*, *params*, *use_filter=True*, *use_skip=False*)
Provides the *from_entity* constraint in the auxiliary table.

insert_entity(*entity*)
Rerouted to a SQL-specific implementation

insert_entity_sql(*entity*, *transaction=None*)
Inserts *entity* into the base collection and creates the link.

This is always done in two steps, bound together in a single transaction (where supported). If this object represents a 1 to 1 relationship then, briefly, we'll be in violation of the model. This will only be an issue in non-transactional systems.

delete_link(*entity*, *transaction=None*)
Called during cascaded deletes to force-remove a link prior to the deletion of the entity itself.

This method is also re-used for simple deletion of the link in this case as the link is in the auxiliary table itself.

clear_links(*transaction=None*)
Deletes all links from this collection's *from_entity*

transaction An optional transaction. If present, the connection is left uncommitted.

classmethod clear_links_unbound(*container*, *from_end*, *from_entity*, *transaction*)
Special class method for deleting all the links from *from_entity*

This is a class method because it has to work even if there is no navigation property bound to this end of the association.

container The *SQLEntityContainer* containing this association set.

from_end The *AssociationSetEnd* that represents the end of the association that *from_entity* is bound to.

from_entity The entity to delete links from

transaction The current transaction (required)

This is a class method because it has to work even if there is no navigation property bound to this end of the association. If there was a navigation property then an instance could be created and the simpler *clear_links()* method used.

classmethod create_table_query(*container*, *aset_name*)
Returns a SQL statement and params to create the auxiliary table.

This is a class method to enable the table to be created before any entities are created.

classmethod create_table(*container*, *aset_name*)
Executes the SQL statement *create_table_query()*

classmethod drop_table_query(*container*, *aset_name*)
Returns a SQL statement to drop the auxiliary table.

classmethod drop_table(*container*, *aset_name*)
Executes the SQL statement *drop_table_query()*

SQLite

This module also contains a fully functional implementation of the API based on the sqlite3 module. The first job with any SQL implementation is to create a base collection class that implements any custom expression handling.

In the case of SQLite we override a handful of the standard SQL functions only. Notice that this class is derived from *SQLCollectionBase*, an abstract class. If your SQL platform adheres to the SQL standard very closely, or you are happy for SQL-level errors to be generated when unsupported SQL syntax is generated by some filter or orderby expressions then you can skip the process of creating customer collection classes completely.

class pyslet.odata2.sqlds.**SQLiteEntityCollectionBase**(*container*, ***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLCollectionBase*

Base class for SQLite SQL custom mappings.

This class provides some SQLite specific mappings for certain functions to improve compatibility with the OData expression language.

sql_expression_length(*expression*, *params*, *context*)
Converts the length method: maps to length(op[0])

sql_expression_year(*expression*, *params*, *context*)
Converts the year method

maps to CAST(strftime('%Y',op[0]) AS INTEGER)

sql_expression_month(*expression*, *params*, *context*)
Converts the month method

maps to CAST(strftime('%m',op[0]) AS INTEGER)

sql_expression_day(*expression*, *params*, *context*)
Converts the day method

maps to CAST(strftime('%d',op[0]) AS INTEGER)

sql_expression_hour(*expression*, *params*, *context*)
Converts the hour method

maps to CAST(strftime('%H',op[0]) AS INTEGER)

sql_expression_minute(*expression*, *params*, *context*)
Converts the minute method

maps to CAST(strftime('%M',op[0]) AS INTEGER)

sql_expression_second(*expression*, *params*, *context*)
Converts the second method

maps to CAST(strftime('%S',op[0]) AS INTEGER)

sql_expression_tolower(*expression*, *params*, *context*)
Converts the tolower method

maps to lower(op[0])

sql_expression_toupper(*expression*, *params*, *context*)
Converts the toupper method

maps to upper(op[0])

To ensure that our custom implementations are integrated in to all the collection classes we have to create specific classes for all collection types. These classes have no implementation!

class pyslet.odata2.sqlds.**SQLiteEntityCollection**(*container*, ***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLiteEntityCollectionBase*, *pyslet.odata2.sqlds.SQLEntityCollection*

SQLite-specific collection for entity sets

class pyslet.odata2.sqlds.**SQLiteForeignKeyCollection**(***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLiteEntityCollectionBase*, *pyslet.odata2.sqlds.SQLForeignKeyCollection*

SQLite-specific collection for navigation from a foreign key

class pyslet.odata2.sqlds.**SQLiteReverseKeyCollection**(***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLiteEntityCollectionBase*, *pyslet.odata2.sqlds.SQLReverseKeyCollection*

SQLite-specific collection for navigation to a foreign key

class pyslet.odata2.sqlds.**SQLiteAssociationCollection**(***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLiteEntityCollectionBase*, *pyslet.odata2.sqlds.SQLAssociationCollection*

SQLite-specific collection for symmetric association sets

Finally, we can override the main container class to provide a complete implementation of our API using the sqlite3 module.

class pyslet.odata2.sqlds.**SQLiteEntityContainer**(*file_path*, *sqlite_options={}*, ***kwargs*)
Bases: *pyslet.odata2.sqlds.SQLEntityContainer*

Creates a container that represents a SQLite database.

Additional keyword arguments:

file_path The path to the SQLite database file.

sqlite_options A dictionary of additional options to pass as named arguments to the connect method. It defaults to an empty dictionary, you won't normally need to pass additional options and you shouldn't change the isolation_level as the collection classes have been designed to work in the default mode. Also, check_same_thread is forced to False, this is poorly documented but we only do it so that we can close a connection in a different thread from the one that opened it when cleaning up.

For more information see sqlite3

All other keyword arguments required to initialise the base class must be passed on construction except *dbapi* which is automatically set to the Python sqlite3 module.

get_collection_class()
Overridden to return *SQLiteEntityCollection*

get_symmetric_navigation_class()
Overridden to return *SQLiteAssociationCollection*

get_fk_class()
Overridden to return *SQLiteForeignKeyCollection*

get_rk_class()
Overridden to return *SQLiteReverseKeyCollection*

open()
Calls the underlying connect method.

Passes the file_path used to construct the container as the only parameter. You can pass the string ':memory:' to create an in-memory database.

Other connection arguments are not currently supported, you can derive a more complex implementation by overriding this method and (optionally) the __init__ method to pass in values for .

break_connection(*connection*)
Calls the underlying interrupt method.

close_connection(*connection*)
Calls the underlying close method.

prepare_sql_type(*simple_value*, *params*, *nullable=None*)
Performs SQLite custom mappings

EDM Type	SQLite Equivalent
Edm.Binary	BLOB
Edm.Decimal	TEXT
Edm.Guid	BLOB
Edm.String	TEXT
Edm.Time	REAL
Edm.Int64	INTEGER

The remainder of the type mappings use the defaults from the parent class.

prepare_sql_value(*simple_value*)
Returns a python value suitable for passing as a parameter.

We inherit most of the value mappings but the following types have custom mappings.

EDM Type	Python value added as parameter
Edm.Binary	buffer object
Edm.Decimal	string representation obtained with str()
Edm.Guid	buffer object containing bytes representation
Edm.Time	value of *pyslet.iso8601.Time.get_total_seconds()*

Our use of buffer type is not ideal as it generates warning when Python is run with the -3 flag (to check for Python 3 compatibility) but it seems unavoidable at the current time.

read_sql_value(*simple_value*, *new_value*)
Reverses the transformation performed by prepare_sql_value

new_from_sql_value(*sql_value*)
Returns a new simple value instance initialised from *sql_value*

Overridden to ensure that buffer objects returned by the underlying DB API are converted to strings. Otherwise *sql_value* is passed directly to the parent.

Utility Classes

Some miscellaneous classes documented mainly to make the implementation of the collection classes easier to understand.

class pyslet.odata2.sqlds.**SQLTransaction**(*container*, *connection*)
Bases: object

Class used to model a transaction.

Python's DB API uses transactions by default, hiding the details from the caller. Essentially, the first execute call on a connection issues a BEGIN statement and the transaction ends with either a commit or a rollback. It is generally considered a bad idea to issue a SQL command and then leave the connection with an open transaction.

The purpose of this class is to help us write methods that can operate either as a single transaction or as part of sequence of methods that form a single transaction. It also manages cursor creation and closing and logging.

Essentially, the class is used as follows:

```
t = SQLTransaction(db_container, db_connection)
try:
        t.begin()
        t.execute("UPDATE SOME_TABLE SET SOME_COL='2'")
        t.commit()
except Exception as e:
        t.rollback(e)
finally:
        t.close(e)
```

The transaction object can be passed to a sub-method between the begin and commit calls provided that method follows the same pattern as the above for the try, except and finally blocks. The object keeps track of these 'nested' transactions and delays the commit or rollback until the outermost method invokes them.

api = None
the database module

connection = None
the database connection

cursor = None
the database cursor to use for executing commands

no_commit = None
used to manage nested transactions

query_count = None
records the number of successful commands

commit()
Ends this transaction with a commit

Nested transactions do nothing.

rollback(*err=None*, *swallow=False*)
Calls the underlying database connection rollback method.

Nested transactions do not rollback the connection, they do nothing except re-raise *err* (if required).

If rollback is not supported the resulting error is absorbed.

err The exception that triggered the rollback. If not None then this is logged at INFO level when the rollback succeeds.

If the transaction contains at least one successfully executed query and the rollback fails then *err* is logged at ERROR rather than INFO level indicating that the data may now be in violation of the model.

swallow A flag (defaults to False) indicating that *err* should be swallowed, rather than re-raised.

close()
Closes this transaction after a rollback or commit.

Each call to `begin()` MUST be balanced with one call to close.

class pyslet.odata2.sqlds.**SQLParams**
Bases: object

An abstract class used to build parameterized queries.

Python's DB API supports three different conventions for specifying parameters and each module indicates the convention in use. The SQL construction methods in this module abstract away this variability for maximum portability using different implementations of the basic SQLParams class.

add_param(*value*)
Adds a value to this set of parameters

Returns the string to include in the query in place of this value.

value: The native representation of the value in a format suitable for passing to the underlying DB API.

classmethod escape_literal(*literal*)
Escapes a literal string, returning the escaped version

This method is only used to escape characters that are interpreted specially by the parameter substitution system. For example, if the parameters are being substituted using python's % operator then the '%' sign needs to be escaped (by doubling) in the output.

This method has nothing to do with turning python values into SQL escaped literals, that task is always deferred to the underlying DB module to prevent SQL injection attacks.

The default implementation does nothing, in most cases that is the correct thing to do.

class pyslet.odata2.sqlds.**QMarkParams**
Bases: *pyslet.odata2.sqlds.SQLParams*

A class for building parameter lists using '?' syntax.

class pyslet.odata2.sqlds.**NumericParams**
Bases: *pyslet.odata2.sqlds.SQLParams*

A class for building parameter lists using ':1', ':2',... syntax

class pyslet.odata2.sqlds.**NamedParams**
Bases: *pyslet.odata2.sqlds.SQLParams*

A class for building parameter lists using ':A', ':B",... syntax

Although there is more freedom with named parameters, in order to support the ordered lists of the other formats we just invent parameter names using ':p0', ':p1', etc.

Misc Definitions

pyslet.odata2.sqlds.**SQL_TIMEOUT = 90**
int(x=0) -> int or long int(x, base=10) -> int or long

Convert a number or string to an integer, or return 0 if no arguments are given. If x is floating point, the conversion truncates towards zero. If x is outside the integer range, the function returns a long instead.

If x is not a number or if base is given, then x must be a string or Unicode object representing an integer literal in the given base. The literal can be preceded by '+' or '-' and be surrounded by whitespace. The base defaults to 10. Valid bases are 0 and 2-36. Base 0 means to interpret the base from the string as an integer literal. >>> int('0b100', base=0) 4

class pyslet.odata2.sqlds.**UnparameterizedLiteral**(*value*)
Bases: pyslet.odata2.core.LiteralExpression

Class used as a flag that this literal is safe and does not need to be parameterized.

This is used in the query converter to prevent things like this happening when the converter itself constructs a LIKE expression:

```
"name" LIKE ?+?+? ; params=[u'%',u"Smith",u'%']
```

pyslet.odata2.sqlds.**SQLOperatorPrecedence = {'>=': 4, '<>': 4, '<=': 4, 'AND': 2, 'LIKE': 4, '+': 5, '*': 6, '-': 5, '**
Look-up table for SQL operator precedence calculations.

The keys are strings representing the operator, the values are integers that allow comparisons for operator precedence. For example:

```
SQLOperatorPrecedence['+']<SQLOperatorPrecedence['*']
SQLOperatorPrecedence['<']==SQLOperatorPrecedence['>']
```

class pyslet.odata2.sqlds.**DummyLock**
Bases: object

An object to use in place of a real Lock, can always be acquired

Exceptions

class pyslet.odata2.sqlds.**DatabaseBusy**
Bases: *pyslet.odata2.sqlds.SQLError*

Raised when a database connection times out.

class pyslet.odata2.sqlds.**SQLError**
Bases: exceptions.Exception

Base class for all module exceptions.

4.3.7 OData Server Reference

CHAPTER 5

Hypertext Transfer Protocol (RFC2616)

This sub-package defines functions and classes for working with HTTP as defined by RFC2616: http://www.ietf.org/rfc/rfc2616.txt and RFC2617: http://www.ietf.org/rfc/rfc2617.txt

The purpose of this module is to expose some of the basic constructs (including the synax of protocol components) to allow them to be used normatively in other contexts. The module also contains a functional HTTP client designed to support non-blocking and persistent HTTP client operations.

5.1 HTTP Client

5.1.1 Sending Requests

Here is a simple example of Pyslet's HTTP support in action from the python interpreter:

```
>>> import pyslet.http.client as http
>>> c = http.Client()
>>> r = http.ClientRequest('http://odata.pyslet.org')
>>> c.process_request(r)
>>> r.response.status
200
>>> print r.response.get_content_type()
text/html; charset=UTF-8
>>> print r.response.entity_body.getvalue()
<html>
<head><title>Pyslet Home</title></head>
<body>
<p><a href="http://qtimigration.googlecode.com/"><img src="logoc-large.png" width="1024"/></a></p>
</body>
</html>
>>> c.close()
```

In its simplest form there are three steps required to make an HTTP request, firstly you need to create a Client object. The purpose of the Client object is sending requests and receiving responses. The second step is to create a ClientRequest object describing the request you want to make. For a simple GET request you only need to specify the URL. The third step is to instruct the Client to process the request. Once this method returns you can examine the request's associated response. The response's entity body is written to a StringIO object by default.

The request and response objects are both derived classes of a basic HTTP Message class. This class has methods for getting and setting headers. You can use the basic *get_header()* and *set_header()* to set headers from strings or, where provided, you can use special wrapper methods such as *get_content_type()* to get and set headers using special-purpose class objects that represent parsed forms of the expected value. In the case of Content-Type

headers the result is a *MediaType()* object. Providing these special object types is one of the main reasons why Pyslet's HTTP support is different from other clients. By exposing these structures you can reuse HTTP concepts in other contexts, particularly useful when other technical specifications make normative references to them.

Here is a glimpse of what you can do with a parsed media type, continuing the above example:

```
>>> type = r.response.get_content_type()
>>> type
MediaType('text','html',{'charset': ('charset', 'UTF-8')})
>>> type.type
'text'
>>> type.subtype
'html'
>>> type['charset']
'UTF-8'
>>> type['name']
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "pyslet/http/params.py", line 382, in __getitem__
    repr(key))
KeyError: "MediaType instance has no parameter 'name'"
>>>
```

There are lots of other special get_ and set_ methods on the *Message*, *Request* and *Response* objects.

5.1.2 Pipelining

One of the use cases that Pyslet's HTTP client is designed to cover is reusing an HTTP connection to make multiple requests to the same host. The example above takes care to close the Client object when we're done because otherwise it would leave the connection to the server open ready for another request.

5.1.3 Reference

The client module imports the grammar, params, messages and auth modules and these can therefore be accessed using a single import in your code. For example:

```
import pyslet.http.client as http
type = http.params.MediaType('application', 'xml')
```

For more details of the objects exposed by those modules see *pyslet.http.grammar*, *pyslet.http.params*, *pyslet.http.messages* and *pyslet.http.auth*.

class pyslet.http.client.**Client**(*max_connections=100*, *ca_certs=None*, *timeout=None*, *max_inactive=None*)

Bases: pyslet.pep8.PEP8Compatibility, object

An HTTP client

Note: In Pyslet 0.4 and earlier the name HTTPRequestManager was used, this name is still available as an alias for Client.

The object manages the sending and receiving of HTTP/1.1 requests and responses respectively. There are a number of keyword arguments that can be used to set operational parameters:

max_connections The maximum number of HTTP connections that may be open at any one time. The method *queue_request()* will block (or raise *RequestManagerBusy*) if an attempt to queue a request would cause this limit to be exceeded.

timeout The maximum wait time on the connection. This is not the same as a limit on the total time to receive a request but a limit on the time the client will wait with no activity on the connection before assuming that the server is no longer responding. Defaults to None, no timeout.

max_inactive (None) The maximum time to keep a connection inactive before terminating it. By default, HTTP connections are kept open when the protocol allows. These idle connections are kept in a pool and can be reused by any thread. This is useful for web-service type use cases (for which Pyslet has been optimised) but it is poor practice to keep these connections open indefinitely and anyway, most servers will hang up after a fairly short period of time anyway.

If not None, this setting causes a cleanup thread to be created that calls the *idle_cleanup()* method periodically passing this setting value as its argument.

ca_certs The file name of a certificate file to use when checking SSL connections. For more information see http://docs.python.org/2.7/library/ssl.html

In practice, there seem to be serious limitations on SSL connections and certificate validation in Python distributions linked to earlier versions of the OpenSSL library (e.g., Python 2.6 installed by default on OS X and Windows).

Warning: By default, ca_certs is optional and can be passed as None. In this mode certificates will not be checked and your connections are not secure from man in the middle attacks. In production use you should always specify a certificate file if you expect to use the object to make calls to https URLs.

Although max_connections allows you to make multiple connections to the same host+port the request manager imposes an additional restriction. Each thread can make at most 1 connection to each host+port. If multiple requests are made to the same host+port from the same thread then they are queued and will be sent to the server over the same connection using HTTP/1.1 pipelining. The manager (mostly) takes care of the following restriction imposed by RFC2616:

> Clients SHOULD NOT pipeline requests using non-idempotent methods or non-idempotent sequences of methods

In other words, a POST (or CONNECT) request will cause the pipeline to stall until all the responses have been received. Users should beware of non-idempotent sequences as these are not automatically detected by the manager. For example, a GET,PUT sequence on the same resource is not idempotent. Users should wait for the GET request to finish fetching the resource before queuing a PUT request that overwrites it.

In summary, to take advantage of multiple simultaneous connections to the same host+port you must use multiple threads.

ConnectionClass
alias of `Connection`

httpUserAgent = None
The default User-Agent string to use, defaults to a string derived from the installed version of Pyslet, e.g.:

```
pyslet 0.5.20140727 (http.client.Client)
```

classmethod get_server_certificate_chain(*url*, *method=None*, *options=None*)
Returns the certificate chain for an https URL

url A *URI* instance. This must use the https scheme or ValueError will be raised.

method (SSL.TLSv1_METHOD) The SSL method to use, one of the constants from the pyOpenSSL module.

options (None) The SSL options to use, as defined by the pyOpenSSL module. For example, SSL.OP_NO_SSLv2.

This method requires pyOpenSSL to be installed, if it isn't then a RuntimeError is raised.

The address and port is extracted from the URL and interrogated for its certificate chain. No validation is performed. The result is a string containing the concatenated PEM format certificate files. This string is equivalent to the output of the following UNIX command:

```
echo | openssl s_client -showcerts -connect host:port 2>&1 |
    sed -ne '/-BEGIN CERTIFICATE-/,/-END CERTIFICATE-/p'
```

The purpose of this method is to provide something like the ssh-style trust whereby you can download the chain the first time you connect, store it to a file and then use that file for the ca_certs argument for SSL validation in future.

If the site certificate changes to one that doesn't validate to a certificate in the same chain then the SSL connection will fail.

As this method does no validation there is no protection against a man-in-the-middle attack when you use this method. You should only use this method when you trust the machine and connection you are using or when you have some other way to independently verify that the certificate chain is good.

queue_request(*request*, *timeout=None*)
Starts processing an HTTP *request*

request A `messages.Request` object.

timeout Number of seconds to wait for a free connection before timing out. A timeout raises *RequestManagerBusy*

None means wait forever, 0 means don't block.

The default implementation adds a User-Agent header from *httpUserAgent* if none has been specified already. You can override this method to add other headers appropriate for a specific context but you must pass this call on to this implementation for proper processing.

active_count()
Returns the total number of active connections.

thread_active_count()
Returns the total number of active connections associated with the current thread.

thread_task(*timeout=None*)
Processes all connections bound to the current thread then blocks for at most timeout (0 means don't block) while waiting to send/receive data from any active sockets.

Each active connection receives one call to `Connection.connection_task()` There are some situations where this method may still block even with timeout=0. For example, DNS name resolution and SSL handshaking. These may be improved in future.

Returns True if at least one connection is active, otherwise returns False.

thread_loop(*timeout=60*)
Repeatedly calls *thread_task()* until it returns False.

process_request(*request*, *timeout=60*)
Process an `messages.Message` object.

The request is queued and then *thread_loop()* is called to exhaust all HTTP activity initiated by the current thread.

idle_cleanup(*max_inactive=15*)
Cleans up any idle connections that have been inactive for more than *max_inactive* seconds.

active_cleanup(*max_inactive=90*)
Clean up active connections that have been inactive for more than *max_inactive* seconds.

This method can be called from any thread and can be used to remove connections that have been abandoned by their owning thread. This can happen if the owning thread stops calling *thread_task()* leaving some connections active.

Inactive connections are killed using `Connection.kill()` and then removed from the active list. Should the owning thread wake up and attempt to finish processing the requests a socket error or `messages.HTTPException` will be reported.

close()
Closes all connections and sets the manager to a state where new connections cannot not be created.

Active connections are killed, idle connections are closed.

add_credentials(*credentials*)
Adds a `pyslet.http.auth.Credentials` instance to this manager.

Credentials are used in response to challenges received in HTTP 401 responses.

remove_credentials(*credentials*)
Removes credentials from this manager.

credentials A `pyslet.http.auth.Credentials` instance previously added with *add_credentials()*.

If the credentials can't be found then they are silently ignored as it is possible that two threads may independently call the method with the same credentials.

dnslookup(*host*, *port*)
Given a host name (string) and a port number performs a DNS lookup using the native socket.getaddrinfo function. The resulting value is added to an internal dns cache so that subsequent calls for the same host name and port do not use the network unnecessarily.

If you want to flush the cache you must do so manually using *flush_dns()*.

flush_dns()
Flushes the DNS cache.

find_credentials(*challenge*)
Searches for credentials that match *challenge*

find_credentials_by_url(*url*)
Searches for credentials that match *url*

class `pyslet.http.client.`**ClientRequest**(*url*, *method='GET'*, *res_body=None*, *protocol=<pyslet.http.params.HTTPVersion object>*, *auto_redirect=True*, *max_retries=3*, *min_retry_time=5*, ***kwargs*)
Bases: *pyslet.http.messages.Request*

Represents an HTTP request.

To make an HTTP request, create an instance of this class and then pass it to an *Client* instance using either *Client.queue_request()* or *Client.process_request()*.

url An absolute URI using either http or https schemes. A *pyslet.rfc2396.URI* instance or an object that can be passed to its constructor.

And the following keyword arguments:

method A string. The HTTP method to use, defaults to "GET"

entity_body A string or stream-like object containing the request body. Defaults to None meaning no message body. For stream-like objects the tell and seek methods must be supported to enable resending the request if required.

res_body A stream-like object to write data to. Defaults to None, in which case the response body is returned as a string in the *res_body*.

protocol An `params.HTTPVersion` object, defaults to HTTPVersion(1,1)

autoredirect Whether or not the request will follow redirects, defaults to True.

max_retries The maximum number of times to attempt to resend the request following an error on the connection or an unexpected hang-up. Defaults to 3, you should not use a value lower than 1 because, when pipelining, it is always possible that the server has gracefully closed the socket and we won't notice until we've sent the request and get 0 bytes back on recv. Although 'normal' this scenario counts as a retry.

manager = None
the *Client* object that is managing us

connection = None
the `Connection` object that is currently sending us

status = None
the status code received, 0 indicates a failed or unsent request

error = None
If status == 0, the error raised during processing

scheme = None
the scheme of the request (http or https)

hostname = None
the hostname of the origin server

port = None
the port on the origin server

url = None
the full URL of the requested resource

res_body = None
the response body received (only used if not streaming)

auto_redirect = None
whether or not auto redirection is in force for 3xx responses

max_retries = None
the maximum number of retries we'll attempt

nretries = None
the number of retries we've had

response = None
the associated *ClientResponse*

send_pipe = None
the send pipe to use on upgraded connections

recv_pipe = None
the recv pipe to use on upgraded connections

set_url (*url*)
Sets the URL for this request

This method sets the Host header and the following local attributes: *scheme*, *hostname*, *port* and request_uri.

can_retry()
Returns True if we reconnect and retry this request

set_client(*client*)
Called when we are queued for processing.

client an *Client* instance

connect(*connection*, *send_pos*)
Called when we are assigned to an HTTPConnection"

connection A Connection object

send_pos The position of the sent bytes pointer after which this request has been (or at least has started to be) sent.

disconnect(*send_pos*)
Called when the connection has finished sending us

This may be before or after the response is received and handled!

send_pos The number of bytes sent on this connection before the disconnect. This value is compared with the value passed to *connect()* to determine if the request was actually sent to the server or abandoned without a byte being sent.

For idempotent methods we lose a life every time. For non-idempotent methods (e.g., POST) we do the same except that if we been (at least partially) sent then we lose all lives to prevent "indeterminate results".

finished()
Called when we have a final response *and* have disconnected from the connection There is no guarantee that the server got all of our data, it might even have returned a 2xx series code and then hung up before reading the data, maybe it already had what it needed, maybe it thinks a 2xx response is more likely to make us go away. Whatever. The point is that you can't be sure that all the data was transmitted just because you got here and the server says everything is OK

class pyslet.http.client.**ClientResponse**(*request*, ***kwargs*)
Bases: *pyslet.http.messages.Response*

handle_headers()
Hook for response header processing.

This method is called when a set of response headers has been received from the server, before the associated data is received! After this call, recv will be called zero or more times until handle_message or handle_disconnect is called indicating the end of the response.

Override this method, for example, if you want to reject or invoke special processing for certain responses (e.g., based on size) before the data itself is received. To abort the response, close the connection using Connection.request_disconnect().

Override the Finished() method instead to clean up and process the complete response normally.

handle_message()
Hook for normal completion of response

handle_disconnect(*err*)
Hook for abnormal completion of the response

Called when the server disconnects before we've completed reading the response. Note that if we are reading forever this may be expected behaviour and *err* may be None.

We pass this information on to the request.

5.1.4 Exceptions

class pyslet.http.client.**RequestManagerBusy**
Bases: *pyslet.http.messages.HTTPException*

The HTTP client is busy

Raised when attempting to queue a request and no connections become available within the specified timeout.

5.2 HTTP Authentication

5.3 HTTP Messages

This modules defines objects that represent the values of HTTP messages and message headers and a special-purpose parser for parsing them from strings of octets.

5.3.1 Messages

class pyslet.http.messages.**Request**(***kwargs*)
Bases: *pyslet.http.messages.Message*

method = None
the http method, always upper case, e.g., 'POST'

request_uri = None
the request uri as it appears in the start line

response = None
the associated response

send_start()
Returns the start-line for this message

send_transferlength()
Adds request-specific processing for transfer-length

Request messages that must not have a message body are automatically detected and will raise an exception if they have a non-None body.

Request messages that may have a message body but have a transfer-length of 0 bytes will have a Content-Length header of 0 added if necessary

get_start()
Returns the start line

is_idempotent()
Returns True if this is an idempotent request

extract_authority()
Extracts the authority from the request

If the request_uri is an absolute URL then it is updated to contain the absolute path only and the Host header is updated with the authority information (host[:port]) extracted from it, otherwise the Host header is read for the authority information. If there is no authority information in the request None is returned.

If the url contains user information it raises NotImplementedError

get_accept()
Returns an *AcceptList* instance or None if no "Accept" header is present.

set_accept(*accept_value*)
Sets the "Accept" header, replacing any existing value.

accept_value A *AcceptList* instance or a string that one can be parsed from.

get_accept_charset()
Returns an *AcceptCharsetList* instance or None if no "Accept-Charset" header is present.

set_accept_charset(*accept_value*)
Sets the "Accept-Charset" header, replacing any existing value.

accept_value A *AcceptCharsetList* instance or a string that one can be parsed from.

get_accept_encoding()
Returns an *AcceptEncodingList* instance or None if no "Accept-Encoding" header is present.

set_accept_encoding(*accept_value*)
Sets the "Accept-Encoding" header, replacing any existing value.

accept_value A *AcceptEncodingList* instance or a string that one can be parsed from.

get_cookie()
Reads the 'Cookie' header(s)

Returns a dictionary of cookies. If there are multiple values for a cookie the dictionary value is a set, otherwise it is a string.

set_cookie(*cookie_list*)
Set a "Set-Cookie" header

cookie_list a list of cookies such as would be returned by *pyslet.http.cookie.CookieStore.search()*.

If cookie list is None the Cookie header is removed.

class pyslet.http.messages.**Response**(*request*, ***kwargs*)
Bases: *pyslet.http.messages.Message*

REASON = {200: 'OK', 201: 'Created', 202: 'Accepted', 203: 'Non-Authoritative Information', 204: 'No Content', 205: 'R
A dictionary mapping status code integers to their default message defined by RFC2616

send_start()
Returns the start-line for this message

get_accept_ranges()
Returns an *AcceptRanges* instance or None if no "Accept-Ranges" header is present.

set_accept_ranges(*accept_value*)
Sets the "Accept-Ranges" header, replacing any existing value.

accept_value A *AcceptRanges* instance or a string that one can be parsed from.

get_age()
Returns an integer or None if no "Age" header is present.

set_age(*age*)
Sets the "Age" header, replacing any existing value.

age an integer or long value or None to remove the header

get_etag()
Returns a EntityTag instance parsed from the ETag header or None if no "ETag" header is present.

set_etag(*etag*)
Sets the "ETag" header, replacing any existing value.

etag a `EntityTag` instance or None to remove any ETag header.

get_location()
Returns a *pyslet.rfc2396.URI* instance created from the Location header.

If no Location header was present None is returned.

set_location(*location*)
Sets the Location header

location: a *pyslet.rfc2396.URI* instance or a string from which one can be parsed. If None, the Location header is removed.

get_www_authenticate()
Returns a list of `Challenge` instances.

If there are no challenges an empty list is returned.

set_www_authenticate(*challenges*)
Sets the "WWW-Authenticate" header, replacing any exsiting value.

challenges a list of `Challenge` instances

get_set_cookie()
Reads all 'Set-Cookie' headers

Returns a list of *Cookie* instances

set_set_cookie(*cookie*, *replace=False*)
Set a "Set-Cookie" header

cookie a *Cookie* instance

replace=True Remove all existing cookies from the response

replace=False Add this cookie to the existing cookies in the response (default value)

If called multiple times the header value will become a list of cookie values. No folding together is performed.

If cookie is None all Set-Cookie headers are removed, implying replace mode.

class `pyslet.http.messages.`**Message**(*entity_body=None*, *protocol=<pyslet.http.params.HTTPVersion object>*, *send_stream=None*, *recv_stream=None*)
Bases: `pyslet.pep8.PEP8Compatibility`, `object`

An abstract class to represent an HTTP message.

The methods of this class are thread safe, using a `lock` to protect all access to internal structures.

The generic syntax of a message involves a start line, followed by a number of message headers and an optional message body.

entity_body The optional entity_body parameter is a byte string containing the *entity* body, a file like object or object derived from io.RawIOBase. There are restrictions on the use of non-seekable streams, in particular the absence of a working seek may affect redirects and retries.

There is a subtle difference between passing None, meaning no entity body and an empty string ''. The difference is that an empty string will generate a Content-Length header indicating a zero length message body when the message is sent, whereas None will not. Some message types are not allowed to have an entity body (e.g., a GET request) and these messages must not have a message body (even a zero length one) or an error will be raised.

File-like objects do not generate a Content-Length header automatically as there is no way to determine their size when sending, however, if a Content-Length header is set explicitly then it will be used to constrain the amount of data read from the entity_body.

GENERAL_HEADERS = {'transfer-encoding': 'Transfer-Encoding', 'connection': 'Connection', 'upgrade': 'Upgrade', 'pr
a mapping from lower case header name to preferred case name

MAX_READAHEAD = 131072
A constant used to control the maximum read-ahead on an entity body's stream. Entity bodies of undetermined length that exceed this size cannot be sent in requests to HTTP/1.0 server.

keep_alive = None
by default we'll keep the connection alive

set_protocol(*version*)
Sets the protocol

version An `params.HTTPVersion` instance or a string that can be parsed for one.

clear_keep_alive()
Clears the keep_alive flag on this message

The flag always starts set to True and cannot be set once cleared.

start_sending(*protocol=<pyslet.http.params.HTTPVersion object>*)
Starts sending this message

protocol The protocol supported by the target of the message, defaults to HTTP/1.1 but can be overridden when the recipient only supports HTTP/1.0. This has the effect of suppressing some features.

The message is sent using the send_ family of methods.

send_start()
Returns the start-line for this message

send_header()
Returns a data string ready to send to the server

send_transferlength()
Calculates the transfer length of the message

It will read the Transfer-Encoding or Content-Length headers to determine the length.

If the length of the entity body is known, this method will verify that it matches the Content-Length or set that header's value accordingly.

If the length of the entity body is not known, this method will set a Transfer-Encoding header.

send_body()
Returns (part of) the message body

Returns an empty string when there is no more data to send.

Returns None if the message is read blocked.

start_receiving()
Starts receiving this message

The message is received using the *recv_mode()* and `recv()` methods.

RECV_HEADERS = -3
recv_mode constant for a set of header lines terminated by CRLF, followed by a blank line.

RECV_LINE = -2
recv_mode constant for a single CRLF terminated line

RECV_ALL = -1
recv_mode constant for unlimited data read

recv_mode()
Indicates the type of data expected during recv

The result is interpreted as follows, using the recv_mode constants defined above:

RECV_HEADERS this message is expecting a set of headers, terminated by a blank line. The next call to recv must be with a list of binary CRLF terminated strings the last of which must the string CRLF only.

RECV_LINE this message is expecting a single terminated line. The next call to recv must be with a binary string representing a single terminated line.

integer > 0 the minimum number of bytes we are waiting for when data is expected. The next call to recv must be with a binary string of up to but not exceeding *integer* number of bytes

0 we are currently write-blocked but still need more data, the next call to recv must pass None to give the message time to write out existing buffered data.

RECV_ALL we want to read until the connection closes, the next call to recv must be with a binary string. The string can be of any length but an empty string signals the end of the data.

None the message is not currently in receiving mode, calling recv will raise an error.

recv_start(*start_line*)
Receives the start-line

Implemented differently for requests and responses.

handle_headers()
Hook for processing the message headers

This method is called after all headers have been received but before the message body (if any) is received. Derived classes should always call this implementation first (using super) to ensure basic validation is performed on the message before the body is received.

recv_transferlength()
Called to calculate the transfer length when receiving

The values of `transferlength` and `transferchunked` are set by this method. The default implementation checks for a Transfer-Encoding header and then a Content-Length header in that order.

If it finds neither then behaviour is determined by the derived classes *Request* and *Response* which wrap this implementation.

RFC2616:

> If a Transfer-Encoding header field is present and has any value other than "identity", then the transfer-length is defined by use of the "chunked" transfer-coding, unless the message is terminated by closing the connection

This is a bit weird, if I have a non-identity value which fails to mention 'chunked' then it seems like I can't imply chunked encoding until the connection closes. In practice, when we handle this case we assume chunked is not being used and read until connection close.

handle_message()
Hook for processing the message

This method is called after the entire message has been received, including any chunk trailer.

get_headerlist()
Returns all header names

The list is alphabetically sorted and lower-cased.

has_header(*field_name*)
True if this message has a header with field_name

get_header(*field_name*, *list_mode=False*)
Returns the header with *field_name* as a string.

list_mode=False In this mode, get_header always returns a single string, this isn't always what you want as it automatically 'folds' multiple headers with the same name into a string using ", " as a separator.

list_mode=True In this mode, get_header always returns a list of strings.

If there is no header with *field_name* then None is returned in both modes.

set_header(*field_name*, *field_value*, *append_mode=False*)
Sets the header with *field_name* to the string *field_value*.

If *field_value* is None then the header is removed (if present).

If a header already exists with *field_name* then the behaviour is determined by *append_mode*:

append_mode==True *field_value* is joined to the existing value using ", " as a separator.

append_mode==False (Default) *field_value* replaces the existing value.

get_allow()
Returns an *Allow* instance or None if no "Allow" header is present.

set_allow(*allowed*)
Sets the "Allow" header, replacing any existing value.

allowed A *Allow* instance or a string that one can be parsed from.

If allowed is None any existing Allow header is removed.

get_authorization()
Returns a Credentials instance.

If there are no credentials None returned.

set_authorization(*credentials*)
Sets the "Authorization" header

credentials a Credentials instance

get_cache_control()
Returns an *CacheControl* instance or None if no "Cache-Control" header is present.

set_cache_control(*cc*)
Sets the "Cache-Control" header, replacing any existing value.

cc A *CacheControl* instance or a string that one can be parsed from.

If *cc* is None any existing Cache-Control header is removed.

get_connection()
Returns a set of connection tokens from the Connection header

If no Connection header was present an empty set is returned. All tokens are returned as lower case.

set_connection(*connection_tokens*)
Set the Connection tokens from an iterable set of *connection_tokens*

If the list is empty any existing header is removed.

get_content_encoding()
Returns a *list* of lower-cased content-coding tokens from the Content-Encoding header

If no Content-Encoding header was present an empty list is returned.

Content-codings are always listed in the order they have been applied.

set_content_encoding(*content_codings*)
Sets the Content-Encoding header from a an iterable list of *content-coding* tokens. If the list is empty any existing header is removed.

get_content_language()
Returns a *list* of `LanguageTag` instances from the Content-Language header

If no Content-Language header was present an empty list is returned.

set_content_language(*lang_list*)
Sets the Content-Language header from a an iterable list of `LanguageTag` instances.

get_content_length()
Returns the integer size of the entity from the Content-Length header

If no Content-Length header was present None is returned.

set_content_length(*length*)
Sets the Content-Length header from an integer or removes it if *length* is None.

get_content_location()
Returns a *pyslet.rfc2396.URI* instance created from the Content-Location header.

If no Content-Location header was present None is returned.

set_content_location(*location*)
Sets the Content-Location header from location, a *pyslet.rfc2396.URI* instance or removes it if *location* is None.

get_content_md5()
Returns a 16-byte binary string read from the Content-MD5 header or None if no Content-MD5 header was present.

The result is suitable for comparing directly with the output of the Python's MD5 digest method.

set_content_md5(*digest*)
Sets the Content-MD5 header from a 16-byte binary string returned by Python's MD5 digest method or similar. If digest is None any existing Content-MD5 header is removed.

get_content_range()
Returns a *ContentRange* instance parsed from the Content-Range header.

If no Content-Range header was present None is returned.

set_content_range(*range*)
Sets the Content-Range header from range, a *ContentRange* instance or removes it if *range* is None.

get_content_type()
Returns a `MediaType` instance parsed from the Content-Type header.

If no Content-Type header was present None is returned.

set_content_type(*mtype=None*)
Sets the Content-Type header from mtype, a `MediaType` instance, or removes it if *mtype* is None.

get_date()
Returns the value of the Date header.

The return value is a `params.FullDate` instance. If no Date header was present None is returned.

set_date(*date=None*)
Sets the value of the Date header

date a `params.FullDate` instance or None to remove the Date header.

To set the date header to the current date use:

```
set_date(params.FullDate.from_now_utc())
```

get_last_modified()
Returns the value of the Last-Modified header

The result is a `params.FullDate` instance. If no Last-Modified header was present None is returned.

set_last_modified(*date=None*)
Sets the value of the Last-Modified header field

date a `FullDate` instance or None to remove the header

To set the Last-Modified header to the current date use:

```
set_last_modified(params.FullDate.from_now_utc())
```

get_transfer_encoding()
Returns a list of `params.TransferEncoding`

If no TransferEncoding header is present None is returned.

set_transfer_encoding(*field_value*)
Set the Transfer-Encoding header

field_value A list of `params.TransferEncoding` instances or a string from which one can be parsed. If None then the header is removed.

set_upgrade(*protocols*)
Sets the "Upgrade" header, replacing any existing value.

protocols An iterable list of `params.ProductToken` instances.

In addition to setting the upgrade header this method ensures that "upgrade" is present in the Connection header.

5.3.2 General Header Types

class `pyslet.http.messages.`**CacheControl**(**args*)
Bases: `object`

Represents the value of a Cache-Control general header.

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they are constructed from a list of arguments which must not be empty. Arguments are treated as follows:

string a simple directive with no parmeter

2-tuple of string and non-tuple a directive with a simple parameter

2-tuple of string and tuple a directive with a quoted list-style parameter

Instances behave like read-only lists implementing len, indexing and iteration in the usual way. Instances also support basic key lookup of directive names by implementing __contains__ and __getitem__ (which returns None for defined directives with no parameter and raises KeyError for undefined directives). Instances are not truly dictionary like.

classmethod **from_str**(*source*)
Create a Cache-Control value from a *source* string.

5.3.3 Request Header Types

class pyslet.http.messages.**AcceptList**(**args*)
Bases: object

Represents the value of an Accept header

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they are constructed from one or more *AcceptItem* instances. There are no comparison methods.

Instances behave like read-only lists implementing len, indexing and iteration in the usual way.

select_type(*mtype_list*)
Returns the best match from mtype_list, a list of media-types

In the event of a tie, the first item in mtype_list is returned.

classmethod **from_str**(*source*)
Create an AcceptList from a *source* string.

class pyslet.http.messages.**MediaRange**(*type='*'*, *subtype='*'*, *parameters={}*)
Bases: *pyslet.http.params.MediaType*

Represents an HTTP media-range.

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they define comparison methods and a hash implementation to allow them to be used as keys in dictionaries. Quoting from the specification:

> "Media ranges can be overridden by more specific media ranges or specific media types. If more than one media range applies to a given type, the most specific reference has precedence."

In other words, the following media ranges would be sorted in the order shown:

1.image/png

2.image/*

3.text/plain;charset=utf-8

4.text/plain

5.text/*

6.*/*

If we have two rules with identical precedence then we sort them alphabetically by type; sub-type and ultimately alphabetically by parameters

classmethod **from_str**(*source*)
Creates a media-rannge from a *source* string.

Unlike the parent media-type we ignore all spaces.

match_media_type(*mtype*)
Tests whether a media-type matches this range.

mtype A `MediaType` instance to be compared to this range.

The matching algorithm takes in to consideration wild-cards so that */* matches all types, image/* matches any image type and so on.

If a media-range contains parameters then each of these must be matched exactly in the media-type being tested. Parameter names are treated case-insensitively and any additional parameters in the media type are ignored. As a result:

- text/plain *does not match* the range text/plain;charset=utf-8
- application/myapp;charset=utf-8;option=on *does* match the range application/myapp;option=on

class pyslet.http.messages.**AcceptItem**(*range=MediaType('*', '*', {})*, *qvalue=1.0*, *extensions={}*)
Bases: *pyslet.http.messages.MediaRange*

Represents a single item in an Accept header

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they define comparison methods and a hash implementation to allow them to be used as keys in dictionaries.

Accept items are sorted by their media ranges. Equal media ranges sort by *descending* qvalue, for example:

text/plain;q=0.75 < text/plain;q=0.5

Extension parameters are ignored in all comparisons.

range = None
the *MediaRange* instance that is acceptable

q = None
the q-value (defaults to 1.0)

classmethod from_str(*source*)
Creates a single AcceptItem instance from a *source* string.

class pyslet.http.messages.**AcceptCharsetItem**(*token='*', *qvalue=1.0*)
Bases: *pyslet.http.messages.AcceptToken*

Represents a single item in an Accept-Charset header

class pyslet.http.messages.**AcceptCharsetList**(**args*)
Bases: *pyslet.http.messages.AcceptTokenList*

Represents an Accept-Charset header

ItemClass
alias of *AcceptCharsetItem*

select_token(*token_list*)
Overridden to provide default handling of iso-8859-1

class pyslet.http.messages.**AcceptEncodingItem**(*token='*', *qvalue=1.0*)
Bases: *pyslet.http.messages.AcceptToken*

Represents a single item in an Accept-Encoding header

class pyslet.http.messages.**AcceptEncodingList**(**args*)
Bases: *pyslet.http.messages.AcceptTokenList*

Represents an Accept-Encoding header

ItemClass
alias of *AcceptEncodingItem*

select_token(*token_list*)
Overridden to provide default handling of identity

class pyslet.http.messages.**AcceptLanguageItem**(*token='*'*, *qvalue=1.0*)
Bases: *pyslet.http.messages.AcceptToken*

Represents a single item in an Accept-Language header.

class pyslet.http.messages.**AcceptLanguageList**(**args*)
Bases: *pyslet.http.messages.AcceptTokenList*

Represents an Accept-Language header

ItemClass
the class used to create items in this token list

alias of *AcceptLanguageItem*

select_token(*token_list*)
Remapped to `select_language()`

class pyslet.http.messages.**AcceptToken**(*token='*'*, *qvalue=1.0*)
Bases: `object`

Represents a single item in a token-based Accept-* header

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they define comparison methods and a hash implementation to allow them to be used as keys in dictionaries.

AcceptToken items are sorted by their token, with wild cards sorting behind specified tokens. Equal values sort by *descending* qvalue, for example:

iso-8859-2;q=0.75 < iso-8859-2;q=0.5

token = None
the token that is acceptable or "*" for any token

q = None
the q-value (defaults to 1.0)

classmethod from_str(*source*)
Creates a single AcceptToken instance from a *source* string.

class pyslet.http.messages.**AcceptTokenList**(**args*)
Bases: `object`

Represents the value of a token-based Accept-* header

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they are constructed from one or more *AcceptToken* instances. There are no comparison methods.

Instances behave like read-only lists implementing len, indexing and iteration in the usual way.

ItemClass
the class used to create new items in this list

alias of *AcceptToken*

select_token(*token_list*)
Returns the best match from token_list, a list of tokens.

In the event of a tie, the first item in token_list is returned.

classmethod from_str(*source*)
Create an AcceptTokenList from a *source* string.

5.3.4 Response Header Types

class pyslet.http.messages.**AcceptRanges**(**args*)
Bases: object

Represents the value of an Accept-Ranges response header.

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they are constructed from a list of string arguments. If the argument list is empty then a value of "none" is assumed.

Instances behave like read-only lists implementing len, indexing and iteration in the usual way. Comparison methods are provided.

classmethod from_str(*source*)
Create an AcceptRanges value from a *source* string.

5.3.5 Entity Header Types

class pyslet.http.messages.**Allow**(**args*)
Bases: object

Represents the value of an Allow entity header.

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they are constructed from a list of string arguments which may be empty.

Instances behave like read-only lists implementing len, indexing and iteration in the usual way. Comparison methods are provided.

classmethod from_str(*source*)
Create an Allow value from a *source* string.

is_allowed(*method*)
Tests if *method* is allowed by this value.

class pyslet.http.messages.**ContentRange**(*first_byte=None*, *last_byte=None*, *total_len=None*)
Bases: object

Represents a single content range

first_byte Specifies the first byte of the range

last_byte Specifies the last byte of the range

total_len Specifies the total length of the entity

With no arguments an invalid range representing an unsatisfied range request from an entity of unknown length is created.

If first_byte is specified on construction last_byte must also be specified or TypeError is raised.

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable.

first_byte = None
first byte in the range

last_byte = None
last byte in the range

classmethod from_str(*source*)
Creates a single ContentRange instance from a *source* string.

is_valid()
Returns True if this range is valid, False otherwise.

A valid range is any non-empty byte range wholly within the entity described by the total length. Unsatisfied content ranges are treated as *invalid*.

5.3.6 Parsing Header Values

In most cases header values will be parsed automatically when reading them from messages. For completeness a header parser is exposed to enable you to parse these values from more complex strings.

class pyslet.http.messages.**HeaderParser**(*source*, *ignore_sp=True*)
Bases: *pyslet.http.params.ParameterParser*

A special parser for parsing HTTP headers from TEXT

require_media_range()
Parses a *MediaRange* instance.

Raises BadSyntax if no media-type was found.

require_accept_item()
Parses a *AcceptItem* instance

Raises BadSyntax if no item was found.

require_accept_list()
Parses a *AcceptList* instance

Raises BadSyntax if no valid items were found.

require_accept_token(*cls=<class 'pyslet.http.messages.AcceptToken'>*)
Parses a single *AcceptToken* instance

Raises BadSyntax if no item was found.

cls An optional sub-class of *AcceptToken* to create instead.

require_accept_token_list(*cls=<class 'pyslet.http.messages.AcceptTokenList'>*)
Parses a list of token-based accept items

Returns a *AcceptTokenList* instance. If no tokens were found then an *empty* list is returned.

cls An optional sub-class of *AcceptTokenList* to create instead.

require_contentrange()
Parses a *ContentRange* instance.

require_product_token_list()
Parses a list of product tokens

Returns a list of `params.ProductToken` instances. If no tokens were found then an empty list is returned.

5.3.7 Exceptions

class pyslet.http.messages.**HTTPException**
Bases: exceptions.Exception

Class for all HTTP message-related errors.

5.4 HTTP Protocol Parameters

This section defines functions for handling basic parameters used by HTTP. Refer to Section 3 of RFC2616 for details.

The approach taken by this module is provide classes for each of the parameter types. Most classes have a class method 'from_str' which returns a new instance parsed from a string and performs the reverse transformation to the builtin str function. Instances are generally immutable objects which is consistent with them representing values of parameters in the protocol.

class pyslet.http.params.**HTTPVersion**(*major=1*, *minor=None*)
Bases: object

Represents the HTTP Version.

major The (optional) major version

minor The (optional) minor version

The default instance, HTTPVersion(), represents HTTP/1.1

HTTPVersion objects are immutable, they define comparison functions (such that 1.1 > 1.0 and 1.2 < 1.25) and a hash implementation is provided.

On conversion to a string the output is of the form:

```
HTTP/<major>.<minor>
```

For convenience, the constants HTTP_1p1 and HTTP_1p0 are provided for comparisons, e.g.:

```
if HTTPVersion.from_str(version_str) == HTTP_1p0:
    # do something to support a legacy system...
```

major = None
major protocol version (read only)

minor = None
minor protocol version (read only)

classmethod from_str(*source*)
Constructs an *HTTPVersion* object from a string.

class pyslet.http.params.**HTTPURL**(*octets='http://localhost/'*, *host=None*, *path=None*, *query=None*, *fragment=None*)
Bases: *pyslet.rfc2396.ServerBasedURL*

Represents http URLs

DEFAULT_PORT = 80
the default HTTP port

canonicalize()
Returns a canonical form of this URI

class pyslet.http.params.**HTTPSURL**(*octets='https://localhost/'*)
Bases: *pyslet.http.params.HTTPURL*

Represents https URLs

DEFAULT_PORT = 443
the default HTTPS port

class pyslet.http.params.**FullDate**(*src=None*, *date=None*, *time=None*)
Bases: *pyslet.iso8601.TimePoint*

A special sub-class for HTTP-formatted dates

classmethod from_http_str(*source*)
Returns an instance parsed from an HTTP formatted string

class pyslet.http.params.**TransferEncoding**(*token='chunked'*, *parameters={}*)
Bases: object

Represents an HTTP transfer-encoding.

token The transfer encoding identifier, defaults to "chunked"

parameters A parameter dictionary mapping parameter names to tuples of strings: (parameter name, parameter value)

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they define comparison methods and a hash implementation.

token = None
the lower-cased transfer-encoding token (defaults to "chunked")

parameters = None
declared extension parameters

classmethod from_str(*source*)
Parses the transfer-encoding from a *source* string.

If the encoding is not parsed correctly BadSyntax is raised.

classmethod list_from_str(*source*)
Creates a list of transfer-encodings from a string

Transfer-encodings are comma-separated

class pyslet.http.params.**Chunk**(*size=0*, *extensions=None*)
Bases: object

Represents an HTTP chunk header

size The size of this chunk (defaults to 0)

extensions A parameter dictionary mapping parameter names to tuples of strings: (chunk-ext-name, chunk-ext-val)

The built-in str function can be used to format instances according to the grammar defined in the specification. The resulting string does *not* include the trailing CRLF.

Instances are immutable, they define comparison methods and a hash implementation.

size = None
the chunk-size

classmethod from_str(*source*)
Parses the chunk header from a *source* string of *TEXT*.

If the chunk header is not parsed correctly BadSyntax is raised. The header includes the chunk-size and any chunk-extension parameters but it does *not* include the trailing CRLF or the chunk-data

class pyslet.http.params.**MediaType**(*type='application'*, *subtype='octet-stream'*, *parameters={}*)
Bases: object

Represents an HTTP media-type.

The built-in str function can be used to format instances according to the grammar defined in the specification.

type The type code string, defaults to 'application'

subtype The sub-type code, defaults to 'octet-stream'

parameters A dictionary such as would be returned by grammar.WordParser.parse_parameters() containing the media type's parameters.

Instances are immutable and support parameter value access by lower-case key, returning the corresponding value or raising KeyError. E.g., mtype['charset']

Instances also define comparison methods and a hash implementation. Media-types are compared by type, subtype and ultimately parameters.

classmethod from_str(*source*)
Creates a media-type from a *source* string.

Enforces the following rule from the specification:

> Linear white space (LWS) MUST NOT be used between the type and subtype, nor between an attribute and its value

class pyslet.http.params.**ProductToken**(*token=None*, *version=None*)
Bases: object

Represents an HTTP product token.

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they define comparison methods and a hash implementation.

The comparison operations use a more interesting sort than plain text on version in order to provide a more intuitive ordering. As it is common practice to use dotted decimal notation for versions (with some alphanumeric modifiers) the version string is exploded (see *explode()*) internally on construction and this exploded value is used in comparisons. The upshot is that version 1.0.3 sorts before 1.0.10 as you would expect and 1.0a < 1.0 < 1.0.3a3 < 1.0.3a20 < 1.0.3b1 < 1.0.3; there are limits to this algorithm. 1.0dev > 1.0b1 even though it looks like it should be the other way around. Similarly 1.0-live < 1.0-prod etc.

You shouldn't use this comparison as a definitive way to determine that one release is more recent or up-to-date than another unless you know that the product in question uses a numbering scheme compatible with these rules.

token = None
the product's token

version = None
the product's version

classmethod explode(*version*)
Returns an exploded version string.

Version strings are split by dot and then by runs of non-digit characters resulting in a list of tuples. Examples will help:

```
        explode("2.15")==((2),(15))
        explode("2.17b3")==((2),(17,"b",3))
        explode("2.b3")==((2),(-1,"b",3))
```

Note that a missing leading numeric component is treated as -1 to force "a3" to sort before "0a3".

classmethod **from_str**(*source*)
Creates a product token from a *source* string.

classmethod **list_from_str**(*source*)
Creates a list of product tokens from a *source* string.

Individual tokens are separated by white space.

class pyslet.http.params.**LanguageTag**(*primary*, **subtags*)
Bases: object

Represents an HTTP language-tag.

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they define comparison methods and a hash implementation.

partial_match(*range*)
True if this tag is a partial match against *range*

range A tuple of lower-cased subtags. An empty tuple matches all instances.

For example:

```
        lang=LanguageTag("en",("US","Texas"))
        lang.partial_match(())==True
        lang.partial_match(("en",)==True
        lang.partial_match(("en","us")==True
        lang.partial_match(("en","us","texas")==True
        lang.partial_match(("en","gb")==False
        lang.partial_match(("en","us","tex")==False
```

classmethod **from_str**(*source*)
Creates a language tag from a *source* string.

Enforces the following rules from the specification:

White space is not allowed within the tag

classmethod **list_from_str**(*source*)
Creates a list of language tags from a *source* string.

class pyslet.http.params.**EntityTag**(*tag*, *weak=True*)
Represents an HTTP entity-tag.

tag The opaque tag

weak A boolean indicating if the entity-tag is a weak or strong entity tag. Defaults to True.

The built-in str function can be used to format instances according to the grammar defined in the specification.

Instances are immutable, they define comparison methods and a hash implementation.

weak = None
True if this is a weak tag

tag = None
the opaque tag

classmethod **from_str**(*source*)
Creates an entity-tag from a *source* string.

5.4.1 Parsing Parameter Values

In most cases parameter values will be parsed directly by the class methods provided in the parameter types themselves. For completeness a parameter parser is exposed to enable you to parse these values from more complex strings.

class pyslet.http.params.**ParameterParser**(*source*, *ignore_sp=True*)
Bases: *pyslet.http.grammar.WordParser*

An extended parser for parameter values

This parser defines attributes for dealing with English date names that are useful beyond the basic parsing functions to allow the formatting of date information in English regardless of the locale.

parse_http_version()
Parses an *HTTPVersion* instance

Returns None if no version was found.

wkday = ['Mon', 'Tue', 'Wed', 'Thu', 'Fri', 'Sat', 'Sun']
A list of English day-of-week abbreviations: wkday[0] == "Mon", etc.

weekday = ['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday']
A list of English day-of-week full names: weekday[0] == "Monday"

month = ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun', 'Jul', 'Aug', 'Sep', 'Oct', 'Nov', 'Dec']
A list of English month names: month[0] == "Jan", etc.

require_fulldate()
Parses a *FullDate* instance.

Raises BadSyntax if none is found.

There are three supported formats as described in the specification:

```
"Sun, 06 Nov 1994 08:49:37 GMT"
"Sunday, 06-Nov-94 08:49:37 GMT"
"Sun Nov  6 08:49:37 1994"
```

The first of these is the preferred format.

parse_delta_seconds()
Parses a delta-seconds value, see WordParser.parse_integer()

parse_charset()
Parses a charset, see WordParser.parse_tokenlower()

parse_content_coding()
Parses a content-coding, see WordParser.parse_tokenlower()

require_transfer_encoding()
Parses a *TransferEncoding* instance

Returns None if no transfer-encoding was found.

require_chunk()
Parses a chunk header

Returns a *Chunk* instance or None if no chunk was found.

require_media_type()
Parses a *MediaType* instance.

Raises BadSyntax if no media-type was found.

require_product_token()
Parses a *ProductToken* instance.

Raises BadSyntax if no product token was found.

parse_qvalue()
Parses a qvalue returning a float

Returns None if no qvalue was found.

require_language_tag()
Parses a language tag returning a *LanguageTag* instance. Raises BadSyntax if no language tag was found.

require_entity_tag()
Parses an entity-tag returning a *EntityTag* instance. Raises BadSyntax if no language tag was found.

5.5 HTTP Grammar

This section defines functions for handling basic elements of the HTTP grammar, refer to Section 2.2 of RFC2616 for details.

The HTTP protocol only deals with octets but as a convenience, and due to the blurring of octet and character strings in Python 2.x we process characters as if they were octets.

pyslet.http.grammar.**is_octet**(*c*)
Returns True if a character matches the production for OCTET.

pyslet.http.grammar.**is_char**(*c*)
Returns True if a character matches the production for CHAR.

pyslet.http.grammar.**is_upalpha**(*c*)
Returns True if a character matches the production for UPALPHA.

pyslet.http.grammar.**is_loalpha**(*c*)
Returns True if a character matches the production for LOALPHA.

pyslet.http.grammar.**is_alpha**(*c*)
Returns True if a character matches the production for ALPHA.

pyslet.http.grammar.**is_digit**(*c*)
Returns True if a character matches the production for DIGIT.

pyslet.http.grammar.**is_digits**(*src*)
Returns True if all characters match the production for DIGIT.

Empty strings return False

pyslet.http.grammar.**is_ctl**(*c*)
Returns True if a character matches the production for CTL.

LWS and TEXT productions are handled by *OctetParser*

pyslet.http.grammar.**is_hex**(*c*)
Returns True if a characters matches the production for HEX.

pyslet.http.grammar.**is_hexdigits**(*src*)
Returns True if all characters match the production for HEX.

Empty strings return False

pyslet.http.grammar.**check_token**(*t*)
Raises ValueError if *t* is *not* a valid token

pyslet.http.grammar.**is_separator**(*c*)
Returns True if a character is a separator

pyslet.http.grammar.**decode_quoted_string**(*qstring*)
Decodes a quoted string, returning the unencoded string.

Surrounding double quotes are removed and quoted characters (characters preceded by) are unescaped.

pyslet.http.grammar.**quote_string**(*s*, *force=True*)
Places a string in double quotes, returning the quoted string.

This is the reverse of *decode_quoted_string()*. Note that only the double quote, and CTL characters other than SP and HT are quoted in the output.

If *force* is False then valid tokens are *not* quoted.

pyslet.http.grammar.**format_parameters**(*parameters*)
Formats a dictionary of parameters

This function is suitable for formatting parameter dictionaries parsed by *WordParser.parse_parameters()*.

Parameter values are quoted only if their values require it, that is, only if their values are *not* valid tokens.

5.5.1 Using the Grammar

The functions and data definitions above are exposed to enable normative use in other modules but use of the grammar is typically through use of a parser. There are two types of parser, an OctetParser that is used for parsing raw strings (or octets) such as those obtained from the HTTP connection itself and a WordParser that tokenizes the input string first and then provides a higher-level word-based parser.

class pyslet.http.grammar.**OctetParser**(*source*)
Bases: *pyslet.unicode5.BasicParser*

A special purpose parser for parsing HTTP productions.

parse_lws()
Parses a single instance of the production LWS

The return value is the LWS string parsed or None if there is no LWS.

parse_onetext(*unfold=False*)
Parses a single TEXT instance.

Parses a single character or run of LWS matching the production TEXT. The return value is the matching character, LWS string or None if no TEXT was found.

If *unfold* is True then any folding LWS is replaced with a single SP. It defaults to False

parse_text(*unfold=False*)
Parses TEXT

Parses a run of characters matching the production TEXT. The return value is the matching TEXT string (including any LWS) or None if no TEXT was found.

If *unfold* is True then any folding LWS is replaced with a single SP. It defaults to False

parse_token()
Parses a token.

Parses a single instance of the production token. The return value is the matching token string or None if no token was found.

parse_comment(*unfold=False*)
Parses a comment.

Parses a single instance of the production comment. The return value is the entire matching comment string (including the brackets, quoted pairs and any nested comments) or None if no comment was found.

If *unfold* is True then any folding LWS is replaced with a single SP. It defaults to False

parse_ctext(*unfold=False*)
Parses ctext.

Parses a run of characters matching the production ctext. The return value is the matching ctext string (including any LWS) or None if no ctext was found.

If *unfold* is True then any folding LWS is replaced with a single SP. It defaults to False

Although the production for ctext would include the backslash character we stop if we encounter one as the grammar is ambiguous at this point.

parse_quoted_string(*unfold=False*)
Parses a quoted-string.

Parses a single instance of the production quoted-string. The return value is the entire matching string (including the quotes and any quoted pairs) or None if no quoted-string was found.

If *unfold* is True then any folding LWS is replaced with a single SP. It defaults to False

parse_qdtext(*unfold=False*)
Parses qdtext.

Parses a run of characters matching the production qdtext. The return value is the matching qdtext string (including any LWS) or None if no qdtext was found.

If *unfold* is True then any folding LWS is replaced with a single SP. It defaults to False

Although the production for qdtext would include the backslash character we stop if we encounter one as the grammar is ambiguous at this point.

parse_quoted_pair()
Parses a single quoted-pair.

The return value is the matching string including the backslash so it will always be of length 2 or None if no quoted-pair was found.

class pyslet.http.grammar.**WordParser**(*source*, *ignore_sp=True*)
Bases: object

A word-level parser and tokeniser for the HTTP grammar.

source is the string to be parsed into words. It will normally be valid TEXT but it can contain control characters if they are escaped as part of a comment or quoted string.

LWS is unfolded automatically. By default the parser ignores spaces according to the rules for implied LWS in the specification and neither SP nor HT will be stored in the word list. If you set *ignore_sp* to False then LWS is not ignored and each run of LWS is returned as a single SP in the word list.

If the source contains a CRLF (or any other non-TEXT character) that is not part of a folding or escape sequence it raises ValueError

The resulting words may be a token, a single separator character, a comment or a quoted string. To determine the type of word, look at the first character.

- '(' means the word is a comment, surrounded by '(' and ')'
- a double quote means the word is an encoded quoted string (use py:func:*decode_quoted_string* to decode it)
- other separator chars are just themselves and only appear as single character strings. (HT is never returned.)
- Any other character indicates a token.

Methods of the form require_* raise *BadSyntax* if the production is not found.

pos = None
a pointer to the current word in the list

the_word = None
the current word or None

setpos(*pos*)
Sets the current position of the parser.

Example usage for look-ahead:

```
# wp is a WordParser instance
savepos=wp.pos
try:
        # parse a token/sub-token combination
        token=wp.require_token()
        wp.require_separator('/')
        subtoken=wp.require_token()
        return token,subtoken
except BadSyntax:
        wp.setpos(savepos)
        return None,None
```

peek()
Returns the next word

If there are no more words, returns None.

syntax_error(*expected*)
Raises *BadSyntax*.

expected a descriptive string indicating the expected production.

require_production(*result*, *production=None*)
Returns *result* if *result* is not None

If result is None, raises BadSyntax.

production can be used to customize the error message with the name of the expected production.

parse_production(*require_method*, **args*)
Executes the bound method *require_method* passing *args*.

If successful the result of the method is returned. If BadSyntax is raised, the exception is caught, the parser rewound and None is returned.

require_production_end(*result*, *production=None*)
Checks for a required production and the end of the word list

Returns *result* if *result* is not None and parsing is now complete, otherwise raises BadSyntax.

production can be used to customize the error message with the name of the expected production.

require_end(*production=None*)
Checks for the end of the word list

If the parser is not at the end of the word list *BadSyntax* is raised.

production can be used to customize the error message with the name of the production being parsed.

parse_word()
Parses any word from the list

Returns the word parsed or None if the parser was already at the end of the word list.

is_token()
Returns True if the current word is a token

parse_token()
Parses a token from the list of words

Returns the token or None if the next word was not a token.

parse_tokenlower()
Returns a lower-cased token parsed from the word list

Returns None if the next word was not a token.

parse_tokenlist()
Parses a list of tokens

Returns the list or [] if no tokens were found. Lists are defined by RFC2616 as being comma-separated. Note that empty items are ignored, so string such as "x,,y" return just ["x", "y"].

require_token(*expected='token'*)
Returns the current token or raises *BadSyntax*

expected the name of the expected production, it defaults to "token".

is_integer()
Returns True if the current word is an integer token

parse_integer()
Parses an integer token from the list of words

Return the integer's *value* or None.

require_integer(*expected='integer'*)
Parses an integer or raises *BadSyntax*

expected can be set to the name of the expected object, defaults to "integer".

is_hexinteger()
Returns True if the current word is a hex token

parse_hexinteger()
Parses a hex integer token from the list of words

Return the hex integer's *value* or None.

require_hexinteger(*expected='hex integer'*)
Parses a hex integer or raises *BadSyntax*

expected can be set to the name of the expected object, defaults to "hex integer".

is_separator(*sep*)
Returns True if the current word matches *sep*

parse_separator(*sep*)
Parses a *sep* from the list of words.

Returns True if the current word matches *sep* and False otherwise.

require_separator(*sep*, *expected=None*)
Parses *sep* or raises `BadSyntax`

expected can be set to the name of the expected object

is_quoted_string()
Returns True if the current word is a quoted string.

parse_quoted_string()
Parses a quoted string from the list of words.

Returns the *decoded* value of the quoted string or None.

parse_sp()
Parses a SP from the list of words.

Returns True if the current word is a SP and False otherwise.

parse_parameters(*parameters*, *ignore_allsp=True*, *case_sensitive=False*, *qmode=None*)
Parses a set of parameters

parameters the dictionary in which to store the parsed parameters

ignore_allsp a boolean (defaults to True) which causes the function to ignore all LWS in the word list. If set to False then space around the '=' separator is treated as an error and raises BadSyntax.

case_sensitive controls whether parameter names are treated as case sensitive, defaults to False.

qmode allows you to pass a special parameter name that will terminate parameter parsing (without being parsed itself). This is used to support headers such as the "Accept" header in which the parameter called "q" marks the boundary between media-type parameters and Accept extension parameters. Defaults to None

Updates the parameters dictionary with the new parameter definitions. The key in the dictionary is the parameter name (converted to lower case if parameters are being dealt with case insensitively) and the value is a 2-item tuple of (name, value) always preserving the original case of the parameter name.

parse_remainder(*sep=''*)
Parses the rest of the words

The result is a single string representing the remaining words joined with *sep*, which defaults to an *empty* string.

Returns an empty string if the parser is at the end of the word list.

class pyslet.http.grammar.**BadSyntax**
Raised when a syntax error is encountered by the parsers

This is just a trivial sub-class of the built-in ValueError.

5.6 HTTP Cookies

This module contains classes for handling Cookies, as defined by RFC6265 HTTP State Management Mechanism

5.6.1 Client Scenarios

By default, Pyslet's HTTP client does not support cookies. Adding support, if you want it, is done with the *CookieStore* class. All you need to do is create an instance and add it to the client before processing any requests:

```
import pyslet.http.client as http

client = http.Client()
cookie_store = http.cookie.CookieStore()
client.set_cookie_store(cookie_store)
```

Support for cookies is then transparently added to each request.

By default, the CookieStore object does not support domain cookies because it doesn't know which domains are effectively top level domains (TLDs) so treats all domains as effective TLDs. Domain cookies can't be stored for TLDs as this would allow a website at www.exampleA.com to set *or overwrite* a cookie in the 'com' domain which would then be sent to www.exampleB.com. There are lots of reasons why this is a bad idea, websites could disrupt each others operation or worse, compromise security and user privacy.

For most applications you can fix this by creating exceptions for domains you want your client to trust. For example, if you want to interact with www.example.com and www2.example.com you might want to allow domain cookies for example.com, knowing that the effective TLD in this case is simply 'com'.

    cookie_store.add_private_suffix('example.com')

If you want to emulate the behaviour of real browsers you will need to upload a proper database of effective TLDs. For more information see *CookieStore.fetch_public_suffix_list()* and *CookieStore.set_public_list()*. Be warned, the public suffix list changes routinely and you'll want to ensure you have the latest values loaded.

5.6.2 Web Application Scenarios

If you are writing a web application you may want to handle cookies directly by adding response headers explicitly to a response object provided by your web framework.

There are two classes for representing cookie definitions, you should use the stricter *Section4Cookie* when creating cookies as this follows the recommended syntax in the RFC and will catch problems such as attempting to set a cookie value containing a comma. Although user agents are supposed to cope with such values some systems are now rejecting cookies that do not adhere to the stricter section 4 definitions.

The following code creates a cookie called SID with a maximum lifespan of 15 minutes:

```
import pyslet.http.cookie as cookie

c = cookie.Section4Cookie("SID", "31d4d96e407aad42", max_age=15*60,
                          path="/", http_only=True, secure=True)
print c
```

It outputs the text required to set the Set-Cookie header:

```
SID=31d4d96e407aad42; Path=/; Max-Age=900; Secure; HttpOnly
```

You may want to add additional attributes such as an expires time for backwards compatibility or a domain to allow the cookie to be sent to other websites in a shared domain. See *Cookie* for details.

5.6.3 Reference

class pyslet.http.cookie.**Cookie**(*name*, *value*, *path=None*, *domain=None*, *expires=None*, *max_age=None*, *secure=False*, *http_only=False*, *extensions=None*)

Bases: object

Represents the definition of a cookie

name The name of the cookie

value The value of the cookie

path (optional) A string: the path of the cookie. If None then the 'directory' of the page that returned the cookie will be used by the client.

domain (optional) A string: the domain of the cookie. If None then the host name of the server that returned the cookie will be used by the client and the cookie will be treated as 'host only'.

expires (optional) An *TimePoint* instance. If None then the cookie will be treated as a session cookie by the client.

max_age (optional) An integer, the length of time before the cookie expires in seconds. Overrides the expires value. If None then the value of expires is used instead, if both are None then the cookie will be treated as a session cookie by the client.

secure (Default: False) Whether or not the cookie should be exposed only over secure protocols, such as https.

http_only (Default: False) Whether or not the cookie should be exposed only via the HTTP protocol. Recommended value: True!

extensions A list strings containing attribute extensions. The strings should be of the form name=value but this is not enforced.

Instances can be converted to strings using the builtin str function and the output that results is a valid Set-Cookie header value.

name = None
the cookie's name

value = None
the cookie's name

path = None
the cookie's path

domain = None
the cookie's domain

secure = None
the cookie's secure flag

http_only = None
the cookie's httponly flag

creation_time = None
the creation time of the cookie, initialised to the current time as returned by the builtin time.time function.

access_time = None
the last access time of the cookie, initialised to the current time as returned by the builtin time.time function.

expires_time = None
the expiry time of the cookie, as an integer compatible with the value returned by time.time

max_age = None
the max_age value

expires = None
the expires value as passed to the constructor, this is preserved and is used when serialising the definition even if Max-Age is also in effect. Some older clients may not support Max-Age and they will look at the Expires time instead.

extensions = None
the list of extensions

classmethod from_str(*src*)
Creates a new instance from a src string

The string is parsed using the generous parsing rules of Section 5 of the specification. Returns a new instance.

is_persistent()
Returns True if there is no expires time on this cookie.

The expires time is calculated from either the max_age or expires attributes.

is_hostonly()
Returns True if this cookie is 'host only'

In other words, it should only be sent to the host that set the cookie originally.

touch(*now=None*)
Updates the cookie's last access time.

now (optional) Time value to use. This can be in the past or the future and improves performance when updating multiple cookies simultaneously.

expired(*now=None*)
Returns True if the cookie has expired

now (optional) Time value at which to test, this can be in the past or the future and is largely provided to aid testing and also to improve performance when a large number of cookies need to be tested sequentially.

class pyslet.http.cookie.**Section4Cookie**(**args*, ***kwargs*)
Bases: *pyslet.http.cookie.Cookie*

Represents a strict cookie definition

The purpose of this class is wrap *Cookie* to enforce more validation rules on the definition to ensure that the cookie adheres to section 4 syntax, and not just the broader section 5 syntax.

Names are checked for token validity, values are checked against the syntax for cookie-value and the attributes are checked against the other constraints in the specification.

The built-in str function will return a string that is valid against the section 4 syntax.

classmethod from_str(*src*)
Creates a new instance from a src string

Overridden to provide stricter parsing. This may still appear more generous than expected because the strict syntax allows an unrestricted set of attribute extensions so unrecognised attributes will often be recorded but not in any useful way.

Client Support

User agents that support cookies are obliged to keep a cookie store in which cookies can be saved and retrieved keyed on their domain, path and cookie name.

Pyslet's approach is to provide an in-memory store with nodes defined for each domain (host) that a cookie has been associated with or which is the target of a public or private suffix rule. Nodes are also created for any implied parent domains and the result is a tree-like structure of dictionaries that can be quickly searched for each request.

class pyslet.http.cookie.**CookieStore**
Bases: object

An object that provides in-memory storage for cookies.

There are no initialisation options. By default, the cookie storage will refuse all 'domain' cookies. That is, cookies that have a domain attribute. If a domain cookie is received from a host that exactly matches its domain attribute then it is converted to a host-only cookie and *is* stored.

This behaviour can be changed by adding exclusions (in the form of calls to *add_private_suffix()*) or by loading in a new public prefix database using *set_public_list()*.

set_cookie(*url*, *c*)
Store a cookie.

urL A *URI* instance representing the resource that is setting the cookie.

c A *Cookie* instance, typically parsed from a Set-Cookie header returned when requesting the resource at url.

If the cookie can't be set then *CookieError* is raised. Reasons why a cookie might be refused are a mismatch between a domain attribute and the url, or an attempt to set a cookie in a public domain, such as 'co.uk'.

search(*url*)
Searches for cookies that match a resource

url A *URI* instance representing the resource that we want to find cookies for.

The return result is a sorted list of *Cookie* objects. The sort order is defined in the specification, longer paths are sorted first, otherwise older cookies are listed before newer ones.

Expired cookies are automatically removed from the repository and all cookies returned have their access time updated to the current time.

expire_cookies(*now=None*, *dnode=None*)
Expire stored cookies.

now (optional) The time at which to expire the cookies, defaults to the current time. This can be used to expire cookies based on some past or future point.

Iterates through all stored cookies and removes any that have expired.

end_session(*now=None*, *dnode=None*)
Expire all session cookies.

now (optional) The time at which to expire cookies. See *expire_cookies()* for details.

Iterates through all stored cookies and removes any session cookies *in addition* to any that have expired.

add_public_suffix(*suffix*)
Marks a domain suffix as being public.

suffix A string: a public suffix, may contain wild-card characters to match any entire label, for example: "*.uk*", ".tokyo.jp", "com"

Once a domain suffix is marked as being public *future* cookies will not be stored against that suffix (except in the unusual case where a cookie is 'host only' and the host name is a public suffix).

add_private_suffix(*suffix*)
Marks a domain suffix as being private.

suffix A string: a public suffix, may contain wild-card characters to match any entire label, for example: "example.co.uk", "*.tokyo.jp", "com"

This method is required to override an existing public rule, thereby ensuring that *future* cookies can be stored against domains matching this suffix.

classmethod fetch_public_suffix_list(*fpath*, *src='https://publicsuffix.org/list/effective_tld_names.dat'*, *overwrite=False*)
Fetches the public suffix list and saves to fpath

fpath A local file path to save the file in

src A string or *URI* instance pointing at the file to retrieve. It default to the data file https://publicsuffix.org/list/effective_tld_names.dat

overwrite (Default: False) A flag to force an overwrite of an existing file at fpath, by default, if fpath already exists this method returns without doing anything.

set_public_list(*black_list*, *tld_depth=1*)
Loads a new public suffix list

black_list A string containing a list of public suffixes in the format defined by: https://publicsuffix.org/list/

tld_depth (Default: 1) The depth of domain that will be automatically treated as public. The default is 1, meaning that all top-level domains will be treated as public.

This methods loads data from a public list using calls to `add_public_prefix()` and `add_private_prefix()`, the latter being for exclusion rules.

If you use the full list published by the Public Suffix List project it is safe to use the default tld_depth value of 1:

https://publicsuffix.org/list/effective_tld_names.dat

If you want to load a much smaller list then you should focus on a large value for tld_depth (255 for example) and documenting exclusions only. For example:

```
// Exclusion list
// Accept domain cookies for example.com, example.co.uk
!example.com
!example.co.uk
```

test_public_domain(*domain_str*)
Test if a domain is public

domain_str A domain string, e.g., "www.example.com"

Returns True if this domain is marked as public, False otherwise.

get_registered_domain(*domain_str*, *u_labels=False*)
Returns the publicly registered portion of a domain

domain_str A domain string, e.g., "www.example.com"

u_labels (Default: False) Flag indicating whether or not to return unicode labels instead of encoded ASCII Labels.

Compares this domain against the database of public domains and returns the publicly registered part of the domain. For example, www.example.com would typically return example.com and www.example.co.uk would typically return example.co.uk.

If domain_str is already a publicly registered domain then it returns None. If domain_str is itself None, None is also returned.

Initially, all domains are marked as public so this function will always return None. It iss intended for use after a public list has been loaded, such as the public suffix list (see *set_public_list()*).

check_public_suffix(*domain_str*, *match_str*)
See Public Suffix Test Data for details.

http://mxr.mozilla.org/mozilla-central/source/netwerk/test/unit/data/test_psl.txt?raw=1

Returns True if there is a match, False otherwise. Negative results are logged at ERROR level. Used for testing the public suffixes loaded with *set_public_list()*.

Syntax

The following basic functions can be used to test characters against the syntax productions defined in the specification. In each case, if the argument is None then False is returned.

class pyslet.http.cookie.**CookieParser**(*source*)
Bases: *pyslet.http.grammar.OctetParser*

General purpose class for parsing RFC6265 productions

Unlike the basic syntax functions these methods allow a longer string, such as that received from an HTTP header, to be parsed into its component parts.

Methods follow inherited naming conventions, require_ methods raise a ValueError if the production is not matched whereas parse_ methods optionally parse a production if it is present and return None if not present.

require_set_cookie_string(*strict=False*)
Parses the set-cookie-string production

strict (Default: False) Use the stricter section 4 syntax rules instead of the more permissive algorithm described in section 5.2

This is the format of the Set-Cookie header, it returns a *Cookie* instance or None if this cookie definition should be ignored.

require_cookie_string(*strict=False*)
Parses the value of a Cookie header.

strict (Default: False) Indicates if stricter section 4 parsing is required.

Returns a dictionary of values, the keys are the names of the cookies in the cookie string and the values are either strings or, in the case of multiply defined names, sets of strings. We use sets as the specification makes it clear that you should not rely on the order of such definitions.

require_name_value_pair()
Returns a (name, value) pair

Parsed according to the looser section 5 syntax so will allow almost anything as a name and value provided it has an '='.

require_cookie_pair()
Returns a (name, value) pair parsed according to cookie-pair

Parsed according to the stricter section 4 syntax so will only accept valid tokens as names, the '=' is required and the value must be parseable with *require_cookie_value()*.

parse_cookie_pair()
See: *require_cookie_pair()*

If not parsed returns (None, None) rather than just None.

require_cookie_value()
Returns a cookie-value string.

Parsed according to the stricter section 4 syntax so will not allow whitespace, comma, semicolon or backslash characters and will only allows double-quote when it is used to complete "enclose" the value, in which case the double-quotes are still considered to be part of the value string.

parse_cookie_av()
Parses a cookie-av string.

This production is effectively the production for extension-av in the stricter section 4 syntax. Effectively it returns everything up to but not including the next ';' or CTL character.

It never returns None, if nothing is found it returns an empty string instead.

parse_sane_cookie_date()
Parses the sane-cookie-date production.

This is the stricter syntax defined in section 4. The returns result is a `FullDate` instance.

parse_cookie_date_tokens()
Parses a date-token-list

This uses the weak section 5.1 syntax

It never returns None, if there are no tokens then it returns an empty list. Delimiters are always discarded.

require_cookie_date()
Parses a date value

This uses the weak section 5.1 syntax and the algorithm described there. It absorbs almost all errors returning None if this date value should be ignored - but warnings are logged to alert you to the failure. The implications of replacing a date with None in this syntax are typically that a cookie that is supposed to be persistent become session only. However, if this was an attempt to remove a cookie with a very early date then the failure could cause more problems.

If successful, it returns a `FullDate` instance.

Date and Time

pyslet.http.cookie.**split_year**(*year_str*)
Parses a year from a string

Uses the generous rules in section 5.1 and returns a year value, adjusted using the 2-digit year algorithm documented there.

If a year value can't be found ValueError is raised.

pyslet.http.cookie.**split_month**(*month_str*)
Parses a month from a string

Uses the generous rules in section 5.1 and returns a month value from 1 (January) to 12 (December).

If a month value can't be found ValueError is raised.

pyslet.http.cookie.**split_day_of_month**(*dom_str*)
Parses a day-of-month from a string

Users the generous rules in section 5.1 and returns a single integer or raises ValueError if a valid day of month can't be found.

pyslet.http.cookie.**split_time**(*time_str*)
Parses a time from a string

Users the generous rules in section 5.1 and returns a triple of hours, minutes, seconds. These values are unchecked!

If the time can't be found ValueError is raised.

Basic Syntax

pyslet.http.cookie.**is_delimiter**(*c*)
Tests a character against the production delimiter

This production is from the weaker section 5 syntax of RFC6265.

pyslet.http.cookie.**is_non_delimiter**(*c*)
Tests a character against the production non-delimiter

The result differs from using *not is_delimiter* only in the handling of None which will return False when passed to either function.

pyslet.http.cookie.**is_non_digit**(*c*)
Tests a character against the production non-digit.

pyslet.http.cookie.**is_cookie_octet**(*c*)
Tests a character against production coookie_octet

Domain Name Syntax

pyslet.http.cookie.**domain_in_domain**(*subdomain*, *domain*)
Returns try if subdomain is a sub-domain of domain.

subdomain A *reversed* list of strings returned by *split_domain()*

domain A *reversed* list of strings as returned by *split_domain()*

For example:

```
>>> domain_in_domain(['com', 'example'],
...                  ['com', 'example', 'www'])
True
```

pyslet.http.cookie.**split_domain**(*domain_str*, *allow_wildcard=False*)
Splits a domain string

domain_str A unicode string, or a UTF-8 encoded binary string.

allow_wildcard (Default: False) Allows the use of a single '*' character as a domain label for the purposes of parsing wildcard domain definitions.

Returns a list of lower cased *ASCII* labels, converting U-Labels to ACE form (xn–) in the process. For example:

```
>>> split_domain('example.COM')
>>> ['example', 'com']
>>> split_domain(u'\u98df\u72ee.com.cn')
>>> ['xn--85x722f', 'com', 'cn']
```

Raises ValueError if domain_str is not valid.

pyslet.http.cookie.**is_ldh_label**(*label*)
Tests a string against the definition of LDH label

LDH Label is defined in RFC5890 as being the classic label syntax defined in RFC1034 and updated in RFC1123. To cut a long story short the update in question is described as follows:

> One aspect of host name syntax is hereby changed: the restriction on the first character is relaxed to allow either a letter or a digit.

Although not spelled out there this would make the updated syntax:

```
<label> ::= <let-dig> [ [ <ldh-str> ] <let-dig> ]
<ldh-str> ::= <let-dig-hyp> | <let-dig-hyp> <ldh-str>
<let-dig-hyp> ::= <let-dig> | "-"
<let-dig> ::= <letter> | <digit>
```

pyslet.http.cookie.**is_rldh_label**(*label*)
Tests a string against the definition or R-LDH label

As defined by RFC5890

> Reserved LDH labels, known as "tagged domain names" in some other contexts, have the property that they contain "–" in the third and fourth characters but which otherwise conform to LDH label rules.
>
> Non-Reserved LDH labels are the set of valid LDH labels that do not have "–" in the third and fourth positions.

Therefore you can test for a NR-LDH label simply by using the *not* operator.

pyslet.http.cookie.**is_a_label**(*label*)
Test a string against the definition of A-label.

As defined by RFC5890

In fact, this function currently only tests for being an XN– label.

> the class of labels that begin with the prefix "xn–" (case independent), but otherwise conform to the rules for LDH labels [is called "XN-labels"]...
>
> The XN-labels that are valid Punycode output are known as "A-labels" if they also meet the other criteria for IDNA-validity

So bear in mind that (a) the remainder of the label may fail to decode properly when passed to the punycode algorithm and (b) even if it does decode it may result in a string that is not actually a valid U-Label.

Exceptions

class pyslet.http.cookie.**CookieError**
Bases: exceptions.ValueError

Raised when an operation violates RFC6265 rules.

CHAPTER 6

Other Supporting Standards

The section contains modules that implement supporting specifications that are not specific, or at least have no special interest in the domains of Learning, Education and Training. In some cases modules provide utilities to help interface with Python's standard libraries.

Contents:

6.1 WSGI Utilities

This module defines special classes and functions to make it easier to write applications based on the WSGI specification.

6.1.1 Overview

WSGI applications are simple callable objects that take two arguments:

```
result = application(environ, start_response)
```

In these utility classes, the arguments are encapsulated into a special context object based on *WSGIContext*. The context object allows you to get and set information specific to handling a single request, it also contains utility methods that are useful for extracting information from the URL, headers and request body and, likewise, methods that are useful for setting the response status and headers. Even in multi-threaded servers, each context instance is used by a single thread.

The application callable itself is modeled by an *instance* of the class *WSGIApp*. The instance may be called by multiple threads simultaneously so any state stored in the application is shared across all contexts and threads.

Many of the app class' methods take an abbreviated form of the WSGI callable signature:

```
result = wsgi_app.page_method(context)
```

In this pattern, wsgi_app is a *WSGIApp* instance and page_method is the name of some response generating method defined in it.

In practice, you'll derive a class from WSGIApp for your application and, possibly, derive a class from WSGIContext too. In the latter case, you must set the class attribute *WSGIApp.ContextClass* to your custom context class before creating your application instance.

The lifecycle of a script that runs your application can be summed up:

1. Define your WSGIApp sub-class

2. Set the values of any class attributes that are specific to a particular runtime environment. For example, you'll probably want to set the path to the *WSGIApp.settings_file* where you can provide other runtime configuration options.
3. Configure the class by calling the *WSGIApp.setup()* *class* method.
4. Create an instance of the class
5. Start handling requests!

Here's an example:

```
#
#   Runtime configuration directives
#

#: path to settings file
SETTINGS_FILE = '/var/www/wsgi/data/settings.json'

#   Step 1: define the WSGIApp sub-class
class MyApp(WSGIApp):
    """Your class definitions here"""

    #   Step 2: set class attributes to configured values
    settings_file = SETTINGS_FILE

#   Step 3: call setup to configure the application
MyApp.setup()

#   Step 4: create an instance
application = MyApp()

#   Step 5: start handling requests, your framework may differ!
application.run_server()
```

In the last step we call a run_server method which uses Python's builtin HTTP/WSGI server implementation. This is suitable for testing an application but in practice you'll probably want to deploy your application with some other WSGI driver, such as Apache and modwsgi

Testing

The core WSGIApp class has a number of methods that make it easy to test your application from the command line, using Python's built-in support for WSGI. In the example above you saw how the run_server method can be used.

There is also a facility to launch an application from the command line with options to override several settings. You can invoke this behaviour simply be calling the main class method:

```
from pyslet.wsgi import WSGIApp

class MyApp(WSGIApp):
    """Your class definitions here"""
    pass

if __name__ == "__main__":
    MyApp.main()
```

This simple example is available in the samples directory. You can invoke your script from the command line, –help can be used to look at what options are available:

```
$ python samples/wsgi_basic.py --help
Usage: wsgi_basic.py [options]

Options:
  -h, --help            show this help message and exit
  -v                    increase verbosity of output up to 3x
  -p PORT, --port=PORT  port on which to listen
  -i, --interactive     Enable interactive prompt after starting server
  --static=STATIC       Path to the directory of static files
  --private=PRIVATE     Path to the directory for data files
  --settings=SETTINGS   Path to the settings file
```

You could start a simple interactive server on port 8081 and hit it from your web browser with the following command:

```
$ python samples/wsgi_basic.py -ivvp8081
INFO:pyslet.wsgi:Starting MyApp server on port 8081
cmd: INFO:pyslet.wsgi:HTTP server on port 8081 running
1.0.0.127.in-addr.arpa - - [11/Dec/2014 23:49:54] "GET / HTTP/1.1" 200 78
cmd: stop
```

Typing 'stop' at the cmd prompt in interactive mode exits the server. Anything other than stop is evaluated as a python expression in the context of a method on your application object which allows you to interrogate you application while it is running:

```
cmd: self
<__main__.MyApp object at 0x1004c2b50>
cmd: self.settings
{'WSGIApp': {'interactive': True, 'static': None, 'port': 8081, 'private': None, 'level': 20}}
```

If you include -vvv on the launch you'll get full debugging information including all WSGI environment information and all application output logged to the terminal.

6.1.2 Handling Pages

To handle a page you need to register your page with the request dispatcher. You typically do this during *WSGIApp.init_dispatcher()* by calling *WSGIApp.set_method()* and passing a pattern to match in the path and a *bound* method:

```
class MyApp(WSGIApp):

    def init_dispatcher(self):
        super(MyApp, self).init_dispatcher()
        self.set_method("/*", self.home)

    def home(self, context):
        data = "<html><head><title>Hello</title></head>" \
            "<body><p>Hello world!</p></body></html>"
        context.set_status(200)
        return self.html_response(context, data)
```

In this example we registered our simple 'home' method as the handler for all paths. The star is used instead of a complete path component and represents a wildcard that matches any value. When used at the end of a path it matches any (possibly empty) sequence of path components.

6.1.3 Data Storage

Most applications will need to read from or write data to some type of data store. Pyslet exposes its own data access layer to web applications, for details of the data access layer see the OData section.

To associate a data container with your application simply derive your application from *WSGIDataApp* instead of the more basic WSGIApp.

You'll need to supply a metadata XML document describing your data schema and information about the data source in the settings file.

The minimum required to get an application working with a sqlite3 database would be to a directory with the following layout:

```
settings.json
metadata.xml
data/
```

The settings.json file would contain:

```
{
"WSGIApp": {
    "private": "data"
    },
"WSGIDataApp": {
    "metadata": "metadata.xml"
    }
}
```

If the settings file is in samples/wsgi_data your source might look this:

```
from pyslet.wsgi import WSGIDataApp

class MyApp(WSGIDataApp):

    settings_file = 'samples/wsgi_data/settings.json'

    # method definitions as before

if __name__ == "__main__":
    MyApp.main()
```

To create your database the first time you will either want to run a custom SQL script or get Pyslet to create the tables for you. With the script above both options can be achieved with the command line:

```
$ python samples/wsgi_data.py --create_tables -ivvp8081
```

This command starts the server as before but instructs it to create the tables in the database before running. Obviously you can only specify this option the first time!

Alternatively you might want to customise the table creation script, in which case you can create a pro-forma to edit using the –sqlout option instead:

```
$ python samples/wsgi_data.py --sqlout > wsgi_data.sql
```

6.1.4 Session Management

The *WSGIDataApp* is further extended by *SessionApp* to cover the common use case of needing to track information across multiple requests from the same user session.

The approach taken requires server side storage (typically in the form of a database) with a single entity set reserved for storing session data. It also requires cookies to be enabled in the user's browser. See *Problems with Cookies* below for details. The entity type must have at least the following fields:

```
<EntityType Name="Session">
    <Key>
        <PropertyRef Name="ID"/>
    </Key>
    <Property Name="ID" Type="Edm.Int32" Nullable="false"/>
    <Property Name="Established" Type="Edm.Boolean" Nullable="false"/>
    <Property Name="UserKey" Type="Edm.String" Nullable="false"
        MaxLength="64" Unicode="false"/>
    <Property Name="ServerKey" Type="Edm.String" Nullable="false"
        MaxLength="64" Unicode="false"/>
    <Property Name="FirstSeen" Type="Edm.DateTime" Nullable="false"/>
    <Property Name="LastSeen" Type="Edm.DateTime" Nullable="false"/>
    <Property Name="UserAgent" Type="Edm.String" Nullable="true"
        MaxLength="256" Unicode="false"/>
</EntityType>
```

A decorator, `session_decoratr()` is defined to make it easy to write (page) methods that depend on the existence of an active session. The session initiation logic is a little convoluted and is likely to involve at least one redirect when a protected page is first requested, but this all happens transparently to your application. You may want to look at overriding the `ctest_page()` and `cfail_page()` methods to provide more user-friendly messages in cases where cookies are blocked.

CSRF

Hand-in-hand with session management is defence against cross-site request forgery (CSRF) attacks. Relying purely on a session cookie to identify a user is problematic because a third party site could cause the user's browser to submit requests to your application on their behalf. The browser will send the session cookie even if the request originated outside one of your application's pages.

POST requests that affect the state of the server or carry out some other action requiring authorisation must be protected. Requests that simply return information (i.e., GET requests) are usually safe, even if the response contains confidential information, as the browser prevents the third party site from actually reading the HTML. Be careful when returning data other than HTML though, for example, data that could be parsed as valid JavaScript will need additional protection. The importance of using HTTP request methods appropriately cannot be understated!

The most common pattern for preventing this type of fraud is to use a special token in POST requests that can't be guessed by the third party and isn't exposed outside the page from which the POSTed form is supposed to originate. If you decorate a page that is the target of a POST request (the page that performs the action) with the session decorator then the request will fail if a CSRF token is not included in the request. The token can be read from the session object and will need to be inserted into any forms in your application. You shouldn't expose your CRSF token in the URL as that makes it vulnerable to being discovered, so don't add it to forms that use the GET action.

Here's a simple example method that shows the use of the session decorator:

```
@session_decorator
def home(self, context):
    page = """<html><head><title>Session Page</title></head><body>
        <h1>Session Page</h1>
        %s
        </body></html>"""
    if context.session.entity['UserName']:
        noform = """<p>Welcome: %s</p>"""
        page = page % (
```

```
            noform % xml.EscapeCharData(
                context.session.entity['UserName'].value))
    else:
        form = """<form method="POST" action="setname">
            <p>Please enter your name: <input type="text" name="name"/>
                <input type="hidden" name=%s value=%s />
                <input type="submit" value="Set"/></p>
            </form>"""
        page = page % (
            form % (xml.EscapeCharData(self.csrf_token, True),
                    xml.EscapeCharData(context.session.sid(), True)))
    context.set_status(200)
    return self.html_response(context, page)
```

We've added a nullable property to the basic session entity type:

```
<Property Name="UserName" Type="Edm.String" Nullable="true"
    MaxLength="256" Unicode="true"/>
```

Our method reads the value of this property from the session and prints a welcome message if it is set. If not, it prints a form allowing you to enter your name. Notice that we must include a hidden field containing the CSRF token. The name of the token parameter is given in *SessionApp.csrf_token* and the value is read from session object directly using the *Session.sid()* method. It's the same value as the session ID that is stored in the cookie - the browser should prevent third parties from reading the cookie's value.

The action method that processes the form looks like this:

```
@session_decorator
def setname(self, context):
    user_name = context.get_form_string('name')
    if user_name:
        context.session.entity['UserName'].set_from_value(user_name)
        context.session.touch()
    return self.redirect_page(context, context.get_app_root())
```

A sample application containing this code is provided and can again be run from the command line:

```
$ python samples/wsgi_session.py --create_tables -ivvp8081
```

Problems with Cookies

There has been significant uncertainty over the use of cookies with some browsers blocking them in certain situations and some users blocking them entirely. In particular, the E-Privacy Directive in the European Union has led to a spate of scrolling consent banners and pop-ups on website landing pages.

It is worth bearing in mind that use of cookies, as opposed to URL-based solutions or cacheable basic basic auth credentials, is currently considered *more* secure for passing session identifiers. When designing your application you need to balance the privacy rights of your users with the need to keep their information safe and secure. Indeed, the main provisions of the directive are about providing security of services. As a result, it is generally accepted that the use of cookies for tracking sessions is essential and does not require any special consent from the user.

By extending *WSGIDataApp* this implementation always persists session data on the server. This gets around most of the perceived issues with the directive and cookies but does not absolve you and your application of the need to obtain consent from a more general data protection perspective!

Perhaps more onerous, but less discussed, is the obligation to remove 'traffic data', sometimes referred to as metadata, about the transmission of a communication. For this reason, we don't store the originating IP address of the session even though doing so might actually increase security. As always, it's a balance.

Finally, by relying on cookies we will sometimes fall foul of browser attempts to automate the privacy preferences of their users. The most common scenario is when our application is opened in a frame within another application. In this case, some browsers will apply a much stricter policy on blocking cookies. For example, Microsoft's Internet Explorer (from version 6) requires the implementation of the P3P standard for communicating privacy information. Although some sites have chosen to fake a policy to trick the browser into accepting their cookies this has resulted in legal action so is not to be recommended.

See: http://msdn.microsoft.com/en-us/library/ms537343(v=VS.85).aspx

To maximise the chances of being able to create a session this class uses automatic redirection to test for cookie storage and a mechanism for transferring the session to a new window if it detects that cookies are blocked.

For a more detailed explanation of how this is achieved see my blog post Putting Cookies in the Frame

In many cases, once the application has been opened in a new window and the test cookie has been set successfully, future framed calls to the application *will* receive cookies and the user experience will be much smoother.

6.1.5 Encrypting Data

Sometimes you'll want to encrypt sensitive data stored in a data store to prevent, say, a database administrator from being able to read it. This module provides a utility class called *AppCipher* which is designed to make this easier.

An AppCipher is initialised with a key. There are various strategies for storing keys for application use, in the simplest case you might read the key from a configuration file that is only available on the application server and not to the database administrator, say.

The default implementation of AppCipher does not use any encryption (it merely obfuscates the input using base64 encoding) so to be useful you'll need to use a class derived from AppCipher. If you have the Pycrypto module installed you can use the *AESAppCipher* class to use the AES algorithm to encrypt the data.

For details, see the reference section below.

6.1.6 Reference

class pyslet.wsgi.**WSGIContext**(*environ*, *start_response*)

Bases: object

A class used for managing WSGI calls

environ The WSGI environment

start_response The WSGI call-back

This class acts as a holding place for information specific to each request being handled by a WSGI-based application. In some frameworks this might be called the request object but we already have requests modelled in the http package and, anyway, this holds information about the WSGI environment and the response too.

MAX_CONTENT = 65536
The maximum amount of content we'll read into memory (64K)

environ = None
the WSGI environ

start_response_method = None
the WSGI start_response callable

status = None
the response status code (an integer), see *set_status()*

status_message = None
the response status message (a string), see *set_status()*

headers = None
a *list* of (name, value) tuples containing the headers to return to the client. name and value must be strings

set_status(*code*)
Sets the status of the response

code An HTTP *integer* response code.

This method sets the *status_message* automatically from the code. You must call this method before calling start_response.

add_header(*name*, *value*)
Adds a header to the response

name The name of the header (a string)

value The value of the header (a string)

start_response()
Calls the WSGI start_response method

If the *status* has not been set a 500 response is generated. The status string is created automatically from *status* and *status_message* and the headers are set from *headers*.

The return value is the return value of the WSGI start_response call, an obsolete callable that older applications use to write the body data of the response.

If you want to use the exc_info mechanism you must call start_response yourself directly using the value of *start_response_method*

get_app_root(*authority=None*)
Returns the root of this application

authority The URL scheme and authority (including optional port) that should be used instead of the information obtained from the WSGI environment (e.g., the SERVER_NAME and SERVER_PORT variables).

The result is a *pyslet.rfc2396.URI* instance, It is calculated from the environment in the same way as *get_url()* but only examines the SCRIPT_NAME portion of the path.

It always ends in a trailing slash. So if you have a script bound to /script/myscript.py running over http on www.example.com then you will get:

```
http://www.example.com/script/myscript.py/
```

This allows you to generate absolute URLs by resolving them relative to the computed application root, e.g.:

```
URI.from_octets('images/counter.png').resolve(
    context.get_app_root())
```

would return:

```
http://www.example.com/script/myscript.py/images/counter.png
```

for the above example. This is preferable to using absolute paths which would strip away the SCRIPT_NAME prefix when used.

get_url(*authority=None*)
Returns the URL used in the request

authority See *get_app_root()*

The result is a *pyslet.rfc2396.URI* instance, It is calculated from the environment using the algorithm described in URL Reconstruction section of the WSGI specification except that it ignores the Host header for security reasons.

Unlike the result of *get_app_root()* it *doesn't* necessarily end with a trailing slash. So if you have a script bound to /script/myscript.py running over http on www.example.com then you may get:

```
http://www.example.com/script/myscript.py
```

A good pattern to adopt when faced with a missing trailing slash on a URL that is intended to behave as a 'directory' is to add the slash to the URL and use xml:base (for XML responses) or HTML's <base> tag to set the root for relative links. The alternative is to issue an explicit redirect but this requires another request from the client.

This causes particular pain in OData services which frequently respond on the service script's URL without a slash but generate incorrect relative links to the contained feeds as a result.

get_query()
Returns a dictionary of query parameters

The dictionary maps parameter names onto strings. In cases where multiple values have been supplied the values are comma separated, so a URL ending in ?option=Apple&option=Pear would result in the dictionary:

```
{'option': 'Apple,Pear'}
```

This method only computes the dictionary once, future calls return the same dictionary!

Note that the dictionary does not contain any cookie values or form parameters.

get_content()
Returns the content of the request as a string

The content is read from the input, up to CONTENT_LENGTH bytes, and is returned as a string. If the content exceeds *MAX_CONTENT* (default: 64K) then BadRequest is raised.

This method can be called multiple times, the content is only actually read from the input the first time. Subsequent calls return the same string.

This call cannot be called on the same context as *get_form()*, whichever is called first takes precedence. Calls to get_content after get_form return None.

get_form()
Returns a FieldStorage object parsed from the content.

The query string is excluded before the form is parsed as this only covers parameters submitted in the content of the request. To search the query string you will need to examine the dictionary returned by *get_query()* too.

This method can be called multiple times, the form is only actually read from the input the first time. Subsequent calls return the same FieldStorage object.

This call cannot be called on the same context as *get_content()*, whichever is called first takes precedence. Calls to get_form after get_content return None.

Warning: get_form will only parse the form from the content if the request method was POST!

get_form_string(*name*, *max_length=65536*)
Returns the value of a string parameter from the form.

name The name of the parameter

max_length (optional, defaults to 64KB) Due to an issue in the implementation of FieldStorage it isn't actually possible to definitively tell the difference between a file upload and an ordinary input field. HTML5 clarifies the situation to say that ordinary fields don't have a content type but FieldStorage assumes 'text/plain' in this case and sets the file and type attribute of the field anyway.

To prevent obtuse clients sending large files disguised as ordinary form fields, tricking your application into loading them into memory, this method checks the size of any file attribute (if present) against max_length before returning the field's value.

If the parameter is missing from the form then an empty string is returned.

get_form_long(*name*)
Returns the value of a (long) integer parameter from the form.

name The name of the parameter

If the parameter is missing from the form then None is returned, if the parameter is present but is not a valid integer then *BadRequest* is raised.

get_cookies()
Returns a dictionary of cookies from the request

If no cookies were passed an empty dictionary is returned.

For details of how multi-valued cookies are handled see: pyslet.http.cookie.CookieParser.request_cooki

class pyslet.wsgi.**WSGIApp**
Bases: pyslet.wsgi.DispatchNode

An object to help support WSGI-based applications.

Instances are designed to be callable by the WSGI middle-ware, on creation each instance is assigned a random identifier which is used to provide comparison and hash implementations. We go to this trouble so that derived classes can use techniques like the functools lru_cache decorator in future versions.

ContextClass
the context class to use for this application, must be (derived from) *WSGIContext*

alias of *WSGIContext*

static_files = None
The path to the directory for *static_files*. Defaults to None.

private_files = None
Private data diretory

The directory used for storing private data. The directory is partitioned into sub-directories based on the lower-cased class name of the object that owns the data. For example, if private_file is set to '/var/www/data' and you derive a class called 'MyApp' from WSGIApp you can assume that it is safe to store and retrieve private data files from '/var/www/data/myapp'.

private_files defaults to None for safety. The current WSGIApp implementation does not depend on any private data.

settings_file = None
The path to the settings file. Defaults to None.

The format of the settings file is a json dictionary. The dictionary's keys are class names that define a scope for class-specific settings. The key 'WSGIApp' is reserved for settings defined by this class. The defined settings are:

level (None) If specified, used to set the root logging level, a value between 0 (NOTSET) and 50 (CRITICAL). For more information see python's logging module.

authority ("http://localhost") The canonical URL scheme, host (and port if required) for the application. This value is passed to *WSGIContext.get_url()* and similar methods and is used in preference to the SERVER_NAME and SEVER_PORT to construct absolute URLs returned or recorded by the application. Note that the Host header is always ignored to prevent related security attacks.

port (8080) The port number used by `run_server()`

interactive (False) Sets the behaviour of `run_server()`, if specified the main thread prompts the user with a command line interface allowing you to interact with the running server. When False, run_server will run forever and can only be killed by an application request that sets *stop* to True or by an external signal that kills the process.

static (None) A URL to the static files (not a local file path). This will normally be an absolute path or a relative path. Relative paths are relative to the settings file in which the setting is defined. As URL syntax is used you must use the '/' as a path separator and add proper URL-escaping. On Windows, UNC paths can be specified by putting the host name in the authority section of the URL.

private (None) A URL to the private files. Interpreted as per the 'static' setting above.

settings = None
the class settings loaded from *settings_file* by *setup()*

base = None
the base URI of this class, set from the path to the settings file itself. This is a *pyslet.rfc2396.FileURL* instance.

private_base = None
the base URI of this class' private files. This is set from the *private_files* member and is a *pyslet.rfc2396.FileURL* instance

content_type = {'ico': MediaType('image','vnd.microsoft.icon',{})}
The mime type mapping table.

This table is used before falling back on Python's built-in guess_type function from the mimetypes module. Add your own custom mappings here.

It maps file extension (without the dot) on to *MediaType* instances.

MAX_CHUNK = 65536
the maximum chunk size to read into memory when returning a (static) file. Defaults to 64K.

js_origin = 0
the integer millisecond time (since the epoch) corresponding to 01 January 1970 00:00:00 UTC the JavaScript time origin.

clslock = <_RLock owner=None count=0>
a threading.RLock instance that can be used to lock the class when dealing with data that might be shared amongst threads.

classmethod main()
Runs the application

Options are parsed from the command line and used to *setup()* the class before an instance is created and launched with `run_server()`.

classmethod add_options(*parser*)
Defines command line options.

parser An OptionParser instance, as defined by Python's built-in optparse module.

The following options are added to *parser* by the base implementation:

-v	Sets the logging level to WARNING, INFO or DEBUG depending on the number of times it is specified. Overrides the 'level' setting in the settings file.
-p, --port	Overrides the value of the 'port' setting in the settings file.
-i, --interactive	Overrides the value of the 'interactive' setting in the settings file.
--static	Overrides the value of *static_files*.
--private	Overrides the value of *private_files*.
--settings	Sets the path to the *settings_file*.

classmethod setup(*options=None*, *args=None*, ***kwargs*)
Perform one-time class setup

options An optional object containing the command line options, such as an optparse.Values instance created by calling parse_args on the OptionParser instance passed to *add_options()*.

args An optional list of positional command-line arguments such as would be returned from parse_args after the options have been removed.

All arguments are given as keyword arguments to enable use of super and diamond inheritance.

The purpose of this method is to perform any actions required to setup the class prior to the creation of any instances.

The default implementation loads the settings file and sets the value of *settings*. If no settings file can be found then an empty dictionary is created and populated with any overrides parsed from options.

Finally, the root logger is initialised based on the level setting.

Derived classes should always use super to call the base implementation before their own setup actions are performed.

classmethod resolve_setup_path(*path*, *private=False*)
Resolves a settings-relative path

path The relative URI of a file or directory.

private (False) Resolve relative to the private files directory

Returns path as a system file path after resolving relative to the settings file location or to the private files location as indicated by the private flag. If the required location is not set then path must be an absolute file URL (starting with, e.g., file:///). On Windows systems the authority component of the URL may be used to specify the host name for a UNC path.

stop = None
flag: set to True to request `run_server()` to exit

id = None
a unique ID for this instance

init_dispatcher()
Used to initialise the dispatcher.

By default all requested paths generate a 404 error. You register pages during *init_dispatcher()* by calling *set_method()*. Derived classes should use super to pass the call to their parents.

set_method(*path*, *method*)
Registers a bound method in the dispatcher

path A path or path pattern

method A bound method or callable with the basic signature:

```
result = method(context)
```

A star in the path is treated as a wildcard and matches a complete path segment. A star at the end of the path (which must be after a '/') matches any sequence of path segments. The matching sequence may be empty, in other words, "/images/*" matches "/images/". In keeping with common practice a missing trailing slash is ignored when dispatching so "/images" will also be routed to a method registered with "/images/*" though if a separate registration is made for "/images" it will be matched in preference.

Named matches always take precedence over wildcards so you can register "/images/*" and "/images/counter.png" and the latter path will be routed to its preferred handler. Similarly you can register "*//*background.png" and "/home/background.png" but remember the '*' only matches a single path component! There is no way to match background.png in any directory.

call_wrapper(*environ*, *start_response*)
Alternative entry point for debugging

Although instances are callable you may use this method instead as your application's entry point when debugging.

This method will log the environ variables, the headers output by the application and all the data (in quoted-printable form) returned at DEBUG level.

It also catches a common error, that of returning something other than a string for a header value or in the generated output. These are logged at ERROR level and converted to strings before being passed to the calling framework.

static_page(*context*)
Returns a static page

This method can be bound to any path using *set_method()* and it will look in the *static_files* directory for that file. For example, if static_files is "/var/www/html" and the PATH_INFO variable in the request is "/images/logo.png" then the path "/var/www/html/images/logo.png" will be returned.

There are significant restrictions on the names of the path components. Each component *must* match a basic label syntax (equivalent to the syntax of domain labels in host names) except the last component which must have a single '.' separating two valid labels. This conservative syntax is designed to be safe for passing to file handling functions.

file_response(*context*, *target_path*)
Returns a file from the file system

target_path The system file path of the file to be returned.

The Content-Length header is set from the file size, the Last-Modified date is set from the file's st_mtime and the file's data is returned in chunks of *MAX_CHUNK* in the response.

The status is *not* set and must have been set before calling this method.

html_response(*context*, *data*)
Returns an HTML page

data A string containing the HTML page data. This may be a unicode or binary string.

The Content-Type header is set to text/html (with an explicit charset if data is a unicode string). The status is *not* set and must have been set before calling this method.

json_response(*context*, *data*)
Returns a JSON response

data A string containing the JSON data. This may be a unicode or binary string (encoded with utf-8).

The Content-Type is set to "application/json". The status is *not* set and must have been set before calling this method.

text_response(*context*, *data*)
Returns a plain text response

data A string containing the text data. This may be a unicode or binary string (encoded with US-ASCII).

The Content-Type is set to "text/plain" (with an explicit charset if a unicode string is passed). The status is *not* set and must have been set before calling this method.

Warning: do not encode unicode strings before passing them to this method as data, if you do you risk problems with non-ASCII characters as the default charset for text/plain is US-ASCII and not UTF-8 or ISO8859-1 (latin-1).

redirect_page(*context*, *location*, *code=303*)
Returns a redirect response

location A *URI* instance or a string of octets.

code (303) The redirect status code. As a reminder the typical codes are 301 for a permanent redirect, a 302 for a temporary redirect and a 303 for a temporary redirect following a POST request. This latter code is useful for implementing the widely adopted pattern of always redirecting the user after a successful POST request to prevent browsers prompting for re-submission and is therefore the default.

This method takes care of setting the status, the Location header and generating a simple HTML redirection page response containing a clickable link to *location*.

error_page(*context*, *code=500*, *msg=None*)
Generates an error response

code (500) The status code to send.

msg (None) An optional plain-text error message. If not given then the status line is echoed in the body of the response.

class pyslet.wsgi.**WSGIDataApp**(***kwargs*)
Bases: *pyslet.wsgi.WSGIApp*

Extends WSGIApp to include a data store

The key 'WSGIDataApp' is reserved for settings defined by this class in the settings file. The defined settings are:

container (None) The name of the container to use for the data store. By default, the default container is used. For future compatibility you should not depend on using this option.

metadata (None) URI of the metadata file containing the data schema. The file is assumed to be relative to the settings_file.

source_type ('sqlite') The type of data source to create. The default value is sqlite. A value of 'mysql' select's Pyslet's mysqldbds module instead.

sqlite_path ('database.sqlite3') URI of the database file. The file is assumed to be relative to the private_files directory, though an absolute path may be given.

dbhost ('localhost') For mysql databases, the hostname to connect to.

dname (None) The name of the database to connect to.

dbuser (None) The user name to connect to the database with.

dbpassword (None) The password to use in conjunction with dbuser

keynum ('0') The identification number of the key to use when storing encrypted data in the container.

secret (None) The key corresponding to keynum. The key is read in plain text from the settings file and must be provided in order to use the *app_cipher* for managing encrypted data. Derived classes could use an alternative mechanism for reading the key, for example, using the keyring python module.

cipher ('aes') The type of cipher to use. By default *AESAppCipher* is used which uses AES internally with a 256 bit key created by computing the SHA256 digest of the secret string. The only other supported value is 'plaintext' which does not provide any encryption but allows the app_cipher object to be used in cases where encryption may or may not be used depending on the deployment environment. For example, it is often useful to turn off encryption in a development environment!

when (None) An optional value indicating when the specified secret comes into operation. The value should be a fully specified time point in ISO format with timezone offset, such as '2015-01-01T09:00:00-05:00'. This value is used when the application is being restarted after a key change, for details see *AppCipher.change_key()*.

The use of AES requires the PyCrypto module to be installed.

classmethod add_options(*parser*)
Adds the following options:

-s, --sqlout	print the suggested SQL database schema and then exit. The setting of –create is ignored.
--create_tables	create tables in the database

-m. –memory Use an in-memory SQLite database. Overrides any source_type and encryption setting values . Implies –create_tables

metadata = None
the metadata document for the underlying data service

data_source = None
the data source object for the underlying data service the type of this object will vary depending on the source type. For SQL-type containers this will be an instance of a class derived from *SQLEntityContainer*

container = None
the entity container (cf database)

classmethod setup(*options=None*, *args=None*, ***kwargs*)
Adds database initialisation

Loads the *metadata* document. Creates the *data_source* according to the configured `settings` (creating the tables only if requested in the command line options). Finally sets the *container* to the entity container for the application.

If the -s or –sqlout option is given in options then the data source's create table script is output to standard output and sys.exit(0) is used to terminate the process.

classmethod new_app_cipher()
Creates an *AppCipher* instance

This method is called automatically on construction, you won't normally need to call it yourself but you may do so, for example, when writing a script that requires access to data encrypted by the application.

If there is no 'secret' defined then None is returned.

Reads the values from the settings file and creates an instance of the appropriate class based on the cipher setting value. The cipher uses the 'AppKeys' entity set in *container* to store information about expired keys. The AppKey entities have the following three properties:

KeyNum (integer key) The key identification number

KeyString (string) The *encrypted* secret, for example:

```
'1:OBimcmOesYOt021NuPXTP01MoBOCSgviOpIL'
```

The number before the colon is the key identification number of the secret used to encrypt the string (and will always be different from the KeyNum field of course). The data after the colon is the base-64 encoded encrypted string. The same format is used for all data enrypted by *AppCipher* objects. In this case the secret was the word 'secret' and the algorithm used is AES.

Expires (DateTime) The UTC time at which this secret will expire. After this time a newer key should be used for encrypting data though this key may of course still be used for decrypting data.

app_cipher = None
the application's cipher, a *AppCipher* instance.

class pyslet.wsgi.**Session**(*entity*)
Bases: object

A session object

A light wrapper for the entity object that is used to persist information on the server to make the user's browser session stateful. The session is persisted in a data store using a single entity passed on construction which must have the following required properties:

ID: Int32 A database key for the session, this value is never exposed to the client.

Established: Boolean A flag indicating that the session has been established. A session is established when we have successfully read the session id from a cookie sent by the browser. Tracking whether or not a session is established helps us defeat session fixation attacks.

UserKey: String This is the string used to set the cookie value

ServerKey: String This is a random string that can be used as a server-side secret specific to this session. It is never revealed to the browser

FirstSeen: DateTime The UTC time when the session started.

LastSeen: DateTime The UTC time of the last request issued in this session.

UserAgent: String The user agent string from the browser, if given.

Derived classes may add optional properties to the basic definition, including optional navigation properties, for their own data.

Changes to the entity are not written back to the database until the *commit()* method is called. This is done automatically by *SessionContext.start_response()*.

entity = None
the session's entity

new_from_context(*context*)
Initialises the entity's fields from a context

Generates new keys for UserKey and ServerKey.. The session is *not* marked as Established. The UserAgent is read from the context and FirstSeen and LastSeen values are set from the current time.

touch()
Indicates the session entity needs to be updated

If you change any of the entity field values directly you must call this method to ensure the entity is written out correctly before the response is returned.

sid()
Returns the UserKey field value

update_sid()
Generates a new UserKey value, and returns it.

seen()
Updates the LastSeen field with the current time.

expired(*timeout*)
Tests for session expiry.

timeout The maximum number of seconds that may have elapsed since the session was 'LastSeen'.

established()
Return True if this session is Established.

establish()
Marks this session as Established.

match_environ(*context*)
Compares the session environment with context

context The current context

The default implementation compares the user agent string to ensure that it is identical.

The purpose behind this check is to make it that little bit harder to carry out session hijacking or fixation. It doesn't add a lot to the security and is here because we might as well check the things we can - we do not rely on it to defeat this type of attack!

absorb(*new_session*)
Merge a session into this one.

new_session A session which was started in the same browser session as this one but (presumably) in a mode where cookies were blocked.

The purpose of this method is to merge information from the new session into this one. The default implementation simply deletes the new session.

commit()
Saves any changes back to the data store

pyslet.wsgi.**session_decorator**(*page_method*)
Decorates a web method with session handling

page_method An unbound method with signature: page_method(obj, context) which performs the WSGI protocol and returns the page generator.

Our decorator just calls `SessionContext.session_wrapper()`.

class pyslet.wsgi.**SessionContext**(*environ*, *start_response*)
Bases: *pyslet.wsgi.WSGIContext*

Extends the base class with a session object.

session = None
a session object, or None if no session available

start_response()
Commits changes to the session object.

If you call start_response with unsaved changes in the session the session's *Session.commit()* method is called to save them to the data store.

class pyslet.wsgi.**SessionApp**(***kwargs*)
Bases: *pyslet.wsgi.WSGIDataApp*

Extends WSGIDataApp to include session handling.

These sessions require support for cookies. The SessionApp class itself uses two cookies purely for session tracking.

The key 'SessionApp' is reserved for settings defined by this class in the settings file. The defined settings are:

timeout (600) The number of seconds after which an inactive session will time out and no longer be accessible to the client.

cookie ('sid') The name of the session cookie.

cookie_test ('ctest') The name of the test cookie. This cookie is set with a longer lifetime and acts both as a test of whether cookies are supported or not and can double up as an indicator of whether user consent has been obtained for any extended use of cookies. It defaults to the value '0', indicating that cookies can be stored but that no special consent has been obtained.

cookie_test_age (8640000) The age of the test cookie (in seconds). The default value is equivalent to 100 days. If you use the test cookie to record consent to some cookie policy you should ensure that when you set the value you use a reasonable lifespan.

csrftoken ('csrftoken') The name of the form field containing the CSRF token

session_set ('Sessions') The name of the entity set to use for persisting session entities.

classmethod setup(*options=None*, *args=None*, ***kwargs*)
Adds database initialisation

csrf_token = None
The name of our CSRF token

ContextClass
Extended context class

alias of *SessionContext*

SessionClass
The session class to use, must be (derived from) *Session*

alias of *Session*

init_dispatcher()
Adds pre-defined pages for this application

These pages are mapped to /ctest and /wlaunch. These names are not currently configurable. See *ctest()* and *wlaunch()* for more information.

set_session(*context*)
Sets the session object in the context

The session id is read from the session cookie, if no cookie is found a new session is created (and an appropriate cookie is added to the response headers).

set_session_cookie(*context*)
Adds the session ID cookie to the response headers

The cookie is bound to the path returned by *WSGIContext.get_app_root()* and is marked as being http_only and is marked secure if we have been accessed through an https URL.

You won't normally have to call this method but you may want to override it if your application wishes to override the cookie settings.

session_page(*context*, *page_method*, *return_path*)
Returns a session protected page

context The *WSGIContext* object

page_method A function or *bound* method that will handle the page. Must have the signature:

```
page_method(context)
```

and return the generator for the page as per the WSGI specification.

return_path A *pyslet.rfc2396.URI* instance pointing at the page that will be returned by page_method, used if the session is not established yet and a redirect to the test page needs to be implemented.

This method is only called *after* the session has been created, in other words, context.session must be a valid session.

This method either calls the page_method (after ensuring that the session is established) or initiates a redirection sequence which culminates in a request to return_path.

session_wrapper(*context*, *page_method*)
Called by the session_decorator

Uses *set_session()* to ensure the context has a session object. If this request is a POST then the form is parsed and the CSRF token checked for validity.

ctest_page(*context*, *target_url*, *return_url*, *sid*)
Returns the cookie test page

Called when cookies are blocked (perhaps in a frame).

context The request context

target_url A string containing the base link to the wlaunch page. This page can opened in a new window (which may get around the cookie restrictions). You must pass the return_url and the sid values as the 'return' and 'sid' query parameters respectively.

return_url A string containing the URL the user originally requested, and the location they should be returned to when the session is established.

sid The session id.

You may want to override this implementation to provide a more sophisticated page. The default simply constructs the URL to the wlaunch page and presents it as a simple hypertext link that will open in a new window.

A more sophisticated application might include a JavaScript to follow the link automatically if it detects that the page is being displayed in a frame.

cfail_page(*context*)
Called when cookies are blocked completely.

The default simply returns a plain text message stating that cookies are blocked. You may want to include a page here with information about how to enable cookies, a link to the privacy policy for your application to help people make an informed decision to turn on cookies, etc.

ctest(*context*)
The cookie test handler

This page takes three query parameters:

return The return URL the user originally requested

sid The session ID that should be received in a cookie

framed (optional) An optional parameter, if present and equal to '1' it means we've already attempted to load the page in a new window so if we still can't read cookies we'll return the *cfail_page()*.

If cookies cannot be read back from the context this page will call the *ctest_page()* to provide an opportunity to open the application in a new window (or *cfail_page()* if this possibility has already been exhausted.

If cookies are successfully read, they are compared with the expected values (from the query) and the user is returned to the return URL with an automatic redirect. The return URL must be within the same application (to prevent 'open redirect' issues) and, to be extra safe, we change the user-visible session ID as we've exposed the previous value in the URL which makes it more liable to snooping.

wlaunch(*context*)
Handles redirection to a new window

The redirection may be manual (by the user clicking a link) or it may have been automated using JavaScript - though this latter technique is liable to fall foul of pop-up blockers so should not be relied upon as the only method.

The query parameters must contain:

return The return URL the user originally requested

sid The session ID that should be received in a cookie

Typically, this page initiates the redirect sequence again, but this time setting the framed query parameter to prevent infinite redirection loops.

check_redirect(*context*, *target_path*)
Checks a target path for an open redirect

target_path A string or *URI* instance.

Returns True if the redirect is *safe*.

The test ensures that the canonical root of our application matches the canonical root of the target. In other words, it must have the same scheme and matching authority (host/port).

class pyslet.wsgi.**AppCipher**(*key_num*, *key*, *key_set*, *when=None*)
Bases: object

A cipher for encrypting application data

key_num A key number

key A binary string containing the application key.

key_set An entity set used to store previous keys. The entity set must have an integer key property 'KeyNum' and a string field 'KeyString'. The string field must be large enough to contain encrypted versions of previous keys.

when (None) A fully specified *pyslet.iso8601.TimePoint* at which time the key will become active. If None, the key is active straight away. Otherwise, the key_set is searched for a key that is still active and that key is used when encrypting data until the when time, at which point the given key takes over.

The object wraps an underlying cipher. Strings are encrypted using the cipher and then encoded using base64. The output is then prefixed with an ASCII representation of the key number (key_num) followed by a ':'. For example, if key_num is 7 and the cipher is plain-text (the default) then encrypt("Hello") results in:

```
"7:SGVsbG8="
```

When decrypting a string, the key number is parsed and matched against the key_num of the key currently in force. If the string was encrypted with a different key then the key_set is used to look up that key (which is itself encrypted of course). The process continues until a key encrypted with key_num is found.

The upshot of this process is that you can change the key associated with an application. See *change_key()* for details.

MAX_AGE = 100
the maximum age of a key, which is the number of times the key can be changed before the original key is considered too old to be used for decryption.

new_cipher(*key*)
Returns a new cipher object with the given key

The default implementation creates a plain-text 'cipher' and is not suitable for secure use.

change_key(*key_num*, *key*, *when*)
Changes the key of this application.

key_num The number given to the new key, must differ from the last *MAX_AGE* key numbers.

key A binary string containing the new application key.

when A fully specified *pyslet.iso8601.TimePoint* at which point the new key will come into effect.

Many organizations have a policy of changing keys on a routine basis, for example, to ensure that people who have had temporary access to the key only have temporary access to the data it protects. This method makes it easier to implement such a policy for applications that use the AppCipher class.

The existing key is encrypted with the new key and a record is written to the `key_set` to record the *existing* key number, the encrypted key string and the *when* time, which is treated as an expiry time in this context.

This procedure ensures that strings encrypted with an old key can always be decrypted because the value of the old key can be looked up. Although it is encrypted, it will be encrypted with a new(er) key and the procedure can be repeated as necessary until a key encrypted with the newest key is found.

The key change process then becomes:

1. Start a utility process connected to the application's entity container using the existing key and then call the change_key method. Pass a value for *when* that will give you time to reconfigure all AppCipher clients. Assuming the key change is planned, a time in hours or even days ahead can be used.
2. Update or reconfigure all existing applications so that they will be initialised with the new key and the same value for *when* next time they are restarted.
3. Restart/refresh all running applications before the change over time. As this does not need to be done simultaneously, a load balanced set of application servers can be cycled on a schedule to ensure continuous running).

Following a key change the entity container will still contain data encrypted with old keys and the architecture is such that compromise of a key is sufficient to read all encrypted data with that key and all previous keys. Therefore, changing the key only protects new data.

In situations where policy dictates a key change it might make sense to add a facility to the application for re-encrypting data in the data store by going through a read-decrypt/encrypt-write cycle with each protected data field. Of course, the old key could still be used to decrypt this information from archived backups of the data store. Alternatively, if the protected data is itself subject to change on a routine basis you may simply rely on the natural turnover of data in the application. The strategy you choose will depend on your application.

The *MAX_AGE* attribute determines the maximum number of keys that can be in use in the data set simultaneously. Eventually you will have to update encrypted data in the data store.

encrypt(*data*)
Encrypts data with the current key

decrypt(*data*)
Decrypts data

class pyslet.wsgi.**AESAppCipher**(*key_num*, *key*, *key_set*, *when=None*)
Bases: *pyslet.wsgi.AppCipher*

A cipher object that uses AES to encrypt the data

The Pycrypto module must be installed to use this class.

The key is hashed using the SHA256 algorithm to obtain a 32 byte value for the AES key. The encrypted strings contain random initialisation vectors so repeated calls won't generate the same encrypted values. The CFB mode of operation is used.

Utility Functions

pyslet.wsgi.**generate_key**(*key_length=128*)
Generates a new key

key_length The minimum key length in bits. Defaults to 128.

The key is returned as a sequence of 16 bit hexadecimal strings separated by '.' to make them easier to read and transcribe into other systems.

pyslet.wsgi.**key60**(*src*)
Generates a non-negative 60-bit long from a source string.

src A binary string.

The idea behind this function is to create an (almost) unique integer from a given string. The integer can then be used as the key field of an associated entity without having to create foreign keys that are long strings. There is of course a small chance that two source strings will result in the same integer.

The integer is calculated by truncating the SHA256 hexdigest to 15 characters (60-bits) and then converting to long. Future versions of Python promise improvements here, which would allow us to squeeze an extra 3 bits using int.from_bytes but alas, not in Python 2.x

Exceptions

If thrown while handling a WSGI request these errors will be caught by the underlying handlers and generate calls to to *WSGIApp.error_page()* with an appropriate 4xx response code.

class pyslet.wsgi.**BadRequest**
Bases: exceptions.Exception

An exception that will generate a 400 response code

class pyslet.wsgi.**PageNotAuthorized**
Bases: *pyslet.wsgi.BadRequest*

An exception that will generate a 403 response code

class pyslet.wsgi.**PageNotFound**
Bases: *pyslet.wsgi.BadRequest*

An exception that will generate a 404 response code

class pyslet.wsgi.**MethodNotAllowed**
Bases: *pyslet.wsgi.BadRequest*

An exception that will generate a 405 response code

Other sub-classes of Exception are caught and generate 500 errors:

class pyslet.wsgi.**SessionError**
Bases: exceptions.RuntimeError

Unexpected session handling error

6.2 XML: Basic Constructs

This module defines classes for working with XML documents. The version of the standard implemented is the Extensible Markup Language (Fifth Edition), for more info see: http://www.w3.org/TR/xml/

XML is an integral part of many standards for LET but Pyslet takes a slightly different approach from the pre-existing XML support in the Python language. XML elements are represented by instances of a basic *Element* class which can be used as a base class to customize document processing for specific types of XML document. It also allows these XML elements to 'come live' with additional methods and behaviours.

6.2.1 Documents

class pyslet.xml20081126.structures.**Node**(*parent*)
Bases: object

Base class for Element and Document shared attributes.

XML documents are defined hierarchicaly, each element has a parent which is either another element or an XML document.

parent = None
The parent of this element, for XML documents this attribute is used as a sentinel to simplify traversal of the hierarchy and is set to None.

GetChildren()
Returns an iterator over this object's children.

classmethod get_element_class(*name*)
Returns a class object suitable for representing element *name*

name is a unicode string representing the element name.

The default implementation returns None - for elements this has the effect of deferring the call to the parent document (where this method is overridden to return *Element*).

This method is called immediately prior to *ChildElement()* and (when applicable) *GetChildClass()*.

The real purpose of this method is to allow an element class to directly control the way the name of a child element maps to a class to represent it. You would normally override this method in the *Document* to map element names to classes but in some cases you may want to tweek the mapping at the individual element level. For example, if the same element name is used for two different purposes in the same XML document, although confusing, this is allowed in XML schema.

GetChildClass(*stag_class*)
Returns the element class implied by the STag for stag_class in this context.

This method is only called when the XMLParser.sgmlOmittag option is in effect. It is called prior to *ChildElement()* below and gives the context (the parent element or document) a chance to modify the child element that will be created (or reject it out-right, by returning None).

For well-formed XML documents the default implementation is sufficient as it simply returns *stag_class*.

The XML parser may pass None for *stag_class* indicating that PCDATA has been found in element content. This method should return the first child element that may contain (directly or indirectly) PCDATA or None if no children may contain PCDATA (or SGML-style omittag is not supported)

ChildElement(*childClass*, *name=None*)
Returns a new child of the given class attached to this object.

- **childClass is a class (or callable) used to create a new instance** of *Element*.
- **name is the name given to the element (by the caller). If no name** is given then the default name for the child is used. When the child returned is an existing instance, name is ignored.

ProcessingInstruction(*target*, *instruction=''*)
Abstract method for handling processing instructions encountered by the parser while parsing this object's content.

By default, processing instructions are ignored.

class pyslet.xml20081126.structures.**Document**(*root=None*, *baseURI=None*, *reqManager=None*, ***args*)
Bases: *pyslet.xml20081126.structures.Node*

Base class for all XML documents.

Initialises a new Document from optional keyword arguments.

With no arguments, a new Document is created with no baseURI or root element.

If root is a class object (descended from Element) it is used to create the root element of the document.

If root is an orphan instance of Element (i.e., it has no parent) is is used as the root element of the document and its *Element.AttachToDocument()* method is called.

baseURI can be set on construction (see SetBase) and a reqManager object can optionally be passed for managing and http(s) connections.

baseURI = None
The base uri of the document.

lang = None
The default language of the document.

declaration = None
The XML declaration (or None if no XMLDeclaration is used)

dtd = None
The dtd associated with the document.

root = None
The root element or None if no root element has been created yet.

GetChildren()
If the document has a root element it is returned in a single item list, otherwise an empty list is returned.

XMLParser(*entity*)
Returns an *XMLParser* instance suitable for parsing this type of document.

This method allows some document classes to override the parser used to parse them. This method is only used when parsing existing document instances (see *Read()* for more information).

Classes that override this method may still register themselves with *RegisterDocumentClass()* but if they do then the default *XMLParser* object will be used when the this document class is automatically created when parsing an unidentified XML stream.

classmethod get_element_class(*name*)
Returns a class object suitable for representing name

name is a unicode string representing the element name.

The default implementation returns Element.

ChildElement(*childClass*, *name=None*)
Creates the root element of the given document.

If there is already a root element it is detached from the document first using *Element.DetachFromDocument()*.

SetBase(*baseURI*)
Sets the baseURI of the document to the given URI.

baseURI should be an instance of *pyslet.rfc2396.URI* or an object that can be passed to its constructor.

Relative file paths are resolved relative to the current working directory immediately and the absolute URI is recorded as the document's *baseURI*.

GetBase()
Returns a string representation of the document's baseURI.

SetLang(*lang*)
Sets the default language for the document.

GetLang()
Returns the default language for the document.

ValidationError(*msg*, *element*, *data=None*, *aname=None*)
Called when a validation error is triggered by element.

This method is designed to be overriden to implement custom error handling or logging (which is likely to be added in future to this module).

msg contains a brief message suitable for describing the error in a log file. data and aname have the same meanings as Element.ValidationError.

Read(*src=None*, ***args*)
Reads this document, parsing it from a source stream.

With no arguments the document is read from the *baseURI* which must have been specified on construction or with a call to the *SetBase()* method.

You can override the document's baseURI by passing a value for *src* which may be an instance of *XMLEntity* or an object that can be passed as a valid source to its constructor.

Create(*dst=None*, ***args*)
Creates the Document.

Create outputs the document as an XML stream. The stream is written to the baseURI by default but if the 'dst' argument is provided then it is written directly to there instead. dst can be any object that supports the writing of unicode strings.

Currently only documents with file type baseURIs are supported. The file's parent directories are created if required. The file is always written using the UTF-8 as per the XML standard.

Update(***args*)
Updates the Document.

Update outputs the document as an XML stream. The stream is written to the baseURI which must already exist! Currently only documents with file type baseURIs are supported.

DiffString(*otherDoc*, *before=10*, *after=5*)
Compares this document to otherDoc and returns first point of difference.

pyslet.xml20081126.structures.**RegisterDocumentClass**(*doc_class*, *root_name*, *public_id=None*, *system_id=None*)
Registers a document class for use by `XMLParser.parse_document()`.

This module maintains a single table of document classes which can be used to identify the correct class to use to represent a document based on the information obtained from the DTD.

- ***doc_class*** is the class object being registered, it must be derived from `Document`
- ***root_name*** is the name of the root element or None if this class can be used with any root element.
- ***public_id*** is the public ID of the doctype, or None if any doctype can be used with this document class.
- ***system_id*** is the system ID of the doctype, this will usually be None indicating that the document class can match any system ID.

Characters

pyslet.xml20081126.structures.**IsChar**(*c*)
Tests if the character *c* matches the production for [2] Char.

If *c* is None IsChar returns False.

pyslet.xml20081126.structures.**IsDiscouraged**(*c*)
Tests if the character *c* is one of the characters discouraged in the specification.

Note that this test is currently limited to the range of unicode characters available in the narrow python build.

Common Syntactic Constructs

pyslet.xml20081126.structures.**is_s**(*c*)
Tests if a single character *c* matches production [3] S

pyslet.xml20081126.structures.**IsWhiteSpace**(*data*)
Tests if every character in *data* matches production [3] S

pyslet.xml20081126.structures.**ContainsS**(*data*)
Tests if data contains any characters matching production [3] S

pyslet.xml20081126.structures.**StripLeadingS**(*data*)
Returns data with leading S removed.

pyslet.xml20081126.structures.**NormalizeSpace**(*data*)
Returns data normalized according to the further processing rules for attribute-value normalization:

"...by discarding any leading and trailing space (#x20) characters, and by replacing sequences of space (#x20) characters by a single space (#x20) character"

pyslet.xml20081126.structures.**CollapseSpace**(*data*, *sMode=True*, *sTest=<function is_s>*)
Returns data with all spaces collapsed to a single space.

sMode determines the fate of any leading space, by default it is True and leading spaces are ignored provided the string has some non-space characters.

You can override the test of what consitutes a space by passing a function for sTest, by default we use is_s.

Note on degenerate case: this function is intended to be called with non-empty strings and will never *return* an empty string. If there is no data then a single space is returned (regardless of sMode).

pyslet.xml20081126.structures.**IsNameStartChar**(*c*)
Tests if the character *c* matches production [4] NameStartChar.

pyslet.xml20081126.structures.**IsNameChar**(*c*)
Tests if a single character *c* matches production [4a] NameChar

pyslet.xml20081126.structures.**IsValidName**(*name*)
Tests if name is a string matching production [5] Name

pyslet.xml20081126.structures.**IsReservedName**(*name*)
Tests if name is reserved for future standardization, e.g., if it begins with 'xml'.

pyslet.xml20081126.structures.**IsPubidChar**(*c*)
Tests if the character *c* matches production for [13] PubidChar.

Character Data and Markup

pyslet.xml20081126.structures.**EscapeCharData**(*src*, *quote=False*)
Returns a unicode string with XML reserved characters escaped.

We also escape return characters to prevent them being ignored. If quote is True then the string is returned as a quoted attribute value.

pyslet.xml20081126.structures.**EscapeCharData7**(*src*, *quote=False*)
Returns a unicode string with reserved and non-ASCII characters escaped.

CDATA Sections

pyslet.xml20081126.structures.**EscapeCDSect**(*src*)
Returns a unicode string enclosed in <!CDATA[[ ]]> with]]> by the clumsy sequence:]]>]]><!CDATA[[

Degenerate case: an empty string is returned as an empty string

Prolog and Document Type Declaration

class pyslet.xml20081126.structures.**XMLDTD**
Bases: object

An object that models a document type declaration.

The document type declaration acts as a container for the entity, element and attribute declarations used in a document.

name = None
The declared Name of the root element

parameterEntities = None
A dictionary of XMLParameterEntity instances keyed on entity name.

generalEntities = None
A dictionary of XMLGeneralEntity instances keyed on entity name.

notations = None
A dictionary of XMLNotation instances keyed on notation name.

elementList = None
A dictionary of *ElementType* definitions keyed on the name of element.

attributeLists = None
A dictionary of dictionaries, keyed on element name. Each of the resulting dictionaries is a dictionary of *XMLAttributeDefinition* keyed on attribute name.

DeclareEntity(*entity*)
Declares an entity in this document.

The same method is used for both general and parameter entities. The value of *entity* can be either an *XMLGeneralEntity* or an *XMLParameterEntity* instance.

GetParameterEntity(*name*)
Returns the parameter entity definition matching *name*.

Returns an instance of *XMLParameterEntity*. If no parameter has been declared with *name* then None is returned.

GetEntity(*name*)
Returns the general entity definition matching *name*.

Returns an instance of *XMLGeneralEntity*. If no general has been declared with *name* then None is returned.

DeclareNotation(*notation*)
Declares a notation for this document.

The value of *notation* must be a *XMLNotation* instance.

GetNotation(*name*)
Returns the notation declaration matching *name*.

Returns an instance of *XMLNotation*. If no notation has been declared with *name* then None is returned.

DeclareElementType(*etype*)
Declares an element type.

etype is an *ElementType* instance containing the element definition.

GetElementType(*element_name*)
Looks up an element type definition.

element_name is the name of the element type to look up

The method returns an instance of *ElementType* or None if no element with that name has been declared.

DeclareAttribute(*element_name*, *attributeDef*)
Declares an attribute.

- ***element_name*** is the name of the element type which should have this attribute applied
- ***attributeDef*** is an *XMLAttributeDefinition* instance describing the attribute being declared.

GetAttributeList(*name*)
Returns a dictionary of attribute definitions for the element type *name*.

If there are no attributes declared for this element type, None is returned.

GetAttributeDefinition(*element_name*, *attributeName*)
Looks up an attribute definition.

element_name is the name of the element type in which to search

attributeName is the name of the attribute to search for.

The method returns an instance of *XMLAttributeDefinition* or None if no attribute matching this description has been declared.

class pyslet.xml20081126.structures.**XMLDeclaration**(*version*, *encoding='UTF-8'*, *standalone=False*)

Bases: *pyslet.xml20081126.structures.XMLTextDeclaration*

Represents a full XML declaration.

Unlike the parent class, *XMLTextDeclaration*, the version is required. *standalone* defaults to False as this is the assumed value if there is no standalone declaration.

standalone = None

Whether an XML document is standalone.

6.2.2 Logical Structures

class pyslet.xml20081126.structures.**Element**(*parent*, *name=None*)

Bases: *pyslet.xml20081126.structures.Node*

Basic class that represents all XML elements.

Some aspects of the element's XML serialisation behaviour are controlled by special class attributes that can be set on derived classes.

XMLNAME the default name of the element the class represents.

XMLCONTENT the default content model of the element; one of the *ElementType* constants.

ID the name of the ID attribute if the element has a unique ID. With this class attribute set, ID handling is automatic (see *SetID()* and `id` below).

By default, attributes are simply stored as strings mapped in an internal dictionary. It is often more useful to map XML attributes on to python attributes, parsing and validating their values to python objects. This mapping can be provided using class attributes of the form XMLATTR_aname where aname is the name of the attribute as it would appear in the XML element start or empty element tag.

XMLATTR_aname=<string>

This form creates a simple mapping from the XML attribute 'aname' to a python attribute with a defined name. For example, you might want to create a mapping like this to avoid a python reserved word:

```
XMLATTR_class="styleClass"
```

This allows XML elements like this:

```
<element class="x"/>
```

To be parsed into python objects that behave like this:

```
element.styleClass=="x"      # True
```

If an instance is missing a python attribute corresponding to a defined XML attribute, or it's value has been set to None, then the XML attribute is omitted from the element's tag when generating XML output.

XMLATTR_aname=(<string>, decodeFunction, encodeFunction)

More complex attributes can be handled by setting XMLATTR_aname to a tuple. The first item is the python attribute name (as above); the *decodeFunction* is a simple callable that takes a string argument and returns the decoded value of the attribute and the *encodeFunction* performs the reverse transformation.

The encode/decode functions can be None to indicate a no-operation.

For example, you might want to create an integer attribute using something like:

```
<!-- source XML -->
<element apples="5"/>

# class attribute definition
XMLATTR_apples=('nApples',int,unicode)

# resulting object behaves like this...
element.nApples==5      # True
```

XMLATTR_aname=(<string>, decodeFunction, encodeFunction, type)

When XML attribute values are parsed from tags the optional *type* component of the tuple descriptor can be used to indicate a multi-valued attribute (for example, XML attributes defined using one of the plural forms, IDREFS, ENTITIES and NMTOKENS). If the *type* value is not None then the XML attribute value is first split by white-space, as per the XML specification, and then the decode function is applied to each resulting component. The instance attribute is then set depending on the value of *type*:

types.ListType

The instance attribute becomes a list, for example:

```
<!-- source XML -->
<element primes="2 3 5 7"/>

# class attribute definition
XMLATTR_primes=('primes',int,unicode)

# resulting object behaves like this...
element.primes==[2,3,5,7]       # True
```

types.DictType

The instance attribute becomes a dictionary mapping parsed values on to their frequency, for example:

```
<!-- source XML -->
<element fruit="apple pear orange pear"/>

# class attribute definition
XMLATTR_fruit=('fruit',None,None,types.DictType)

# resulting object behaves like this...
element.fruit=={'apple':1, 'orange':1, 'pear':2}        # True
```

In this case, the decode function (if given) must return a hashable object.

When creating XML output the reverse transformations are performed using the encode functions and the type (plain, list or dict) of the attribute's current value. The declared multi-valued type is ignored. For dictionary values the order of the output values may not be the same as the order originally read from the XML input.

Warning: Empty lists and dictionaries result in XML attribute values which are present but with empty strings. If you wish to omit these attributes in the output XML you must set the attribute value to None in the instance.

XMLAMAP XMLARMAP

Internally, the XMLATTR_* descriptors are parsed into two mappings. The XMLAMAP maps XML attribute names onto a tuple of:

(<python attribute name>, decodeFunction, type)

The XMLARMAP maps python attribute names onto a tuple of:

(<xml attribute name>, encodeFunction)

The mappings are created automatically as needed.

For legacy reasons, the multi-valued rules can also be invoked by setting an instance member to either a list or dictionary prior to parsing the instance from XML (e.g., in a constructor).

XML attribute names may contain many characters that are not legal in Python method names and automated attribute processing is not supported for these attributes. In practice, the only significant limitation is the colon. The common xml-prefixed attributes such as xml:lang are handled using special purposes methods.

XMLCONTENT = 2
for consistency with the behaviour of the default methods we claim to be mixed content

reset(*resetAttributes=False*)
Clears all attributes and (optional) children.

GetDocument()
Returns the document that contains the element.

If the element is an orphan, or is the descendent of an orphan then None is returned.

SetID(*id*)
Sets the id of the element, registering the change with the enclosing document.

If the id is already taken then XMLIDClashError is raised.

MangleAttributeName(*name*)
Returns a mangled attribute name, used when setting attributes.

If name cannot be mangled, None is returned.

UnmangleAttributeName(*mName*)
Returns an unmangled attribute name, used when getting attributes.

If mName is not a mangled name, None is returned.

GetAttributes()
Returns a dictionary object that maps attribute names onto values.

Each attribute value is represented as a (possibly unicode) string. Derived classes should override this method if they define any custom attribute setters.

The dictionary returned represents a copy of the information in the element and so may be modified by the caller.

SetAttribute(*name*, *value*)
Sets the value of an attribute.

If *value* is None then the attribute is removed or, if an XMLATTR_ mapping is in place its value is set to an empty list, dictionary or None as appropriate.

GetAttribute(*name*)
Gets the value of a single attribute as a string.

If the element has no attribute with *name* then KeyError is raised.

IsEmpty()
Returns True/False indicating whether this element *must* be empty.

If the class defines the XMLCONTENT attribute then the model is taken from there and this method returns True only if XMLCONTENT is XMLEmpty.

Otherwise, the method defaults to False

IsMixed()
Indicates whether or not the element *may* contain mixed content.

If the class defines the XMLCONTENT attribute then the model is taken from there and this method returns True only if XMLCONTENT is XMLMixedContent.

Otherwise, the method default ot True

GetChildren()
Returns an iterable of the element's children.

This method iterates through the internal list of children. Derived classes with custom factory elements MUST override this method.

Each child is either a string type, unicode string type or instance of Element (or a derived class thereof). We do not represent comments, processing instructions or other meta-markup.

GetCanonicalChildren()
A wrapper for *GetChildren()* that returns an iterable of the element's children canonicalized for white space.

We check the current setting of xml:space, returning the same list of children as *GetChildren()* if 'preserve' is in force. Otherwise we remove any leading space and collapse all others to a single space character.

ChildElement(*childClass*, *name=None*)
Returns a new child of the given class attached to this element.

A new child is created and attached to the element's model unless the model supports a single element of the given childClass and the element already exists, in which case the existing instance is returned.

childClass is a class (or callable) used to create a new instance.

name is the name given to the element (by the caller). If no name is given then the default name for the child is used. When the child returned is an existing instance, name is ignored.

The default implementation checks for a custom factory method and calls it if defined and does no further processing. A custom factory method is a method of the form ClassName or an attribute that is being used to hold instances of this child. The attribute must already exist and can be one of None (optional child, new child is created), a list (optional repeatable child, new child is created and appended) or an instance of childClass (required/existing child, no new child is created, existing instance returned).

When no custom factory method is found the class hierarchy of *childClass* is enumerated and the search continues for factory methods corresponding to these parent classes.

If no custom factory method is defined then the default processing simply creates an instance of child (if necessary) and attaches it to the internal list of children.

DeleteChild(*child*)
Deletes the given child from this element's children.

We follow the same factory conventions as for child creation except that an attribute pointing to a single child (of this class) will be replaced with None. If a custom factory method is found then the corresponding Delete_ClassName method must also be defined.

FindChildren(*childClass*, *childList*, *max=None*)
Finds up to max children of class childClass from the element and its children.

Deprecated in favour of list(FindChildrenDepthFirst(childClass,False))

All matching children are added to childList. If specifing a max number of matches then the incoming list must originally be empty to prevent early termination.

Note that if max is None, the default, then all children of the given class are returned with the proviso that nested matches are not included. In other words, if the model of childClass allows further elements of type childClass as children (directly or indirectly) then only the top-level match is returned.

Effectively this method provides a depth-first list of children. For example, to get all elements in an HTML <body> you would have to recurse over the resulting list calling FindChildren again until the list of matching children stops growing.

FindChildrenBreadthFirst(*childClass*, *subMatch=True*, *maxDepth=1000*)
A generator method that iterates over children of class *childClass* using a breadth first scan.

childClass may also be a tuple as per the definition of the builtin isinstance function in python.

If *subMatch* is True (the default) then matching elements are also scanned for nested matches. If False, only the outer-most matching element is returned.

maxDepth controls the depth of the scan with level 1 indicating direct children only. It must be a positive integer and defaults to 1000.

Warning: to reduce memory requirements when searching large documents this method performs a two-pass scan of the element's children, i.e., `GetChildren()` will be called twice.

Given that XML documents tend to be broader than they are deep `FindChildrenDepthFirst()` is a better method to use for general purposes.

FindChildrenDepthFirst(*childClass*, *subMatch=True*, *maxDepth=1000*)
A generator method that iterates over children of class *childClass* using a depth first scan.

childClass may also be a tuple as per the definition of the builtin isinstance function in python.

If *subMatch* is True (the default) then matching elements are also scanned for nested matches. If False, only the outer-most matching element is returned.

maxDepth controls the depth of the scan with level 1 indicating direct children only. It must be a positive integer and defaults to 1000.

FindParent(*parentClass*)
Finds the first parent of class parentClass of this element.

If this element has no parent of the given class then None is returned.

AttachToParent(*parent*)
Called to attach an orphan element to a parent.

This method does not do any special handling of child elements, the caller takes responsibility for ensuring that this element will be returned by future calls to parent.GetChildren(). However, `AttachToDocument()` is called to ensure id registrations are made.

AttachToDocument(*doc=None*)
Called when the element is first attached to a document.

The default implementation ensures that any ID attributes belonging to this element or its descendents are registered.

DetachFromParent()
Called to detach an element from its parent, making it an orphan

This method does not do any special handling of child elements, the caller takes responsibility for ensuring that this element will no longer be returned by future calls to parent.GetChildren(). However, *DetachFromDocument()* is called to ensure id registrations are removed.

DetachFromDocument(*doc=None*)
Called when an element is being detached from a document.

The default implementation ensures that any ID attributes belonging to this element or its descendents are unregistered.

AddData(*data*)
Adds a string or unicode string to this element's children.

This method raises a ValidationError if the element cannot take data children.

content_changed()
Notifies an element that its content has changed.

The default implementation tidies up the list of children to make future comparisons simpler and faster.

GenerateValue(*ignoreElements=False*)
A generator function that returns the strings that compromise this element's value (useful when handling elements that contain a large amount of data). For more information see *GetValue()*. Note that:

```
string.join(e.GenerateValue(),u'')==e.GetValue()
```

GetValue(*ignoreElements=False*)
By default, returns a single unicode string representing the element's data.

The default implementation is only supported for elements where mixed content is permitted (*IsMixed()*). It uses *GetChildren()* to iterate through the children.

If the element is empty an empty string is returned.

Derived classes may return more complex objects, such as values of basic python types or class instances, performing validation based on application-defined rules.

If the element contains child elements then XMLMixedContentError is raised. You can pass *ignoreElements* as True to override this behaviour in the unlikely event that you want:

```
<!-- elements like this... -->
<data>This is <em>the</em> value</data>

# to behave like this:
data.GetValue(True)==u"This is  value"
```

SetValue(*value*)
Replaces the value of the element with the (unicode) value.

The default implementation is only supported for elements where mixed content is permitted (*IsMixed()*) and only affects the internally maintained list of children. Elements with more complex mixed models MUST override this method.

If *value* is None then the element becomes empty.

Derived classes may allow more complex values to be set, such as values of basic python types or class instances depending on the element type being represented in the application.

ValidationError(*msg*, *data=None*, *aname=None*)
Indicates that a validation error occurred in this element.

An error message indicates the nature of the error.

The data that caused the error may be given in data.

Furthermore, the attribute name may also be given indicating that the offending data was in an attribute of the element and not the element itself.

SortNames(*nameList*)
Given a list of element or attribute names, sorts them in a predictable order

The default implementation assumes that the names are strings or unicode strings so uses the default sort method.

Copy(*parent=None*)
Creates a new instance of this element which is a deep copy of this one.

parent is the parent node to attach the new element to. If it is None then a new orphan element is created.

This method mimics the process of serialisation and deserialisation (without the need to generate markup). As a result, element attributes are serialised and deserialised to strings during the copy process.

GetBase()
Returns the value of the xml:base attribute as a string.

SetBase(*base*)
Sets the value of the xml:base attribute from a string.

Changing the base of an element effects the interpretation of all relative URIs in this element and its children.

ResolveBase()
Returns a fully specified URI for the base of the current element.

The URI is calculated using any xml:base values of the element or its ancestors and ultimately relative to the baseURI.

If the element is not contained by a Document, or the document does not have a fully specified baseURI then the return result may be a relative path or even None, if no base information is available.

ResolveURI(*uriref*)
Resolves a URI reference in the current context.

uriref A *pyslet.rfc2396.URI* instance or a string

The argument is resolved relative to the xml:base values of the element's ancestors and ultimately relative to the document's baseURI. Ther result may still be a relative URI, there may be no base set or the base may only be known in relative terms.

RelativeURI(*href*)
Returns href expressed relative to the element's base.

If href is a relative URI then it is converted to a fully specified URL by interpreting it as being the URI of a file expressed relative to the current working directory.

If the element does not have a fully-specified base URL then href is returned as a fully-specified URL itself.

GetLang()
Returns the value of the xml:lang attribute as a string.

SetLang(*lang*)
Sets the value of the xml:lang attribute from a string.

See *ResolveLang()* for how to obtain the effective language of an element.

ResolveLang()
Returns the effective language for the current element.

The language is resolved using the xml:lang value of the element or its ancestors. If no xml:lang is in effect then None is returned.

PrettyPrint()
Indicates if this element's content should be pretty-printed.

This method is used when formatting XML files to text streams. The behaviour can be affected by the xml:space attribute or by derived classes that can override the default behaviour.

If this element has xml:space set to 'preserve' then we return False. If self.parent.PrettyPrint() returns False then we return False.

Otherwise we return False if we know the element is (or should be) mixed content, True otherwise.

Note: an element of undetermined content model that contains only elements and white space *is* pretty printed.

WriteXMLAttributes(*attributes*, *escapeFunction=<function EscapeCharData>*, *root=False*)
Adds strings representing the element's attributes

attributes is a list of unicode strings. Attributes should be appended as strings of the form 'name="value"' with values escaped appropriately for XML output.

GenerateXML(*escapeFunction=<function EscapeCharData>*, *indent=''*, *tab='\t'*, *root=False*)
A generator function that returns strings representing the serialised version of this element:

```
# the element's serialised output can be obtained as a single string
string.join(e.GenerateXML(),'')
```

class pyslet.xml20081126.structures.**ElementType**
Bases: object

An object for representing element type definitions.

Any = 1
Content type constant for EMPTY

Mixed = 2
Content type constant for ANY

ElementContent = 3
Content type constant for mixed content

SGMLCDATA = 4
Content type constant for element content

name = None
The name of this element

contentType = None
The content type of this element, one of the constants defined above.

contentModel = None
A *XMLContentParticle* instance which contains the element's content model or None in the case of EMPTY or ANY declarations.

particleMap = None
A mapping used to validate the content model during parsing. It maps the name of the first child element found to a list of *XMLNameParticle* instances that can represent it in the content model. For more information see *XMLNameParticle.particleMap*.

BuildModel()
Builds internal strutures to support model validation.

IsDeterministic()
Tests if the content model is deterministic.

For degenerates cases (elements declared with ANY or EMPTY) the method always returns True.

class pyslet.xml20081126.structures.**XMLContentParticle**
Bases: object

An object for representing content particles.

ZeroOrOne = 1
Occurrence constant for '?'

OneOrMore = 3
Occurrence constant for '+'

occurrence = None
One of the occurrence constants defined above.

BuildParticleMaps(*exitParticles*)
Abstract method that builds the particle maps for this node or its children.

For more information see *XMLNameParticle.particleMap*.

Although only name particles have particle maps this method is called for all particle types to allow the model to be built hierarchically from the root out to the terminal (name) nodes. *exitParticles* provides a mapping to all the following particles outside the part of the hierarchy rooted at the current node that are directly reachable from the particles inside.

SeekParticles(*pMap*)
Abstract method that adds all possible entry particles to pMap.

pMap is a mapping from element name to a list of XMLNameParticles XMLNameParticle.

Returns True if a required particle was added, False if all particles added are optional.

Like *BuildParticleMaps()*, this method is called for all particle types. The mappings requested represent all particles inside the part of the hierarchy rooted at the current node that are directly reachable from the preceeding particles outside.

AddParticles(*srcMap*, *pMap*)
A utility method that adds particles from srcMap to pMap.

Both maps are mappings from element name to a list of XMLNameParticles XMLNameParticle. All entries in *srcMap* not currently in *pMap* are added.

IsDeterministic(*pMap*)
A utility method for identifying deterministic particle maps.

A deterministic particle map is one in which name maps uniquely to a single content particle. A non-deterministic particle map contains an ambiguity, for example ((b,d)|(b,e)). The particle map created by *SeekParticles()* for the enclosing choice list is would have two entries for 'b', one to map the first particle of the first sequence and one to the first particle of the second sequence.

Although non-deterministic content models are not allowed in SGML they are tolerated in XML and are only flagged as compatibility errors.

class pyslet.xml20081126.structures.**XMLNameParticle**
Bases: *pyslet.xml20081126.structures.XMLContentParticle*

An object representing a content particle for a named element in the grammar

name = None
the name of the element type that matches this particle

particleMap = None
Each *XMLNameParticle* has a particle map that maps the name of the 'next' element found in the content model to the list of possible XMLNameParticles XMLNameParticle that represent it in the content model.

The content model can be traversed using ContentParticleCursor.

class pyslet.xml20081126.structures.**XMLChoiceList**
Bases: *pyslet.xml20081126.structures.XMLContentParticle*

An object representing a choice list of content particles in the grammar

class pyslet.xml20081126.structures.**XMLSequenceList**
Bases: *pyslet.xml20081126.structures.XMLContentParticle*

An object representing a sequence list of content particles in the grammar

class pyslet.xml20081126.structures.**XMLAttributeDefinition**
Bases: object

An object for representing attribute declarations.

CData = 0
Type constant representing CDATA

ID = 1
Type constant representing ID

IDRef = 2
Type constant representing IDREF

IDRefs = 3
Type constant representing IDREFS

Entity = 4
Type constant representing ENTITY

Entities = 5
Type constant representing ENTITIES

NmToken = 6
Type constant representing NMTOKEN

NmTokens = 7
Type constant representing NMTOKENS

Notation = 8
Type constant representing NOTATION

Implied = 0
Presence constant representing #IMPLIED

Required = 1
Presence constant representing #REQUIRED

Fixed = 2
Presence constant representing #FIXED

Default = 3
Presence constant representing a declared default value

entity = None
the entity in which this attribute was declared

name = None
the name of the attribute

type = None
One of the above type constants

values = None
An optional dictionary of values

defaultValue = None
An optional default value

6.2.3 Physical Structures

class pyslet.xml20081126.structures.**XMLEntity**(*src=None*, *encoding=None*, *reqManager=None*)

Bases: object

An object representing an entity.

This object serves two purposes, it acts as both the object used to store information about declared entities and also as a parser for feeding unicode characters to the main XMLParser.

Optional *src*, *encoding* and *reqManager* parameters can be provided, if src is not None then these parameters are used to open the entity reader immediately using one of the Open methods described below.

src may be a unicode string, a byte string, an instance of *pyslet.rfc2396.URI* or any object that supports file-like behaviour. If using a file, the file must support seek behaviour.

location = None
the location of this entity (used as the base URI to resolve relative links)

mimetype = None
the mime type of the entity, if known, or None

encoding = None
the encoding of the entity (text entities)

charSource = None
A unicode data reader used to read characters from the entity. If None, then the entity is closed.

bom = None
flag to indicate whether or not the byte order mark was detected. If detected the flag is set to True. An initial byte order mark is not reported in *the_char* or by the *next_char()* method.

the_char = None
the character at the current position in the entity

lineNum = None
the current line number within the entity (first line is line 1)

linePos = None
the current character position within the entity (first char is 1)

buffText = None
used by XMLParser.push_entity()

ChunkSize = 4096
Characters are read from the dataSource in chunks. The default chunk size is 4KB.

In fact, in some circumstances the entity reader starts more cautiously. If the entity reader expects to read an XML or Text declaration, which may have an encoding declaration then it reads one character at a time

until the declaration is complete. This allows the reader to change to the encoding in the declaration without causing errors caused by reading too many characters using the wrong codec. See *ChangeEncoding()* and *KeepEncoding()* for more information.

GetName()
Abstract method to return a name to represent this entity in logs and error messages.

IsExternal()
Returns True if this is an external entity.

The default implementation returns True if *location* is not None, False otherwise.

Open()
Opens the entity for reading.

The default implementation uses *OpenURI()* to open the entity from *location* if available, otherwise it raises UnimplementedError.

IsOpen()
Returns True if the entity is open for reading.

OpenUnicode(*src*)
Opens the entity from a unicode string.

OpenString(*src*, *encoding=None*)
Opens the entity from a byte string.

The optional *encoding* is used to convert the string to unicode and defaults to None - meaning that the auto-detection method will be applied.

The advantage of using this method instead of converting the string to unicode and calling *OpenUnicode()* is that this method creates a unicode reader object to parse the string instead of making a copy of it in memory.

OpenFile(*src*, *encoding='utf-8'*)
Opens the entity from an existing (open) binary file.

The optional *encoding* provides a hint as to the intended encoding of the data and defaults to UTF-8. Unlike other Open* methods we do not assume that the file is seekable however, you may set encoding to None for a seekable file thus invoking auto-detection of the encoding.

OpenURI(*src*, *encoding=None*, *reqManager=None*)
Opens the entity from a URI passed in *src*.

The file, http and https schemes are the only ones supported.

The optional *encoding* provides a hint as to the intended encoding of the data and defaults to UTF-8. For http(s) resources this parameter is only used if the charset cannot be read successfully from the HTTP headers.

The optional *reqManager* allows you to pass an existing instance of *pyslet.http.client.Client* for handling URI with http or https schemes.

OpenHTTPResponse(*src*, *encoding='utf-8'*)
Opens the entity from an HTTP response passed in *src*.

The optional *encoding* provides a hint as to the intended encoding of the data and defaults to UTF-8. This parameter is only used if the charset cannot be read successfully from the HTTP response headers.

reset()
Resets an open entity, causing it to return to the first character in the entity.

GetPositionStr()
Returns a short string describing the current line number and character position.

For example, if the current character is pointing to character 6 of line 4 then it will return the string 'Line 4.6'

next_char()
Advances to the next character in an open entity.

This method takes care of the End-of-Line handling rules for XML which force us to remove any CR characters and replace them with LF if they appear on their own or to silenty drop them if they appear as part of a CR-LF combination.

AutoDetectEncoding(*srcFile*)
Auto-detects the character encoding in *srcFile*.

Should only be called for seek-able streams opened in binary mode.

ChangeEncoding(*encoding*)
Changes the encoding used to interpret the entity's stream.

In many cases we can only guess at the encoding used in a file or other byte stream. However, XML has a mechanism for declaring the encoding as part of the XML or Text declaration. This declaration can typically be parsed even if the encoding has been guessed incorrectly initially. This method allows the XML parser to notify the entity that a new encoding has been declared and that future characters should be interpreted with this new encoding.

You can only change the encoding once. This method calls *KeepEncoding()* once the encoding has been changed.

KeepEncoding()
Tells the entity parser that the encoding will not be changed again.

This entity parser starts in a cautious mode, parsing the entity one character a time to avoid errors caused by buffering with the wrong encoding. This method should be called once the encoding is determined so that the entity parser can use its internal character buffer.

NextLine()
Called when the entity reader detects a new line.

This method increases the internal line count and resets the character position to the beginning of the line. You will not normally need to call this directly as line handling is done automatically by *next_char()*.

close()
Closes the entity.

class pyslet.xml20081126.structures.**XMLGeneralEntity**(*name=None*, *definition=None*, *notation=None*)
Bases: pyslet.xml20081126.structures.XMLDeclaredEntity

An object for representing general entities.

A general entity can be constructed with an optional *name*, *definition* and *notation*, used to initialise the following fields.

notation = None
the notation name for external unparsed entities

GetName()
Returns the name of the entity formatted as a general entity reference.

class pyslet.xml20081126.structures.**XMLParameterEntity**(*name=None*, *definition=None*)
Bases: pyslet.xml20081126.structures.XMLDeclaredEntity

An object for representing parameter entities.

A parameter entity can be constructed with an optional *name* and *definition*, used to initialise the following two fields.

next_char()
Overrridden to provide trailing space during special parameter entity handling.

OpenAsPE()
Opens the parameter entity for reading in the context of a DTD.

This special method implements the rule that the replacement text of a parameter entity, when included as a PE, must be enlarged by the attachment of a leading and trailing space.

GetName()
Returns the name of the entity formatted as a parameter entity reference.

class pyslet.xml20081126.structures.**XMLExternalID**(*public=None*, *system=None*)
Bases: object

Used to represent external references to entities.

Returns an instance of XMLExternalID. One of *public* and *system* should be provided.

get_location(*base=None*)
Returns the absolute URI where the external entity can be found.

Returns a *pyslet.rfc2396.URI* resolved against base if applicable. If there is no system identifier then None is returned.

class pyslet.xml20081126.structures.**XMLTextDeclaration**(*version='1.0'*, *encoding='UTF-8'*)
Bases: object

Represents the text components of an XML declaration.

Both *version* and *encoding* are optional, though one or other are required depending on the context in which the declaration will be used.

class pyslet.xml20081126.structures.**XMLNotation**(*name*, *external_id*)
Bases: object

Represents an XML Notation

Returns an XMLNotation instance.

external_id is a *XMLExternalID* instance in which one of *public* or *system* must be provided.

name = None
the notation name

external_id = None
the external ID of the notation (an XMLExternalID instance)

Character Classes

pyslet.xml20081126.structures.**IsLetter**(*c*)
Tests if the character *c* matches production [84] Letter.

pyslet.xml20081126.structures.**IsBaseChar**(*c*)
Tests if the character *c* matches production [85] BaseChar.

pyslet.xml20081126.structures.**IsIdeographic**(*c*)
Tests if the character *c* matches production [86] Ideographic.

pyslet.xml20081126.structures.**IsCombiningChar**(*c*)
Tests if the character *c* matches production [87] CombiningChar.

pyslet.xml20081126.structures.**is_digit**(*c*)
Tests if the character *c* matches production [88] Digit.

pyslet.xml20081126.structures.**IsExtender**(*c*)
Tests if the character *c* matches production [89] Extender.

6.3 XML: Parsing XML Documents

This module exposes a number of internal functions typically defined privately in XML parser implementations which make it easier to reuse concepts from XML in other modules. For example, the `IsNameStartChar()` tells you if a character matches the production for NameStartChar in the XML standard.

class pyslet.xml20081126.parser.**XMLParser**(*entity*)
Bases: pyslet.pep8.PEP8Compatibility

An XMLParser object

entity The *XMLEntity* to parse.

XMLParser objects are used to parse entities for the constructs defined by the numbered productions in the XML specification.

XMLParser has a number of optional attributes, all of which default to False. Attributes with names started 'check' increase the strictness of the parser. All other parser flags, if set to True, will not result in a conforming XML processor.

DocumentClassTable = {}
A dictionary mapping doctype parameters onto class objects.

For more information about how this is used see *get_document_class()* and *RegisterDocumentClass()*.

RefModeNone = 0
Default constant used for setting *refMode*

RefModeInContent = 1
Treat references as per "in Content" rules

RefModeInAttributeValue = 2
Treat references as per "in Attribute Value" rules

RefModeAsAttributeValue = 3
Treat references as per "as Attribute Value" rules

RefModeInEntityValue = 4
Treat references as per "in EntityValue" rules

RefModeInDTD = 5
Treat references as per "in DTD" rules

PredefinedEntities = {'amp': '&', 'lt': '<', 'gt': '>', 'apos': "'", 'quot': '"'}
A mapping from the names of the predefined entities (lt, gt, amp, apos, quot) to their replacement characters.

checkValidity = None
checks XML validity constraints If *checkValidity* is True, and all other options are left at their default (False) setting then the parser will behave as a validating XML parser.

valid = None
Flag indicating if the document is valid, only set if *checkValidity* is True

nonFatalErrors = None
A list of non-fatal errors discovered during parsing, only populated if *checkValidity* is True

checkCompatibility = None
checks XML compatibility constraints; will cause *checkValidity* to be set to True when parsing

checkAllErrors = None
checks all constraints; will cause *checkValidity* and *checkCompatibility* to be set to True when parsing.

raiseValidityErrors = None
treats validity errors as fatal errors

dontCheckWellFormedness = None
provides a loose parser for XML-like documents

unicodeCompatibility = None
See http://www.w3.org/TR/unicode-xml/

sgmlNamecaseGeneral = None
option that simulates SGML's NAMECASE GENERAL YES

sgmlNamecaseEntity = None
option that simulates SGML's NAMECASE ENTITY YES

sgmlOmittag = None
option that simulates SGML's OMITTAG YES

sgmlShorttag = None
option that simulates SGML's SHORTTAG YES

sgmlContent = None
This option simulates some aspects of SGML content handling based on class attributes of the element being parsed.

Element classes with XMLCONTENT=:py:data:*XMLEmpty* are treated as elements declared EMPTY, these elements are treated as if they were introduced with an empty element tag even if they weren't, as per SGML's rules. Note that this SGML feature "has nothing to do with markup minimization" (i.e., *sgmlOmittag*.)

refMode = None
The current parser mode for interpreting references.

XML documents can contain five different types of reference: parameter entity, internal general entity, external parsed entity, (external) unparsed entity and character entity.

The rules for interpreting these references vary depending on the current mode of the parser, for example, in content a reference to an internal entity is replaced, but in the definition of an entity value it is not. This means that the behaviour of the *parse_reference()* method will differ depending on the mode.

The parser takes care of setting the mode automatically but if you wish to use some of the parsing methods in isolation to parse fragments of XML documents, then you will need to set the *refMode* directly using one of the RefMode* family of constants defined above.

entity = None
The current entity being parsed

the_char = None
the current character; None indicates end of stream

declaration = None
The declaration being parsed or None

dtd = None
The documnet type declaration of the document being parsed. This member is initialised to None as well-formed XML documents are not required to have an associated dtd.

doc = None
The document being parsed

docEntity = None
The document entity

element = None
The current element being parsed

elementType = None
The element type of the current element

get_context()
Returns the parser's context

This is either the current element or the document if no element is being parsed.

next_char()
Moves to the next character in the stream.

The current character can always be read from *the_char*. If there are no characters left in the current entity then entities are popped from an internal entity stack automatically.

buff_text(*unused_chars*)
Buffers characters that have already been parsed.

unused_chars A string of characters to be pushed back to the parser in the order in which they are to be parsed.

This method enables characters to be pushed back into the parser forcing them to be parsed next. The current character is saved and will be parsed (again) once the buffer is exhausted.

push_entity(*entity*)
Starts parsing an entity

entity An *XMLEntity* instance which is to be parsed.

the_char is set to the current character in the entity's stream. The current entity is pushed onto an internal stack and will be resumed when this entity has been parsed completely.

Note that in the degenerate case where the entity being pushed is empty (or is already positioned at the end of the file) then push_entity does nothing.

check_encoding(*entity*, *declared_encoding*)
Checks the entity against the declared encoding

entity An *XMLEntity* instance which is being parsed.

declared_encoding A string containing the declared encoding in any declaration or None if there was no declared encoding in the entity.

get_external_entity()
Returns the external entity currently being parsed.

If no external entity is being parsed then None is returned.

standalone()
True if the document should be treated as standalone.

A document may be declared standalone or it may effectively be standalone due to the absence of a DTD, or the absence of an external DTD subset and parameter entity references.

declared_standalone()
True if the current document was declared standalone.

well_formedness_error(*msg='well-formedness error'*, *error_class=<class 'pyslet.xml20081126.structures.XMLWellFormedError'>*)
Raises an XMLWellFormedError error.

msg An optional message string

error_class an optional error class which must be a class object derived from py:class:*XMLWellFormednessError*.

Called by the parsing methods whenever a well-formedness constraint is violated.

The method raises an instance of *error_class* and does not return. This method can be overridden by derived parsers to implement more sophisticated error logging.

validity_error(*msg='validity error'*, *error=<class 'pyslet.xml20081126.structures.XMLValidityError'>*)
Called when the parser encounters a validity error.

msg An optional message string

error An optional error class or instance which must be a (class) object derived from py:class:*XMLValidityError*.

The behaviour varies depending on the setting of the *checkValidity* and *raiseValidityErrors* options. The default (both False) causes validity errors to be ignored. When checking validity an error message is logged to *nonFatalErrors* and *valid* is set to False. Furthermore, if *raiseValidityErrors* is True *error* is raised (or a new instance of *error* is raised) and parsing terminates.

This method can be overridden by derived parsers to implement more sophisticated error logging.

compatibility_error(*msg='compatibility error'*)
Called when the parser encounters a compatibility error.

msg An optional message string

The behaviour varies depending on the setting of the *checkCompatibility* flag. The default (False) causes compatibility errors to be ignored. When checking compatibility an error message is logged to *nonFatalErrors*.

This method can be overridden by derived parsers to implement more sophisticated error logging.

processing_error(*msg='Processing error'*)
Called when the parser encounters a general processing error.

msg An optional message string

The behaviour varies depending on the setting of the *checkAllErrors* flag. The default (False) causes processing errors to be ignored. When checking all errors an error message is logged to *nonFatalErrors*.

This method can be overridden by derived parsers to implement more sophisticated error logging.

parse_literal(*match*)
Parses an optional literal string.

match The literal string to match

Returns True if *match* is successfully parsed and False otherwise. There is no partial matching, if *match* is not found then the parser is left in its original position.

parse_required_literal(*match*, *production='Literal String'*)
Parses a required literal string.

match The literal string to match

production An optional string describing the context in which the literal was expected.

There is no return value. If the literal is not matched a wellformed error is generated.

parse_decimal_digits()
Parses a, possibly empty, string of decimal digits.

Decimal digits match [0-9]. Returns the parsed digits as a string or an *empty string* if no digits were matched.

parse_required_decimal_digits(*production='Digits'*)
Parses a required sring of decimal digits.

production An optional string describing the context in which the decimal digits were expected.

Decimal digits match [0-9]. Returns the parsed digits as a string.

parse_hex_digits()
Parses a, possibly empty, string of hexadecimal digits

Hex digits match [0-9a-fA-F]. Returns the parsed digits as a string or an *empty string* if no digits were matched.

parse_required_hex_digits(*production='Hex Digits'*)
Parses a required string of hexadecimal digits.

production An optional string describing the context in which the hexadecimal digits were expected.

Hex digits match [0-9a-fA-F]. Returns the parsed digits as a string.

parse_quote(*q=None*)
Parses the quote character

q An optional character to parse as if it were a quote. By default either one of “”” or “”” is accepted.

Returns the character parsed or raises a well formed error.

parse_document(*doc=None*)
[1] document: parses a Document.

doc The *Document* instance that will be parsed. The declaration, dtd and elements are added to this document. If *doc* is None then a new instance is created using *get_document_class()* to identify the correct class to use to represent the document based on information in the prolog or, if the prolog lacks a declaration, the root element.

This method returns the document that was parsed, an instance of *Document*.

get_document_class(*dtd*)
Returns a class object suitable for this dtd

dtd A *XMLDTD* instance

Returns a *class* object derived from *Document* suitable for representing a document with the given document type declaration.

In cases where no doctype declaration is made a dummy declaration is created based on the name of the root element. For example, if the root element is called “database” then the dtd is treated as if it was declared as follows:

```
<!DOCTYPE database>
```

This default implementation uses the following three pieces of information to locate a class registered with *RegisterDocumentClass()*. The PublicID, SystemID and the name of the root element. If an exact match is not found then wildcard matches are attempted, ignoring the SystemID, PublicID and finally the root element in turn. If a document class still cannot be found then wildcard matches are tried matching *only* the PublicID, SystemID and root element in turn.

If no document class cab be found, *Document* is returned.

is_s()
Tests if the current character matches S

Returns a boolean value, True if S is matched.

By default calls *is_s()*

In Unicode compatibility mode the function maps the unicode white space characters at code points 2028 and 2029 to line feed and space respectively.

parse_s()
[3] S

Parses white space returning it as a string. If there is no white space at the current position then an *empty string* is returned.

The productions in the specification do not make explicit mention of parameter entity references, they are covered by the general statement that "Parameter entity references are recognized anwhere in the DTD..." In practice, this means that while parsing the DTD, anywhere that an S is permitted a parameter entity reference may also be recognized. This method implements this behaviour, recognizing parameter entity references within S when *refMode* is *RefModeInDTD*.

parse_required_s(*production='[3] S'*)
[3] S: Parses required white space

production An optional string describing the production being parsed. This allows more useful errors than simply 'expected [3] S' to be logged.

If there is no white space then a well-formedness error is raised.

parse_name()
[5] Name

Parses an optional name. The name is returned as a unicode string. If no Name can be parsed then None is returned.

parse_required_name(*production='Name'*)
[5] Name

production An optional string describing the production being parsed. This allows more useful errors than simply 'expected [5] Name' to be logged.

Parses a required Name, returning it as a string. If no name can be parsed then a well-formed error is raised.

parse_names()
[6] Names

This method returns a tuple of unicode strings. If no names can be parsed then None is returned.

parse_nmtoken()
[7] Nmtoken

Returns a Nmtoken as a string or, if no Nmtoken can be parsed then None is returned.

parse_nmtokens()
[8] Nmtokens

This method returns a tuple of unicode strings. If no tokens can be parsed then None is returned.

parse_entity_value()
[9] EntityValue

Parses an EntityValue, returning it as a unicode string.

This method automatically expands other parameter entity references but does not expand general or character references.

parse_att_value()
[10] AttValue

The value is returned without the surrounding quotes and with any references expanded.

The behaviour of this method is affected significantly by the setting of the *dontCheckWellFormedness* flag. When set, attribute values can be parsed without surrounding quotes. For compatibility with SGML these values should match one of the formal value types (e.g., Name) but this is not enforced so values like width=100% can be parsed without error.

parse_system_literal()
[11] SystemLiteral

The value of the literal is returned as a string *without* the enclosing quotes.

parse_pubid_literal()
[12] PubidLiteral

The value of the literal is returned as a string *without* the enclosing quotes.

parse_char_data()
[14] CharData

Parses a run of character data. The method adds the parsed data to the current element. In the default parsing mode it returns None.

When the parser option *sgmlOmittag* is selected the method returns any parsed character data that could not be added to the current element due to a model violation. Note that in this SGML-like mode any S is treated as being in the current element as the violation doesn't occur until the first non-S character (so any implied start tag is treated as being immediately prior to the first non-S).

parse_comment(*got_literal=False*)
[15] Comment

got_literal If True then the method assumes that the '<!–' literal has already been parsed.

Returns the comment as a string.

parse_pi(*got_literal=False*)
[16] PI: parses a processing instruction.

got_literal If True the method assumes the '<?' literal has already been parsed.

This method calls the `Node.ProcessingInstruction()` of the current element or of the document if no element has been parsed yet.

parse_pi_target()
[17] PITarget

Parses a processing instruction target name, the name is returned.

parse_cdsect(*got_literal=False*, *cdend=u']]>'*)
[18] CDSect

got_literal If True then the method assumes the initial literal has already been parsed. (By default, CDStart.)

cdend Optional string. The literal used to signify the end of the CDATA section can be overridden by passing an alternative literal in *cdend*. Defaults to ']]>'

This method adds any parsed data to the current element, there is no return value.

parse_cdstart()
[19] CDStart

Parses the literal that starts a CDATA section.

parse_cdata(*cdend=']]>'*)
[20] CData

Parses a run of CData up to but not including *cdend*.

This method adds any parsed data to the current element, there is no return value.

parse_cdend()
[21] CDEnd

Parses the end of a CDATA section.

parse_prolog()
[22] prolog

Parses the document prolog, including the XML declaration and dtd.

parse_xml_decl(*got_literal=False*)
[23] XMLDecl

got_literal If True the initial literal '<?xml' is assumed to have already been parsed.

Returns an *XMLDeclaration* instance. Also, if an encoding is given in the declaration then the method changes the encoding of the current entity to match. For more information see *ChangeEncoding()*.

parse_version_info(*got_literal=False*)
[24] VersionInfo

got_literal If True, the method assumes the initial white space and 'version' literal has been parsed already.

The version number is returned as a string.

parse_eq(*production='[25] Eq'*)
[25] Eq

production An optional string describing the production being parsed. This allows more useful errors than simply 'expected [25] Eq' to be logged.

Parses an equal sign, optionally surrounded by white space

parse_version_num()
[26] VersionNum

Parses the XML version number, returning it as a string, e.g., "1.0".

parse_misc()
[27] Misc

This method parses everything that matches the production Misc*

parse_doctypedecl(*got_literal=False*)
[28] doctypedecl

got_literal If True, the method assumes the initial '<!DOCTYPE' literal has been parsed already.

This method creates a new instance of *XMLDTD* and assigns it to py:attr:*dtd*, it also returns this instance as the result.

parse_decl_sep()
[28a] DeclSep

Parses a declaration separator.

parse_int_subset()
[28b] intSubset

Parses an internal subset.

parse_markup_decl(*got_literal=False*)
[29] markupDecl

got_literal If True, the method assumes the initial '<' literal has been parsed already.

Returns True if a markupDecl was found, False otherwise.

parse_ext_subset()
[30] extSubset

Parses an external subset

parse_ext_subset_decl()
[31] extSubsetDecl

Parses declarations in the external subset.

check_pe_between_declarations(*check_entity*)
[31] extSubsetDecl

check_entity A *XMLEntity* object, the entity we should still be parsing.

Checks the well-formedness constraint on use of PEs between declarations.

parse_sd_decl(*got_literal=False*)
[32] SDDecl

got_literal If True, the method assumes the initial 'standalone' literal has been parsed already.

Returns True if the document should be treated as standalone; False otherwise.

parse_element()
[39] element

The class used to represent the element is determined by calling the *get_element_class()* method of the current document. If there is no document yet then a new document is created automatically (see *parse_document()* for more information).

The element is added as a child of the current element using `Node.ChildElement()`.

The method returns a boolean value:

True the element was parsed normally

False the element is not allowed in this context

The second case only occurs when the *sgmlOmittag* option is in use and it indicates that the content of the enclosing element has ended. The Tag is buffered so that it can be reparsed when the stack of nested

parse_content() and *parse_element()* calls is unwound to the point where it is allowed by the context.

check_attributes(*name*, *attrs*)
Checks *attrs* against the declarations for an element.

name The name of the element

attrs A dictionary of attributes

Adds any omitted defaults to the attribute list. Also, checks the validity of the attributes which may result in values being further normalized as per the rules for collapsing spaces in tokenized values.

match_xml_name(*element*, *name*)
Tests if *name* is a possible name for *element*.

element A *Element* instance.

name The name of an end tag, as a string.

This method is used by the parser to determine if an end tag is the end tag of this element. It is provided as a separate method to allow it to be overridden by derived parsers.

The default implementation simply compares *name* with `GetXMLName()`

check_expected_particle(*name*)
Checks the validity of element name in the current context.

name The name of the element encountered. An empty string for *name* indicates the enclosing end tag was found.

This method also maintains the position of a pointer into the element's content model.

get_stag_class(*name*, *attrs=None*)
[40] STag

name The name of the element being started

attrs A dictionary of attributes of the element being started

Returns information suitable for starting the element in the current context.

If there is no *Document* instance yet this method assumes that it is being called for the root element and selects an appropriate class based on the contents of the prolog and/or *name*.

When using the *sgmlOmittag* option *name* may be None indicating that the method should return information about the element implied by PCDATA in the current context (only called when an attempt to add data to the current context has already failed).

The result is a triple of:

element_class the element class that this STag must introduce or None if this STag does not belong (directly or indirectly) in the current context

element_name the name of the element (to pass to ChildElement) or None to use the default

buff_flag True indicates an omitted tag and that the triggering STag (i.e., the STag with name *name*) should be buffered.

parse_stag()
[40] STag, [44] EmptyElemTag

This method returns a tuple of (name, attrs, emptyFlag) where:

name the name of the element parsed

attrs a dictionary of attribute values keyed by attribute name

emptyFlag a boolean; True indicates that the tag was an empty element tag.

parse_attribute()
[41] Attribute

Returns a tuple of (*name*, *value*) where:

name is the name of the attribute or None if *sgmlShorttag* is True and a short form attribute value was supplied.

value the attribute value.

If *dontCheckWellFormedness* is set the parser uses a very generous form of parsing attribute values to accomodate common syntax errors.

parse_etag(*got_literal=False*)
[42] ETag

got_literal If True, the method assumes the initial '</' literal has been parsed already.

The method returns the name of the end element parsed.

parse_content()
[43] content

The method returns:

True indicates that the content was parsed normally

False indicates that the content contained data or markup not allowed in this context

The second case only occurs when the *sgmlOmittag* option is in use and it indicates that the enclosing element has ended (i.e., the element's ETag has been omitted). See py:meth:*parse_element* for more information.

handle_data(*data*, *cdata=False*)
[43] content

data A string of data to be handled

cdata If True *data* is treated as character data (even if it matches the production for S).

Data is handled by calling *AddData()* even if the data is optional white space.

unhandled_data(*data*)
[43] content

data A string of unhandled data

This method is only called when the *sgmlOmittag* option is in use. It processes *data* that occurs in a context where data is not allowed.

It returns a boolean result:

True the data was consumed by a sub-element (with an omitted start tag)

False the data has been buffered and indicates the end of the current content (an omitted end tag).

parse_empty_elem_tag()
[44] EmptyElemTag

There is no method for parsing empty element tags alone.

This method raises NotImplementedError. Instead, you should call *parse_stag()* and examine the result. If it returns False then an empty element was parsed.

parse_element_decl(*got_literal=False*)
[45] elementdecl

got_literal If True, the method assumes that the '<!ELEMENT' literal has already been parsed.

Declares the element type in the *dtd*, (if present). There is no return result.

parse_content_spec(*etype*)
[46] contentspec

etype An *ElementType* instance.

Sets the *contentType* and *contentModel* attributes of *etype*, there is no return value.

parse_children(*got_literal=False*, *group_entity=None*)
[47] children

got_literal If True, the method assumes that the initial '(' literal has already been parsed, including any following white space.

group_entity An optional *XMLEntity* object. If *got_literal* is True then *group_entity* must be the entity in which the opening '(' was parsed which started the choice group.

The method returns an instance of *XMLContentParticle*.

parse_cp()
[48] cp

Returns an *XMLContentParticle* instance.

parse_choice(*first_child=None*, *group_entity=None*)
[49] choice

first_child An optional *XMLContentParticle* instance. If present the method assumes that the first particle and any following white space has already been parsed.

group_entity An optional *XMLEntity* object. If *first_child* is given then *group_entity* must be the entity in which the opening '(' was parsed which started the choice group.

Returns an *XMLChoiceList* instance.

parse_seq(*first_child=None*, *group_entity=None*)
[50] seq

first_child An optional *XMLContentParticle* instance. If present the method assumes that the first particle and any following white space has already been parsed. In this case, *group_entity* must be set to the entity which contained the opening '(' literal.

group_entity An optional *XMLEntity* object, see above.

Returns a *XMLSequenceList* instance.

parse_mixed(*got_literal=False*, *group_entity=None*)
[51] Mixed

got_literal If True, the method assumes that the #PCDATA literal has already been parsed. In this case, *group_entity* must be set to the entity which contained the opening '(' literal.

group_entity An optional *XMLEntity* object, see above.

Returns an instance of *XMLChoiceList* with occurrence ZeroOrMore representing the list of elements that may appear in the mixed content model. If the mixed model contains #PCDATA only the choice list will be empty.

parse_attlist_decl(*got_literal=False*)
[52] AttlistDecl

got_literal If True, assumes that the leading '<!ATTLIST' literal has already been parsed.

Declares the attriutes in the *dtd*, (if present). There is no return result.

parse_att_def(*got_s=False*)
[53] AttDef

got_s If True, the method assumes that the leading S has already been parsed.

Returns an instance of *XMLAttributeDefinition*.

parse_att_type(*a*)
[54] AttType

a A required *XMLAttributeDefinition* instance.

This method sets the *type* and *values* fields of *a*.

Note that, to avoid unnecessary look ahead, this method does not call *parse_string_type()* or *parse_enumerated_type()*.

parse_string_type(*a*)
[55] StringType

a A required *XMLAttributeDefinition* instance.

This method sets the *type* and *values* fields of *a*.

This method is provided for completeness. It is not called during normal parsing operations.

parse_tokenized_type(*a*)
[56] TokenizedType

a A required *XMLAttributeDefinition* instance.

This method sets the *type* and *values* fields of *a*.

parse_enumerated_type(*a*)
[57] EnumeratedType

a A required *XMLAttributeDefinition* instance.

This method sets the *type* and *values* fields of *a*.

This method is provided for completeness. It is not called during normal parsing operations.

parse_notation_type(*got_literal=False*)
[58] NotationType

got_literal If True, assumes that the leading 'NOTATION' literal has already been parsed.

Returns a list of strings representing the names of the declared notations being referred to.

parse_enumeration()
[59] Enumeration

Returns a dictionary of strings representing the tokens in the enumeration.

parse_default_decl(*a*)
[60] DefaultDecl: parses an attribute's default declaration.

a A required *XMLAttributeDefinition* instance.

This method sets the `presence` and *defaultValue* fields of *a*.

parse_conditional_sect(*got_literal_entity=None*)
[61] conditionalSect

got_literal_entity An optional *XMLEntity* object. If given, the method assumes that the initial literal '<![' has already been parsed from that entity.

parse_include_sect(*got_literal_entity=None*)
[62] includeSect:

got_literal_entity An optional *XMLEntity* object. If given, the method assumes that the production, up to and including the keyword 'INCLUDE' has already been parsed and that the opening '<![' literal was parsed from that entity.

There is no return value.

parse_ignore_sect(*got_literal_entity=None*)
[63] ignoreSect

got_literal_entity An optional *XMLEntity* object. If given, the method assumes that the production, up to and including the keyword 'IGNORE' has already been parsed and that the opening '<![' literal was parsed from this entity.

There is no return value.

parse_ignore_sect_contents()
[64] ignoreSectContents

Parses the contents of an ignored section. The method returns no data.

parse_ignore()
[65] Ignore

Parses a run of characters in an ignored section. This method returns no data.

parse_char_ref(*got_literal=False*)
[66] CharRef

got_literal If True, assumes that the leading '&' literal has already been parsed.

The method returns a unicode string containing the character referred to.

parse_reference()
[67] Reference

This method returns any data parsed as a result of the reference. For a character reference this will be the character referred to. For a general entity the data returned will depend on the parsing context. For more information see *parse_entity_ref()*.

parse_entity_ref(*got_literal=False*)
[68] EntityRef

got_literal If True, assumes that the leading '&' literal has already been parsed.

This method returns any data parsed as a result of the reference. For example, if this method is called in a context where entity references are bypassed then the string returned will be the literal characters parsed, e.g., "&ref;".

If the entity reference is parsed successfully in a context where Entity references are recognized, the reference is looked up according to the rules for validating and non-validating parsers and, if required by the parsing mode, the entity is opened and pushed onto the parser so that parsing continues with the first character of the entity's replacement text.

A special case is made for the predefined entities. When parsed in a context where entity references are recognized these entities are expanded immediately and the resulting character returned. For example, the entity & returns the '&' character instead of pushing an entity with replacement text '&'.

Inclusion of an unescaped & is common so when we are not checking well-formedness we treat '&' not followed by a name as if it were '&'. Similarly we are generous about the missing ';'.

lookup_predefined_entity(*name*)
Looks up pre-defined entities, e.g., "lt"

This method can be overridden by variant parsers to implement other pre-defined entity tables.

parse_pe_reference(*got_literal=False*)
[69] PEReference

got_literal If True, assumes that the initial '%' literal has already been parsed.

This method returns any data parsed as a result of the reference. Normally this will be an empty string because the method is typically called in contexts where PEReferences are recognized. However, if this method is called in a context where PEReferences are not recognized the returned string will be the literal characters parsed, e.g., "%ref;"

If the parameter entity reference is parsed successfully in a context where PEReferences are recognized, the reference is looked up according to the rules for validating and non-validating parsers and, if required by the parsing mode, the entity is opened and pushed onto the parser so that parsing continues with the first character of the entity's replacement text.

parse_entity_decl(*got_literal=False*)
[70] EntityDecl

got_literal If True, assumes that the literal '<!ENTITY' has already been parsed.

Returns an instance of either *XMLGeneralEntity* or *XMLParameterEntity* depending on the type of entity parsed.

parse_ge_decl(*got_literal=False*)
[71] GEDecl

got_literal If True, assumes that the literal '<!ENTITY' *and the required S* has already been parsed.

Returns an instance of *XMLGeneralEntity*.

parse_pe_decl(*got_literal=False*)
[72] PEDecl

got_literal If True, assumes that the literal '<!ENTITY' *and the required S* has already been parsed.

Returns an instance of *XMLParameterEntity*.

parse_entity_def(*ge*)
[73] EntityDef

ge The general entity being parsed, an *XMLGeneralEntity* instance.

This method sets the `definition` and *notation* fields from the parsed entity definition.

parse_pe_def(*pe*)
[74] PEDef

pe The parameter entity being parsed, an *XMLParameterEntity* instance.

This method sets the `definition` field from the parsed parameter entity definition. There is no return value.

parse_external_id(*allow_public_only=False*)
[75] ExternalID

allow_public_only An external ID must have a SYSTEM literal, and may have a PUBLIC identifier. If *allow_public_only* is True then the method will also allow an external identifier with a PUBLIC

identifier but no SYSTEM literal. In this mode the parser behaves as it would when parsing the production:

```
(ExternalID | PublicID) S?
```

Returns an *XMLExternalID* instance.

resolve_external_id(*external_id*, *entity=None*)
[75] ExternalID: resolves an external ID, returning a URI.

external_id A *XMLExternalID* instance.

entity An optional *XMLEntity* instance. Can be used to force the resolution of relative URIs to be relative to the base of the given entity. If it is None then the currently open external entity (where available) is used instead.

Returns an instance of *pyslet.rfc2396.URI* or None if the external ID cannot be resolved.

The default implementation simply calls *get_location()* with the entity's base URL and ignores the public ID. Derived parsers may recognize public identifiers and resolve accordingly.

parse_ndata_decl(*got_literal=False*)
[76] NDataDecl

got_literal If True, assumes that the literal 'NDATA' has already been parsed.

Returns the name of the notation used by the unparsed entity as a string without the preceding 'NDATA' literal.

parse_text_decl(*got_literal=False*)
[77] TextDecl

got_literal If True, assumes that the literal '<?xml' has already been parsed.

Returns an *XMLTextDeclaration* instance.

parse_encoding_decl(*got_literal=False*)
[80] EncodingDecl

got_literal If True, assumes that the literal 'encoding' has already been parsed.

Returns the declaration name without the enclosing quotes.

parse_enc_name()
[81] EncName

Returns the encoding name as a string or None if no valid encoding name start character was found.

parse_notation_decl(*got_literal=False*)
[82] NotationDecl

got_literal If True, assumes that the literal '<!NOTATION' has already been parsed.

Declares the notation in the *dtd*, (if present). There is no return result.

parse_public_id()
[83] PublicID

The literal string is returned without the PUBLIC prefix or the enclosing quotes.

6.4 XML Schema Datatypes

This module implements some useful concepts drawn from http://www.w3.org/TR/xmlschema-2/

One of the main purposes of this module is to provide classes and functions for converting data between python-native representations of the value-spaces defined by this specification and the lexical representations defined in the specification.

The result is typically a pair of DecodeX and EncodeX functions that are used to define custom attribute handling in classes that are derived from `xml20081126.structures.XMLElement`. For example:

```
import xsdatatypes20041028 as xsi

class MyElement(XMLElement):
        XMLATTR_flag=('flag',xsi.DecodeBoolean,xsi.EncodeBoolean)
```

6.4.1 Primitive Datatypes

pyslet.xsdatatypes20041028.**DecodeBoolean**(*src*)
Decodes a boolean value from src.

Returns python constants True or False. As a convenience, if src is None then None is returned.

pyslet.xsdatatypes20041028.**EncodeBoolean**(*src*)
Encodes a boolean value using the canonical lexical representation.

src can be anything that can be resolved to a boolean except None, which raises ValueError.

pyslet.xsdatatypes20041028.**DecodeDecimal**(*src*)
Decodes a decimal value from a string returning a python float value.

If string is not a valid lexical representation of a decimal value then ValueError is raised.

pyslet.xsdatatypes20041028.**EncodeDecimal**(*value*, *digits=None*, *stripZeros=True*)
Encodes a decimal value into a string.

You can control the maximum number of digits after the decimal point using *digits* which must be greater than 0 - None indicates no maximum. This function always returns the canonical representation which means that it will strip trailing zeros in the fractional part. To override this behaviour and return exactly *digits* decimal places set *stripZeros* to False.

pyslet.xsdatatypes20041028.**DecodeFloat**(*src*)
Decodes a float value from a string returning a python float.

The precision of the python float varies depending on the implementation. It typically exceeds the precision of the XML schema *float*. We make no attempt to reduce the precision to that of schema's float except that we return 0.0 or -0.0 for any value that is smaller than the smallest possible float defined in the specification. (Note that XML schema's float canonicalizes the representation of zero to remove this subtle distinction but it can be useful to preserve it for numerical operations. Likewise, if we are given a representation that is larger than any valid float we return one of the special float values INF or -INF as appropriate.

pyslet.xsdatatypes20041028.**EncodeFloat**(*value*)
Encodes a python float value as a string.

To reduce the chances of our output being rejected by external applications that are strictly bound to a 32-bit float representation we ensure that we don't output values that exceed the bounds of float defined by XML schema.

Therefore, we convert values that are too large to INF and values that are too small to 0.0E0.

pyslet.xsdatatypes20041028.**DecodeDouble**(*src*)
Decodes a double value from a string returning a python float.

The precision of the python float varies depending on the implementation. It may even exceed the precision of the XML schema *double*. The current implementation ignores this distinction.

pyslet.xsdatatypes20041028.**EncodeDouble**(*value*, *digits=None*, *stripZeros=True*)
Encodes a double value returning a unicode string.

digits controls the number of digits after the decimal point in the mantissa, None indicates no maximum and the precision of python's float is used to determine the appropriate number. You may pass the value 0 - in which case no digits are given after the point and the point itself is omitted, but such values are *not* in their canonical form.

stripZeros determines whether or not trailing zeros are removed, if False then exactly *digits* digits will be displayed after the point. By default zeros are stripped (except there is always one zero left after the decimal point).

pyslet.xsdatatypes20041028.**DecodeDateTime**(*src*)
Returns an *pyslet.iso8601.TimePoint* instance.

pyslet.xsdatatypes20041028.**EncodeDateTime**(*value*)
Returns the canonical lexical representation of a *pyslet.iso8601.TimePoint* instance.

6.4.2 Derived Datatypes

pyslet.xsdatatypes20041028.**DecodeName**(*src*)
Decodes a name from a string. Returns the same string or raised ValueError.

pyslet.xsdatatypes20041028.**EncodeName**(*src*)
A convenience function, returns src unchanged.

pyslet.xsdatatypes20041028.**DecodeInteger**(*src*)
Decodes an integer value from a string returning an Integer or Long value.

If string is not a valid lexical representation of an integer then ValueError is raised.

pyslet.xsdatatypes20041028.**EncodeInteger**(*value*)
Encodes an integer value using the canonical lexical representation.

6.4.3 Constraining Facets

Enumeration

class pyslet.xsdatatypes20041028.**Enumeration**
An abstract class designed to make generating enumeration types easier. The class is not designed to be instantiated but to act as a method of defining constants to represent the values of an enumeration.

The basic usage of this class is to derive a class from it with a single class member called 'decode' which is a mapping from canonical strings to simple integers. You then call the function *MakeEnumeration()* to complete the declaration, after which, you can use the enumeration as if you had defined the constants as class members and call any of the following class methods to convert enumeration values to and from their string representations.

classmethod DecodeValue(*src*)
Decodes a string returning a value in this enumeration.

If no legal value can be decoded then ValueError is raised.

classmethod DecodeLowerValue(*src*)
Decodes a string, converting it to lower case first.

Returns a value in this enumeration. If no legal value can be decoded then ValueError is raised.

classmethod DecodeUpperValue(*src*)
Decodes a string, converting it to upper case first.

Returns a value in this enumeration. If no legal value can be decoded then ValueError is raised.

classmethod DecodeTitleValue(*src*)
Decodes a string, converting it to title case first.

Returns a value in this enumeration. If no legal value can be decoded then ValueError is raised.

classmethod DecodeValueList(*decoder*, *src*)
Decodes a space-separated string of values using *decoder* which must be one of the Decode*Value methods of the enumeration. The result is an ordered list of values (possibly containing duplicates).

Example usage:

```
fruit.DecodeValueList(fruit.DecodeLowerValue,"apples oranges, pears")
# returns [ fruit.apples, fruit.oranges, fruit.pears ]
```

classmethod DecodeValueDict(*decoder*, *src*)
Decodes a space-separated string of values using *decoder* which must be one of the Decode*Value methods of the enumeration. The result is a dictionary mapping the values found as keys onto the strings used to represent them. Duplicates are mapped to the first occurrence of the encoded value.

Example usage:

```
fruit.DecodeValueDict(fruit.DecodeLowerValue,"Apples oranges PEARS")
# returns...
{ fruit.apples:'Apples', fruit.oranges:'oranges', fruit.pears:'PEARS' }
```

classmethod EncodeValue(*value*)
Encodes one of the enumeration constants returning a string.

If value is None then the encoded default value is returned (if defined) or None.

classmethod EncodeValueList(*valueList*)
Encodes a list of enumeration constants returning a space-separated string.

If valueList is empty then an empty string is returned.

classmethod EncodeValueDict(*valueDict*, *sortKeys=True*)
Encodes a dictionary of enumeration constants returning a space-separated string.

If valueDict is empty then an empty string is returned. Note that the canonical representation of each value is used. Extending the example given in *DecodeValueDict()*:

```
fruit.EncodeValueDict(fruit.DecodeValueDict(fruit.DecodeLowerValue,
        "Apples oranges PEARS"))
# returns...
"apples oranges pears"
```

The order of the encoded values in the string is determined by the sort order of the enumeration constants. This ensures that equivalent dictionaries are always encoded to equivalent strings. In the above example:

```
fruit.apples < fruit.oranges and fruit.oranges < fruit.pears
```

If you have large lists then you can skip the sorting step by passing False for *sortKeys* to improve performance at the expense of a predictable encoding.

pyslet.xsdatatypes20041028.**MakeEnumeration**(*e*, *defaultValue=None*)
Adds convenience attributes to the class 'e'

This function assumes that e has an attribute 'decode' that is a dictionary which maps strings onto enumeration values. This function creates the reverse mapping called 'encode' and also defines constant attribute values that are equivalent to the keys of decode and can be used in code in the form e.key.

If *defaultValue* is not None then it must be on of the strings in the decode dictionary. It is then used to set the *DEFAULT* value.

pyslet.xsdatatypes20041028.**MakeEnumerationAliases**(*e*, *aliases*)
Adds *aliases* from a dictionary, declaring additional convenience attributes.

This function assumes that *MakeEnumeration()* has already been used to complete the declaration of the enumeration. The aliases are added to the decode dictionary but, for obvious reasons, not to the encode dictionary.

pyslet.xsdatatypes20041028.**MakeLowerAliases**(*e*)
Adds *aliases* by converting all keys to lower case.

Assumes that *MakeEnumeration()* has already been used to complete the declaration of the enumeration. You must call this function to complete the declaration before relying on calls to *Enumeration.DecodeLowerValue()*.

pyslet.xsdatatypes20041028.**MakeEnumeration**(*e*, *defaultValue=None*)
Adds convenience attributes to the class 'e'

This function assumes that e has an attribute 'decode' that is a dictionary which maps strings onto enumeration values. This function creates the reverse mapping called 'encode' and also defines constant attribute values that are equivalent to the keys of decode and can be used in code in the form e.key.

If *defaultValue* is not None then it must be on of the strings in the decode dictionary. It is then used to set the *DEFAULT* value.

pyslet.xsdatatypes20041028.**MakeEnumeration**(*e*, *defaultValue=None*)
Adds convenience attributes to the class 'e'

This function assumes that e has an attribute 'decode' that is a dictionary which maps strings onto enumeration values. This function creates the reverse mapping called 'encode' and also defines constant attribute values that are equivalent to the keys of decode and can be used in code in the form e.key.

If *defaultValue* is not None then it must be on of the strings in the decode dictionary. It is then used to set the *DEFAULT* value.

WhiteSpace

pyslet.xsdatatypes20041028.**WhiteSpaceReplace**(*value*)
Replaces tab, line feed and carriage return with space.

pyslet.xsdatatypes20041028.**WhiteSpaceCollapse**(*value*)
Replaces all runs of white space with a single space. Also removes leading and trailing white space.

6.4.4 Regular Expressions

Appendix F of the XML Schema datatypes specification defines a regular expression language. This language differs from the native Python regular expression language but it is close enough to enable us to define a wrapper class which parses schema regular expressions and converts them to equivalent python regular expressions.

class pyslet.xsdatatypes20041028.**RegularExpression**(*src*)
Models a regular expression as defined by XML schema.

Regular expressions are constructed from unicode source strings. Internally they are parsed and converted to Python regular expressions to speed up matching. Warning: because the XML schema expression language contains concepts not supported by Python the python regular expression may not be very readable.

src = None
the original source string

match(*target*)
A convenience function, returns True if the expression matches *target*.

For completeness we also document the parser we use to do the conversion, it draws heavily on the *pyslet.unicode5.CharClass* concept.

class pyslet.xsdatatypes20041028.**RegularExpressionParser**(*source*)
Bases: *pyslet.unicode5.BasicParser*

A custom parser for XML schema regular expressions.

The parser is initialised from a source string, the string to be parsed.

ParseRegExp()
Returns a unicode string representing the regular expression.

ParseBranch()
Returns a unicode string representing this piece as a python regular expression.

ParseQuantifier()
Returns a tuple of n,m.

Symbolic values are expanded to the appropriate pair. The second value may be None indicating unbounded.

ParseQuantity()
Returns a tuple of n,m even if an exact quantity is given.

In other words, the exact quantity 'n' returns n,n. The second value may be None indicated unbounded.

ParseQuantExact()
Returns an integer.

ParseAtom()
Returns a unicode string representing this atom as a python regular expression.

IsChar(*c=None*)
The definition of this function is designed to be conservative with respect to the specification, which is clearly in error around production [10] as the prose and the BNF do not match. It appears that | was intended to be excluded in the prose but has been omitted, the reverse being true for the curly-brackets.

ParseCharClass()
Returns a CharClass instance representing this class.

ParseCharClassExpr()
Returns a CharClass instance representing this class expression.

ParseCharGroup()
Returns a CharClass representing this group. This method also handles the case of a class subtraction directly to reduce the need for look-ahead. If you specifically want to parse a subtraction you can do this with *ParseCharClassSub()*.

ParsePosCharGroup()
Returns a CharClass representing a positive range

ParseNegCharGroup()
Returns a CharClass representing this range.

ParseCharClassSub()
Returns a CharClass representing this range - this method is not normally used by the parser as in present for completeness. See *ParseCharGroup()*.

ParseCharRange()
Returns a CharClass representing this range.

ParseSERange()
Returns a CharClass representing this range.

ParseCharOrEsc()
Returns a single unicode character.

ParseCharClassEsc()
Returns a CharClass instance representing one of the escape sequences.

ParseSingleCharEsc()
Returns a single unicode character parsed from a single char escape.

ParseCatEsc()
Returns a CharClass, parsing a category escape.

ParseComplEsc()
Returns a CharClass, parsing the complement of a category escape.

ParseCharProp()
Returns a CharClass, parsing an IsCategory or IsBlock.

ParseIsCategory()
Returns a CharClass corresponding to one of the character categories or raises an error.

ParseIsBlock()
Returns a CharClass corresponding to one of the Unicode blocks.

ParseMultiCharEsc()
Returns a CharClass corresponding to one of the multichar escapes, if parsed.

ParseWildcardEsc()
Returns a CharClass corresponding to the wildcard '.' character if parsed.

6.5 HTML

This module defines functions and classes for working with HTML documents. The version of the standard implemented is, loosely speaking, the HTML 4.0.1 Specification: http://www.w3.org/TR/html401/

This module contains code that can help parse HTML documents into classes based on the basic `xml20081126` XML module, acting as a gateway to XHTML.

This module also exposes a number of internal functions typically defined privately in HTML parser implementations which make it easier to reuse concepts from HTML in other modules. For example, the *LengthType* used for storing HTML lengths (which can be pixel or relative) is used extensively by `imsqtiv2p1`.

pyslet.html40_19991224.**HTML40_PUBLICID**
The public ID to use in the declaration of an HTML document

pyslet.html40_19991224.**XHTML_NAMESPACE**
The namespace to use in the delcaration of an XHTML document

6.5.1 (X)HTML Documents

This module contains an experimental class for working with HTML documents. At the time of writing the implementation is designed to provide just enough HTML parsing to support the use of HTML within other standards (such as Atom and QTI).

class pyslet.html40_19991224.**XHTMLDocument**(***args*)
Bases: pyslet.xmlnames20091208.XMLNSDocument

Represents an HTML document.

Although HTML documents are not always represented using XML they can be, and therefore we base our implementation on the pyslet.xmlnames20091208.XMLNSDocument class - a namespace-aware variant of the basic pyslet.xml20081126.XMLDocument class.

classMap = {('http://www.w3.org/1999/xhtml', 'dl'): <class 'pyslet.html40_19991224.DL'>, ('http://www.w3.org/1999/xh
Data member used to store a mapping from element names to the classes used to represent them. This mapping is initialized when the module is loaded.

XMLParser(*entity*)
We override the basic XML parser to use a custom parser that is intelligent about the use of omitted tags, elements defined to have CDATA content and other SGML-based variations. If the document starts with an XML declaration then the normal XML parser is used instead.

You won't normally need to call this method as it is invoked automatically when you call pyslet.xml20081126.XMLDocument.Read().

The result is always a proper element hierarchy rooted in an HTML node, even if no tags are present at all the parser will construct an HTML document containing a single Div element to hold the parsed text.

GetChildClass(*stag_class*)
Always returns HTML.

6.5.2 Basic Types

Length Values

Length values are used in many places in HTML, the most common being the width and height values on images. There are two ways of specifying a Length, a simple integer number of pixels or a percentage of some base length defined by the context (such as the width of the browser window).

class pyslet.html40_19991224.**LengthType**(*value*, *valueType=None*)
Bases: object

Represents the HTML Length:

```
<!ENTITY % Length "CDATA" -- nn for pixels or nn% for percentage length -->
```

- **value can be either an integer value, another LengthType instance or a** string.
- **if value is an integer then valueType can be used to select Pixel or** Percentage
- **if value is a string then it is parsed for the length as per the format** defined for length attributes in HTML.

By default values are assumed to be Pixel lengths but valueType can be used to force such a value to be a Percentage if desired.

Pixel = 0
data constant used to indicate pixel co-ordinates

Percentage = 1
data constant used to indicate relative (percentage) co-ordinates

type = None
type is one of the the LengthType constants: Pixel or Percentage

value = None
value is the integer value of the length

__nonzero__()
Length values are non-zero if they have a non-zero value (pixel or percentage).

__str__()
Formats the length as a string of form nn for pixels or nn% for percentage.

__unicode__()
Formats the length as a unicode string of form nn for pixels or nn% for percentage.

GetValue(*dim=None*)
Returns the value of the Length, *dim* is the size of the dimension used for interpreting percentage values. I.e., 100% will return *dim*.

Add(*value*)
Adds *value* to the length.

If value is another LengthType instance then its value is added to the value of this instances' value only if the types match. If value is an integer it is assumed to be a value of pixel type - a mismatch raises ValueError.

__weakref__
list of weak references to the object (if defined)

Coordinate Values

Coordinate values are simple lists of Lengths. In most cases Pyslet doesn't define special types for lists of basic types but coordinates are represented in attribute values using comma separation, not space-separation. As a result they require special processing in order to be decoded/encoded correctly from/to XML streams.

class pyslet.html40_19991224.**Coords**(*values=None*)
Represents HTML Coords values

```
<!ENTITY % Coords "CDATA" -- comma-separated list of lengths -->
```

Instances can be initialized from an existing list of *LengthType*, or a list of any object that can be used to construct a LengthType. It can also be constructed from a string formatted as per the HTML attribute definition.

The resulting object behaves like a list of LengthType instances, for example:

```
x=Coords("10, 50, 60%,75%")
len(x)==4
x[0].value==10
x[2].type==LengthType.Percentage
str(x[3])=="75%"
# items are also assignable...
x[1]="40%"
x[1].type==LengthType.Percentage
x[1].value==40
```

values = None
a list of *LengthType* values

__unicode__()
Formats the Coords as comma-separated unicode string of Length values.

__str__()
Formats the Coords as a comma-separated string of Length values.

TestRect(*x*, *y*, *width*, *height*)
Tests an x,y point against a rect with these coordinates.

HTML defines the rect co-ordinates as: left-x, top-y, right-x, bottom-y

TestCircle(*x*, *y*, *width*, *height*)
Tests an x,y point against a circle with these coordinates.

HTML defines a circle as: center-x, center-y, radius.

The specification adds the following note:

> When the radius value is a percentage value, user agents should calculate the final radius value based on the associated object's width and height. The radius should be the smaller value of the two.

TestPoly(*x*, *y*, *width*, *height*)
Tests an x,y point against a poly with these coordinates.

HTML defines a poly as: x1, y1, x2, y2, ..., xN, yN.

The specification adds the following note:

> The first x and y coordinate pair and the last should be the same to close the polygon. When these coordinate values are not the same, user agents should infer an additional coordinate pair to close the polygon.

The algorithm used is the "Ray Casting" algorithm described here: http://en.wikipedia.org/wiki/Point_in_polygon

URIs

URIs are represented by instances of the underlying `pyselt.rfc2396.URI` class, these functions provide a simple wrapper around the functions defined in that module.

pyslet.html40_19991224.**DecodeURI**(*src*)
Decodes a URI from src:

```
    <!ENTITY % URI "CDATA"  -- a Uniform Resource Identifier -->
```

We adopt the algorithm recommended in Appendix B of the specification, which involves replacing non-ASCII characters with percent-encoded UTF-sequences.

For more information see `psylet.rfc2396.encode_unicode_uri()`

pyslet.html40_19991224.**EncodeURI**(*uri*)
Encoding a URI means just converting it into a string.

By definition, a URI will only result in ASCII characters that can be freely converted to Unicode by the default encoding. However, it does mean that this function doesn't adhere to the principal of using the ASCII encoding only at the latest possible time.

6.6 Uniform Resource Identifiers (RFC2396)

This module defines functions and classes for working with URI as defined by RFC2396: http://www.ietf.org/rfc/rfc2396.txt

In keeping with usage in the specification we use URI in both the singular and plural sense.

In addition to parsing and formating URI from strings, this module also supports computing and resolving relative URI. To do this we define two notional operators.

The resolve operator:

```
U = B [*] R
```

calculates a new URI 'U' from a base URI 'B' and a relative URI 'R'.

The relative operator:

```
U [/] B = R
```

calcualtes the relative URI 'R' formed by expressing 'U' relative to 'B'.

The Relative operator defines the reverse of the resolve operator, however note that in some cases several different values of R can resolve to the same URL with a common base URI.

6.6.1 Creating URI Instances

To create URI use the *URI.from_octets()* class method. This method takes both character and binary strings though in the first case the string must contain only ASCII characters and in the latter only bytes that represent ASCII characters. The following function can help convert general character strings to a suitable format but it is not a full implementation of the IRI specification, in particular it does not encode delimiters (such as space) and it does not deal intelligently with unicode domain names (these must be converted to their ASCII URI forms first).

pyslet.rfc2396.**encode_unicode_uri**(*usrc*)
Extracts a URI octet-string from a unicode string.

usrc A character string

Returns a character string with any characters outside the US-ASCII range replaced by URI-escaped UTF-8 sequences. This is not a general escaping method. All other characters are ignored, including non-URI characters like space. It is assumed that any (other) characters requiring escaping are already escaped.

The encoding algorithm used is the same as the one adopted by HTML. This is not part of the RFC standard which only defines the behaviour for streams of octets but it is in line with the approach adopted by the later IRI spec.

6.6.2 URI

class pyslet.rfc2396.**URI**(*octets*)
Bases: *pyslet.py2.CmpMixin*, pyslet.pep8.PEP8Compatibility

Class to represent URI References

You won't normally instantiate a URI directly as it represents a generic URI. This class is designed to be overridden by scheme-specific implementations. Use the class method *from_octets()* to create instances.

If you are creating your own derived classes call the parent contstructor to populate the attributes defined here from the URI's string representation passing a character string representing the octets of the URI. (For

backwards compatibility a binary string will be accepted provided it can be decoded as US ASCII characters.) You can override the scheme-specific part of the parsing by defining your own implementation of *parse_scheme_specific_part()*.

It is an error if the octets string contains characters that are not allowed in a URI.

Note: The following details have changed significantly following updates in 0.5.20160123 to introduce support for Python 3. Although the character/byte/octet descriptions have changed the actual affect on running code is minimal when running under Python 2.

Unless otherwise stated, all attributes are character strings that encode the 'octets' in each component of the URI. These atrributes retain the %-escaping. To obtain the actual data use *unescape_data()* to obtain the original octets (as a byte string). The specification does not specify any particular encoding for interpreting these octets, indeed in some types of URI these binary components may have no character-based interpretation.

For example, the URI "%E8%8B%B1%E5%9B%BD.xml" is a character string that represents a UTF-8 and URL-encoded path segment using the Chinese word for United Kingdom. To obtain the correct unicode path segment you would first use *unescape_data()* to obtain the binary string of bytes and then decode with UTF-8:

```
>>> src = "%E8%8B%B1%E5%9B%BD.xml"
>>> uri.unescape_data(src).decode('utf-8')
u'\\u82f1\\u56fd.xml'
```

URI can be converted to strings but the result is a character string that retains any %-encoding. Therefore, these character strings always use the restricted character set defined by the specification (a subset of US ASCII) and, in Python 2, can be freely converted between the str and unicode types.

URI are immutable and can be compared and used as keys in dictionaries. Two URI compare equal if their *canonical* forms are identical. See *canonicalize()* for more information.

classmethod from_octets(*octets*, *strict=False*)
Creates an instance of *URI* from a string

Note: This method was changed in Pyslet 0.5.20160123 to introduce support for Python 3. It now takes either type of string but a character string is now *preferred*.

This is the main method you should use for creating instances. It uses the URI's scheme to determine the appropriate subclass to create. See *register()* for more information.

octets A string of characters that represents the URI's octets. If a binary string is passed it is assumed to be US ASCII and converted to a character string.

strict (defaults to False) If the character string contains characters outside of the US ASCII character range then *encode_unicode_uri()* is called before the string is used to create the instance. You can turn off this behaviour (to enable strict URI-parsing) by passing strict=True

Pyslet manages the importing and registering of the following URI schemes using it's own classes: http, https, file and urn. Additional modules are loaded and schemes registered 'on demand' when instances of the corresponding URI are first created.

scheme_class = {'urn': <class 'pyslet.urn.URN'>, 'http': <class 'pyslet.http.params.HTTPURL'>, 'https': <class 'pysl
A dictionary mapping lower-case URI schemes onto the special classes used to represent them

classmethod register(*scheme*, *uri_class*)
Registers a class to represent a scheme

scheme A string representing a URI scheme, e.g., 'http'. The string is converted to lower-case before it is registered.

uri_class A class derived from URI that is used to represent URI from scheme

If a class has already been registered for the scheme it is replaced. The mapping is kept in the *scheme_class* dictionary.

classmethod from_virtual_path(*path*)
Converts a virtual file path into a *URI* instance

path A *pyslet.vfs.VirtualFilePath* instance representing a file path in a virtual file system. The path is always made absolute before being converted to a *FileURL*.

The authority (host name) in the resulting URL is usually left blank except when running under Windows, in which case the URL is constructed according to the recommendations in this blog post. In other words, UNC paths are mapped to both the network location and path components of the resulting file URL.

For named virtual file systems (i.e., those that don't map directly to the functions in Python's built-in os and os.path modules) the file system name is used for the authority. (If path is from a named virutal file system and is a UNC path then URIException is raised.)

classmethod from_path(*path*)
Converts a local file path into a *URI* instance.

path A file path string.

Uses *path* to create an instance of *pyslet.vfs.OSFilePath*, see *from_virtual_path()* for more info.

octets = None
The character string representing this URI's octets

fragment = None
The fragment string that was appended to the URI or None if no fragment was given.

scheme = None
The URI scheme, if present

authority = None
The authority (e.g., host name) of a hierarchical URI

abs_path = None
The absolute path of a hierarchical URI (None if the path is relative)

query = None
The optional query associated with a hierarchical URI

scheme_specific_part = None
The scheme specific part of the URI

rel_path = None
The relative path of a hierarchical URI (None if the path is absolute)

opaque_part = None
None if the URI is hierarchical, otherwise the same as scheme_specific_part

parse_scheme_specific_part()
Parses the scheme specific part of the URI

Parses the scheme specific part of the URI from *scheme_specific_part*. This attribute is set by the constructor, the role of this method is to parse this attribute and set any scheme-specific attribute values.

This method should overridden by derived classes if they use a format other than the hierarchical URI format described in RFC2396.

The default implementation implements the generic parsing of hierarchical URI setting the following attribute values: *authority*, *abs_path* and *query*. If the URI is not of a hierarchical type then *opaque_part* is set instead. Unset attributes have the value None.

canonicalize()
Returns a canonical form of this URI

For unknown schemes we simply convert the scheme to lower case so that, for example, X-scheme:data becomes x-scheme:data.

Derived classes should apply their own transformation rules.

get_canonical_root()
Returns a new URI comprised of the scheme and authority only.

Only valid for absolute URI, returns None otherwise.

The canonical root does not include a trailing slash. The canonical root is used to define the domain of a resource, often for security purposes.

If the URI is non-hierarchical then the just the scheme is returned.

resolve(*base*, *current_doc_ref=None*)
Resolves a relative URI against a base URI

base A *URI* instance representing the base URI against which to resolve this URI. You may also pass a URI string for this parameter.

current_doc_ref The optional *current_doc_ref* allows you to handle the special case of resolving the empty URI. Strictly speaking, fragments are not part of the URI itself so a relative URI consisting of the empty string, or a relative URI consisting of just a fragment both refer to the current document. By default, *current_doc_ref* is assumed to be the same as *base* but there are cases where the base URI is not the same as the URI used to originally retrieve the document and this optional parameter allows you to cope with those cases.

Returns a new *URI* instance.

If the base URI is also relative then the result is a relative URI, otherwise the result is an absolute URI. The RFC does not actually go into the procedure for combining relative URI but if B is an absolute URI and R1 and R2 are relative URI then using the resolve operator ([*], see above):

```
U1 = B [*] R1
U2 = U1 [*] R2
U2 = ( B [*] R1 ) [*] R2
```

The last expression prompts the issue of associativity, in other words, is the following expression also valid?

```
U2 = B [*] ( R1 [*] R2 )
```

For this to work it must be possible to use the resolve operator to combine two relative URI to make a third, which is what we allow here.

relative(*base*)
Calculates a URI expressed relative to *base*.

base A *URI* instance representing the base URI against which to calculate the relative URI. You may also pass a URI string for this parameter.

Returns a new *URI* instance.

As we allow the *resolve()* method for two relative paths it makes sense for the Relative operator to also be defined:

```
R3 = R1 [*] R2
R3 [/] R1 = R2
```

There are some significant restrictions, URI are classified by how specified they are with:

absolute URI > authority > absolute path > relative path

If R is absolute, or simply more specified than B on the above scale and:

```
U = B [*] R
```

then U = R regardless of the value of B and therefore:

```
U [/] B = U if B is less specified than U
```

Also note that if U is a relative URI then B cannot be absolute. In fact B must always be less than, or equally specified to U because B is the base URI from which U has been derived:

```
U [/] B = undefined if B is more specified than U
```

Therefore the only interesting cases are when B is equally specified to U. To give a concrete example:

```
U = /HD/User/setting.txt
B = /HD/folder/file.txt

/HD/User/setting.txt [\] /HD/folder/file.txt = ../User/setting.txt
/HD/User/setting.txt = /HD/folder/file.txt [*] ../User/setting.txt
```

And for relative paths:

```
U = User/setting.txt
B = User/folder/file.txt

User/setting.txt [\] User/folder/file.txt = ../setting.txt
User/setting.txt = User/folder/file.txt [*] ../setting.txt
```

match(*other_uri*)
Compares this URI with another

other_uri Another URI instance.

Returns True if the canonical representations of the URIs match.

is_absolute()
Returns True if this URI is absolute

An absolute URI is fully specified with a scheme, e.g., 'http'.

get_file_name()
Gets the file name associated with this resource

Returns None if the URI scheme does not have the concept. By default the file name is extracted from the last component of the path. Note the subtle difference between returning None and returning an empty string (indicating that the URI represents a directory-like object).

The return result is always a character string.

class pyslet.rfc2396.**ServerBasedURL**(*octets*)
Bases: *pyslet.rfc2396.URI*

Represents server-based URI

A server-based URI is one of the form:

```
<scheme> '://' [<userinfo> '@'] <host> [':' <port>] <path>
```

DEFAULT_PORT = None
the default port for this type of URL

get_addr()
Returns a hostname and integer port tuple

The format is suitable for socket operations. The main purpose of this method is to determine if the port is set on the URL and, if it isn't, to return the default port for this URL type instead.

canonicalize()
Returns a canonical form of this URI

In addition to returning the scheme in lower-case form, this method forces the host to be lower case and removes the port specifier if it matches the *DEFAULT_PORT* for this type or URI.

No transformation is performed on the path component.

class pyslet.rfc2396.**FileURL**(*octets='file:///'*)
Bases: *pyslet.rfc2396.ServerBasedURL*

Represents the file URL scheme defined by RFC1738

The initialisation string is optional, if omitted the URL will represent the root of the default file system:

```
file:///
```

get_pathname(*force8bit=False*)
Returns the system path name corresponding to this file URL

If the system supports unicode file names (as reported by os.path.supports_unicode_filenames) then get_pathname also returns a unicode string, otherwise it returns an 8-bit string encoded in the underlying file system encoding.

force8bit There are some libraries (notably sax) that will fail when passed files opened using unicode paths. The force8bit flag can be used to force get_pathname to return a byte string encoded using the native file system encoding.

If the URL does not represent a path in the native file system then URIException is raised.

get_virtual_file_path()
Returns a virtual file path corresponding to this URL

The result is a pyslet.vfs.FilePath instance.

The host component of the URL is used to determine which virtual file system the file belongs to. If there is no virtual file system matching the URL's host and the native file system support UNC paths (i.e., is Windows) the host will be placed in the machine portion of the UNC path.

Path parameters e.g., /dir/file;lang=en in the URL are ignored.

to_local_text()
Returns a locally portable version of the URL

The result is a character string, not a URI instance.

In Pyslet, all hiearchical URI are treated as using the UTF-8 encoding for characters outside US ASCII. As a result, file URL are expressed using percent-encoded UTF-8 multi-byte sequences. When converting these URLs to file paths the difference is taken into account correctly but if you attempt to output a URL generated by Pyslet and use it in another application you may find that the URL is not recognised. This is

paritcularly a problem on Windows where file URLs are expected to be encoded with the native file system encoding.

The purpose of this method is to return a version of the URL re-encoded in the local file system encoding for portability such as being copy-pasted into a browser address bar.

6.6.3 Canonicalization and Escaping

pyslet.rfc2396.**canonicalize_data**(*source*, *unreserved_test=<bound method CharClass.test of CharClass(u'!', (u"", u'*'), (u'-', u'.'), (u'0', u'9'), (u'A', u'Z'), u'_', (u'a', u'z'), u'~')>*, *allowed_test=<bound method CharClass.test of CharClass(u'!', u'$', (u'&', u';'), u'=', (u'?', u'['), u']', u'_', (u'a', u'z'), u'~')>*)

Returns the canonical form of *source* string.

The canonical form is the same string but any unreserved characters represented as hex escapes in source are unencoded and any unescaped characters that are neither reserved nor unreserved are escaped.

source A string of characters. Characters must be in the US ASCII range. Use *encode_unicode_uri()* first if necessary. Will raise UnicodeEncodeError if non-ASCII characters are encountered.

unreserved_test A function with the same signature as *is_unreserved()*, which it defaults to. By providing a different function you can control which characters will have their escapes removed. It does not affect which unescaped characters are escaped.

To give an example, by default the '.' is unreserved so the sequence %2E will be removed when canonicalizing the source. However, if the specific part of the URL scheme you are dealing with applies some reserved purpose to '.' then *source* may contain both encoded and unencoded versions to disambiguate its usage. In this case you would want to remove '.' from the definition of unreserved to prevent it being unescaped.

If you don't want any escapes removed, simply pass:

```
lambda x: False
```

allowed_test Defaults to *is_allowed()*

See *parse_uric()* for more information.

All hex escapes are promoted to upper case.

pyslet.rfc2396.**escape_data**(*source*, *reserved_test=<bound method CharClass.test of CharClass(u'$', u'&', (u'+', u','), u'/', (u':', u';'), u'=', (u'?', u'@'), u'[', u']')>*, *allowed_test=<bound method CharClass.test of CharClass(u'!', u'$', (u'&', u';'), u'=', (u'?', u'['), u']', u'_', (u'a', u'z'), u'~')>*)

Performs URI escaping on source

Returns the escaped *character* string.

source The input string. This can be a binary or character string. For character strings all characters must be in the US ASCII range. Use *encode_unicode_uri()* first if necessary. Will raise UnicodeEncodeError if non-ASCII characters are encountered. For binary strings there is no constraint on the range of allowable octets.

Note: In Python 2 the ASCII character constraint is only applied when *source* is of type unicode.

reserved_test Default *is_reserved()*, the function to test if a character should be escaped. This function should take a single character as an argument and return True if the character must be escaped. Characters

for which this function returns False will still be escaped if they are not allowed to appear unescaped in URI (see *allowed_test* below).

Quoting from RFC2396:

> Characters in the "reserved" set are not reserved in all contexts. The set of characters actually reserved within any given URI component is defined by that component. In general, a character is reserved if the semantics of the URI changes if the character is replaced with its escaped US-ASCII encoding.

Therefore, you may want to reduce the set of characters that are escaped based on the target component for the data. Different rules apply to a path component compared with, for example, the query string. A number of alternative test functions are provided to assist with escaping an alternative set of characters.

For example, suppose you want to ensure that your data is escaped to the rules of the earlier RFC1738. In that specification, a fore-runner of RFC2396, the "~" was not classifed as a valid URL character and required escaping. It was later added to the mark category enabling it to appear unescaped. To ensure that this character is escaped for compatibility with older systems you might do this when escaping data with a path component (where '~' is often used):

```
path_component = uri.escape_data(
    dir_name, reserved_test=uri.is_reserved_1738)
```

In addition to escaping "~", the above will also leave "$", "+" and "," unescaped as they were classified as 'extra' characters in RFC1738 and were not reserved.

allowed_test Defaults to *is_allowed()*

See *parse_uric()* for more information.

By default there is no difference between RFC2396 and RFC2732 in operation as in RFC2732 "[" and "]" are legal URI characters *but* they are also in the default reserved set so will be escaped anyway. In RFC2396 they were escaped on the basis of not being allowed.

The difference comes if you are using a reduced set of reserved characters. For example:

```
>>> print uri.escape_data("[file].txt")
%5Bfile%5D.txt
>>> print uri.escape_data(
        "[file].txt", reserved_test=uri.is_path_segment_reserved)
[file].txt
>>> print uri.escape_data(
        "[file].txt", reserved_test=uri.is_path_segment_reserved,
        allowed_test=uri.is_allowed_2396)
%5Bfile%5D.txt
```

pyslet.rfc2396.**unescape_data**(*source*)

Performs URI unescaping

source The URI-encoded string

Removes escape sequences. The string is returned as a *binary* string of octets, not a string of characters. Escape sequences such as %E9 will result in the byte value 233 and not the character é.

The character encoding that applies may depend on the context and it cannot always be assumed to be UTF-8 (though in most cases that will be the correct way to interpret the result).

pyslet.rfc2396.**path_sep = u'/'**

Constant for "/" character.

6.6.4 Basic Syntax

RFC2396 defines a number of character classes (see *pyslet.unicode5.CharClass*) to assist with the parsing of URI.

The bound test method of each class is exposed for convenience (you don't need to pass an instance). These pseudo-functions therefore all take a single character as an argument and return True if the character matches the class. They will also accept None and return False in that case.

pyslet.rfc2396.**is_upalpha**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_lowalpha**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_alpha**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_digit**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_alphanum**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_reserved**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_reserved_2396**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_reserved_1738**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_unreserved**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_unreserved_1738**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_safe_1738**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_extra_1738**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_mark**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_allowed**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_allowed_2396**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_allowed_1738**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_hex**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_control**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_space**(*c*)
Tests production: space

pyslet.rfc2396.**is_delims**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_unwise**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_unwise_2396**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_authority_reserved**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

pyslet.rfc2396.**is_query_reserved**(*self*, *c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

Some fragments of URI parsing are exposed for reuse by other modules.

pyslet.rfc2396.**parse_uric**(*source*, *pos=0*, *allowed_test=<bound method CharClass.test of CharClass(u'!', u'$', (u'&', u';'), u'=', (u'?', u'['), u']', u'_', (u'a', u'z'), u'~')>*)
Returns the number of URI characters in a source string

source A source string (of characters)

pos The place at which to start parsing (defaults to 0)

allowed_test Defaults to *is_allowed()*

Test function indicating if a character is allowed unencoded in a URI. For stricter RFC2396 compliant parsing you may also pass *is_allowed_2396()* or *is_allowed_1738()*.

For information, RFC2396 added "~" to the range of allowed characters and RFC2732 added "[" and "]" to support IPv6 literals.

This function can be used to scan a string of characters for a URI, for example:

```
x = "http://www.pyslet.org/ is great"
url = x[:parse_uric(x, 0)]
```

It does not check the validity of the URI against the specification. The purpose is to allow a URI to be extracted from some source text. It assumes that all characters that must be encoded in URI *are* encoded, so characters outside the ASCII character set automatically terminate the URI as do any unescaped characters outside the

allowed set (defined by the *allowed_test*). See *encode_unicode_uri()* for details of how to create an appropriate source string in contexts where non-ASCII characters may be present.

pyslet.rfc2396.**split_server**(*authority*)
Splits an authority component

authority A character string containing the authority component of a URI.

Returns a triple of:

```
(userinfo, host, port)
```

There is no parsing of the individual components which may or may not be syntactically valid according to the specification. The userinfo is defined as anything up to the "@" symbol or None if there is no "@". The port is defined as any digit-string (possibly empty) after the last ":" character or None if there is no ":" or if there is non-empty string containing anything other than a digit after the last ":".

The return values are always character strings (or None). There is no unescaping or other parsing of the values.

pyslet.rfc2396.**split_path**(*path*, *abs_path=True*)
Splits a URI-encoded path into path segments

path A character string containing the path component of a URI. If path is None we treat as for an empty string.

abs_path A flag (defaults to True) indicating whether or not the path is relative or absolute. This flag only affects the handling of the empty path. An empty absolute path is treated as if it were '/' and returns a list containing a single empty path segment whereas an empty relative path returns a list with no path segments, in other words, an empty list.

The return result is always a list of character strings split from *path*. It will only end in an empty path segment if the path ends with a slash.

pyslet.rfc2396.**split_abs_path**(*path*, *abs_path=True*)
Provided for backwards compatibility

Equivalent to:

```
split_path(abs_path, True)
```

pyslet.rfc2396.**split_rel_path**(*rel_path*)
Provided for backwards compatibility

Equivalent to:

```
split_path(abs_path, False)
```

pyslet.rfc2396.**normalize_segments**(*path_segments*)
Normalizes a list of path_segments

path_segments A list of character strings representing path segments, for example, as returned by *split_path()*.

Normalizing follows the rules for resolving relative URI paths, './' and trailing '.' are removed, 'seg/../' and trailing seg/.. are also removed.

6.6.5 Exceptions

class pyslet.rfc2396.**URIException**
Bases: exceptions.Exception

Base class for URI-related exceptions

class pyslet.rfc2396.**URIRelativeError**
Bases: *pyslet.rfc2396.URIException*

Exceptions raised while resolve relative URI

6.6.6 Legacy

The following definitions are provided for backwards compatibility only.

pyslet.rfc2396.**URIFactory**
An instance of *URIFactoryClass* that can be used for creating *URI* instances.

class pyslet.rfc2396.**URIFactoryClass**
Bases: pyslet.pep8.PEP8Compatibility

6.7 The Atom Syndication Format (RFC4287)

This module defines functions and classes for working with the Atom Syndication Format as defined by RFC4287: http://www.ietf.org/rfc/rfc4287.txt

6.7.1 Reference

Elements

class pyslet.rfc4287.**Feed**(*parent*)
Bases: *pyslet.rfc4287.Source*

Represents an Atom feed.

This is the document (i.e., top-level) element of an Atom Feed Document, acting as a container for metadata and data associated with the feed

AtomIdClass
alias of *AtomId*

TitleClass
alias of *Title*

UpdatedClass
alias of *Updated*

Entry = None
atomEntry

class pyslet.rfc4287.**Source**(*parent*)
Bases: *pyslet.rfc4287.Entity*

Metadata from the original source feed of an entry.

This class is also used a base class for *Feed*.

Generator = None
atomGenerator

Icon = None
atomIcon

Logo = None
atomLogo

Subtitle = None
atomSubtitle

class pyslet.rfc4287.**Entry**(*parent*)
Bases: *pyslet.rfc4287.Entity*

An individual entry, acting as a container for metadata and data associated with the entry.

AtomIdClass
alias of *AtomId*

TitleClass
alias of *Title*

UpdatedClass
alias of *Updated*

LinkClass
alias of *Link*

class pyslet.rfc4287.**Entity**(*parent*)
Bases: *pyslet.rfc4287.AtomElement*

Base class for feed, entry and source elements.

LinkClass
alias of *Link*

AtomId = None
the atomId of the object

Note that we qualify the class name used to represent the id to avoid confusion with the existing 'id' attribute in *Element*.

Author = None
atomAuthor

Link = None
atomLink

Title = None
atomTitle

class pyslet.rfc4287.**Author**(*parent*)
Bases: *pyslet.rfc4287.Person*

A Person construct that indicates the author of the entry or feed.

class pyslet.rfc4287.**Category**(*parent*)
Bases: *pyslet.rfc4287.AtomElement*

Information about a category associated with an entry or feed.

term = None
a string that identifies the category to which the entry or feed belongs

scheme = None
an IRI that identifies a categorization scheme.

This is not converted to a *pyslet.rfc2396.URI* instance as it is not normally resolved to a resource. Instead it defines a type of namespace.

label = None
a human-readable label for display in end-user applications

class pyslet.rfc4287.**Content**(*parent*)
Bases: *pyslet.rfc4287.Text*

Contains or links to the content of the entry.

Although derived from *Text* this class overloads the meaning of the `Text.type` attribute allowing it to be a media type.

src = None
link to remote content

GetValue()
Gets a single unicode string representing the value of the element.

Overloads the basic *GetValue()*, if `type` is a media type rather than one of the text types then a ValueError is raised.

class pyslet.rfc4287.**Contributor**(*parent*)
Bases: *pyslet.rfc4287.Person*

A Person construct that indicates a person or other entity who contributed to the entry or feed.

class pyslet.rfc4287.**Generator**(*parent*)
Bases: *pyslet.rfc4287.AtomElement*

Identifies the agent used to generate a feed, for debugging and other purposes.

uri = None
the uri of the tool used to generate the feed

version = None
the version of the tool used to generate the feed

SetPysletInfo()
Sets this generator to a default representation of this Pyslet module.

class pyslet.rfc4287.**Icon**(*parent*)
Bases: *pyslet.rfc4287.AtomElement*

Identifies an image that provides iconic visual identification for a feed.

uri = None
a *URI* instance representing the URI of the icon

GetValue()
Overrides *GetValue()*, returning a *pyslet.rfc2396.URI* instance.

SetValue(*value*)
Overrides *SetValue()*, enabling the value to be set from a *pyslet.rfc2396.URI* instance.

If *value* is a string it is used to set the element's content, *content_changed()* is then called to update the value of *uri*. If *value* is a URI instance then *uri* is set directory and it is then converted to a string and used to set the element's content.

content_changed()
Re-reads the value of the element and sets *uri* accordingly.

class pyslet.rfc4287.**AtomId**(*parent*, *name=None*)
Bases: *pyslet.rfc4287.AtomElement*

A permanent, universally unique identifier for an entry or feed.

class pyslet.rfc4287.**Link**(*parent*)
Bases: *pyslet.rfc4287.AtomElement*

A reference from an entry or feed to a Web resource.

href = None
a *URI* instance, the link's IRI

rel = None
a string indicating the link relation type

type = None
an advisory media type

title = None
human-readable information about the link

class pyslet.rfc4287.**Logo**(*parent*)
Bases: *pyslet.rfc4287.Icon*

An image that provides visual identification for a feed.

class pyslet.rfc4287.**Published**(*parent*)
Bases: *pyslet.rfc4287.Date*

A Date construct indicating an instant in time associated with an event early in the life cycle of the entry.

class pyslet.rfc4287.**Rights**(*parent*)
Bases: *pyslet.rfc4287.Text*

A Text construct that conveys information about rights held in and over an entry or feed.

class pyslet.rfc4287.**Subtitle**(*parent*)
Bases: *pyslet.rfc4287.Text*

A *Text* construct that conveys a human-readable description or subtitle for a feed.

class pyslet.rfc4287.**Summary**(*parent*)
Bases: *pyslet.rfc4287.Text*

A *Text* construct that conveys a short summary, abstract, or excerpt of an entry.

class pyslet.rfc4287.**Title**(*parent*)
Bases: *pyslet.rfc4287.Text*

A *Text* construct that conveys a human-readable title for an entry or feed.

class pyslet.rfc4287.**Updated**(*parent*)
Bases: *pyslet.rfc4287.Date*

A Date construct indicating the most recent instant in time when an entry or feed was modified in a way the publisher considers significant.

Base Classes

class pyslet.rfc4287.**Person**(*parent*)
Bases: *pyslet.rfc4287.AtomElement*

An element that describes a person, corporation, or similar entity

NameClass
alias of *Name*

URIClass
alias of *URI*

class pyslet.rfc4287.**Name**(*parent*, *name=None*)
Bases: *pyslet.rfc4287.AtomElement*

A human-readable name for a person.

class pyslet.rfc4287.**URI**(*parent*, *name=None*)
Bases: *pyslet.rfc4287.AtomElement*

An IRI associated with a person

class pyslet.rfc4287.**Email**(*parent*, *name=None*)
Bases: *pyslet.rfc4287.AtomElement*

An e-mail address associated with a person

class pyslet.rfc4287.**Text**(*parent*)
Bases: *pyslet.rfc4287.AtomElement*

Base class for atomPlainTextConstruct and atomXHTMLTextConstruct.

SetValue(*value*, *type=1*)
Sets the value of the element. *type* must be a value from the *TextType* enumeration

Overloads the basic *SetValue()* implementation, adding an additional *type* attribute to enable the value to be set to either a plain TextType.text, TextType.html or TextType.xhtml value. In the case of an xhtml type, *value* is parsed for the required XHTML div element and this becomes the only child of the element. Given that the div itself is not considered to be part of the content the value can be given without the enclosing div, in which case it is generated automatically.

GetValue()
Gets a single unicode string representing the value of the element.

Overloads the basic *GetValue()* implementation to add support for text of type xhtml.

When getting the value of TextType.xhtml text the child div element is not returned as it is not considered to be part of the content.

class pyslet.rfc4287.**TextType**
Bases: *pyslet.xsdatatypes20041028.Enumeration*

text type enumeration:

```
"text" | "html" | "xhtml"
```

This enumeration is used for setting the `Text.type` attribute.

Usage: TextType.text, TextType.html, TextType.xhtml

class pyslet.rfc4287.**Date**(*parent*)
Bases: *pyslet.rfc4287.AtomElement*

An element conforming to the definition of date-time in RFC3339.

This class is modeled using the iso8601 module.

date = None
a *TimePoint* instance representing this date

GetValue()
Overrides *GetValue()*, returning a *pyslet.iso8601.TimePoint* instance.

SetValue(*value*)
Overrides *SetValue()*, enabling the value to be set from a *pyslet.iso8601.TimePoint* instance.

If *value* is a string the behaviour is unchanged, if *value* is a TimePoint instance then it is formatted using the extended format of ISO 8601 in accordance with the requirements of the Atom specification.

content_changed()
Re-reads the value of the element and sets *date* accordingly.

class pyslet.rfc4287.**AtomElement**(*parent*, *name=None*)
Bases: pyslet.xmlnames20091208.XMLNSElement

Base class for all APP elements.

All atom elements can have xml:base and xml:lang attributes, these are handled by the *Element* base class.

See *GetLang()* and *SetLang()*, *GetBase()* and *SetBase()*

Constants

pyslet.rfc4287.**ATOM_NAMESPACE = 'http://www.w3.org/2005/Atom'**
The namespace to use for Atom Document elements

pyslet.rfc4287.**ATOM_MIMETYPE = 'application/atom+xml'**
The mime type for Atom Document

6.8 The Atom Publishing Protocol (RFC5023)

This module defines functions and classes for working with the Atom Publishing Protocl as defined by RFC5023: http://www.ietf.org/rfc/rfc5023.txt

6.8.1 Reference

Elements

class pyslet.rfc5023.**Service**(*parent*)
Bases: *pyslet.rfc5023.APPElement*

The container for service information

Associated with one or more Workspaces.

Workspace = None
a list of *Workspace* instances

class pyslet.rfc5023.**Workspace**(*parent*)
Bases: *pyslet.rfc5023.APPElement*

Workspaces are server-defined groups of Collections.

Title = None
the title of this workspace

Collection = None
a list of *Collection*

class pyslet.rfc5023.**Collection**(*parent*)
Bases: *pyslet.rfc5023.APPElement*

Describes a collection (feed).

Title = None
the URI of the collection (feed)

Accept = None
the human readable title of the collection

Categories = None
list of *Accept* media ranges that can be posted to the collection

get_feed_url()
Returns a fully resolved URL for the collection (feed).

class pyslet.rfc5023.**Categories**(*parent*)
Bases: *pyslet.rfc5023.APPElement*

The root of a Category Document.

A category document is a document that describes the categories allowed in a collection.

fixed = None
an optional *URI* to the category

scheme = None
indicates whether the list of categories is a fixed set. By default they're open.

Category = None
identifies the default scheme for categories defined by this element

Base Classes

class pyslet.rfc5023.**Accept**(*parent*, *name=None*)
Bases: *pyslet.rfc5023.APPElement*

Represents the accept element.

class pyslet.rfc5023.**Document**(***args*)
Bases: pyslet.rfc4287.AtomDocument

Class for working with APP documents.

This call can represent both APP and Atom documents.

ValidateMimeType(*mimetype*)
Checks *mimetype* against the APP or Atom specifications.

classmethod get_element_class(*name*)
Returns the APP or Atom class used to represent name.

Overrides `get_element_class()` when the namespace is *APP_NAMESPACE*.

class pyslet.rfc5023.**APPElement**(*parent*, *name=None*)
Bases: pyslet.xmlnames20091208.XMLNSElement

Base class for all APP elements.

All APP elements can have xml:base, xml:lang and/or xml:space attributes. These are handled by the base *Element* base class.

Constants

pyslet.rfc5023.**APP_NAMESPACE** = **'http://www.w3.org/2007/app'**
The namespace to use for Atom Publishing Protocol elements

pyslet.rfc5023.**ATOMSVC_MIMETYPE** = **'application/atomsvc+xml'**
The mime type for service documents

pyslet.rfc5023.**ATOMCAT_MIMETYPE** = **'application/atomcat+xml'**
The mime type for category documents

6.9 ISO 8601 Dates and Times

This module defines special classes for handling ISO 8601 dates and times.

class pyslet.iso8601.**Date**(*src=None*, *base=None*, *century=None*, *decade=None*, *year=None*, *month=None*, *day=None*, *week=None*, *weekday=None*, *ordinal_day=None*, *absolute_day=None*, ***kwargs*)
Bases: pyslet.pep8.PEP8Compatibility, *pyslet.py2.CmpMixin*, *pyslet.py2.UnicodeMixin*

A class for representing ISO dates.

Values can represent dates with reduced precision, for example:

```
Date(century=20,year=13,month=12)
```

represents December 2013, no specific day.

There are a number of different forms of the constructor based on named parameters, the simplest is:

```
Date(century=19,year=69,month=7,day=20)
```

You can also use weekday format (note that decade must be provided separately):

```
Date(century=19,decade=6,year=9,week=29,weekday=7)
```

Ordinal format (where day 1 is 1st Jan):

```
Date(century=19,year=69,ordinal_day=201)
```

Absolute format (where day 1 is the notional 1st Jan 0001):

```
Date(absolute_day=718998)
```

An empty constructor is equivalent to:

```
Date()==Date(absolute_day=1)
```

All constructors except the absolute form allow the passing of a *base* date which allows the most-significant values to be omitted, for example:

```
base=Date(century=19,year=69,month=7,day=20)
newDate=Date(day=21,base=base)  #: 21st July 1969
```

Note that *base* always represents a date *before* the newly constructed date, so:

```
base=Date(century=19,year=99,month=12,day=31)
newDate=Date(day=5,base=base)
```

constructs a Date representing the 5th January 2000

Given that Date can hold imprecise dates, there is some ambiguity over the comparisons between things such as January 1985 and Week 3 1985. Although at first sight it may be tempting to declare 1st April to be greater than March, it is harder to determine the relationship between 1st April and April itself. Especially if a complete ordering is required.

The approach taken here is to disallow comparisons between dates with different precisions.

Date objects are immutable and so can be used as the keys in dictionaries provided they all share the same precision.

Some older functions did allow modification but these no raise an error with an appropriate suggested refactoring.

Instances can be converted directly to strings using the default, extended calendar format. Other formats are supported through format specific methods.

century = None
the century, 0..99

year = None
the year, 0..99

month = None
the month, 1..12 (for dates stored in calendar form)

week = None
the week (for dates stored in week form)

Fully specified dates are always stored in calendar form but instances can represent reduced precision dates in week format, e.g., 2016-W01. In these cases, *day* and *month* will be None and the week will be recorded instead.

day = None
the day, 1..31

get_absolute_day()
Return a notional day number

The number 1 being the 0001-01-01 which is the base day of our calendar.

get_calendar_day()
Returns a tuple of: (century,year,month,day)

get_ordinal_day()
Returns a tuple of (century,year,ordinal_day)

get_week_day()
Returns a tuple of (century,decade,year,week,weekday), note that Monday is 1 and Sunday is 7

classmethod from_struct_time(*t*)
Constructs a *Date* from a struct_time, such as might be returned from time.gmtime() and related functions.

update_struct_time(*t*)
update_struct_time changes the year, month, date, wday and ydat fields of t, a struct_time, to match the values in this date.

classmethod from_now()
Constructs a *Date* from the current local time.

offset(*centuries=0*, *years=0*, *months=0*, *weeks=0*, *days=0*)
Adds an offset

Constructs a *Date* from the given date + a given offset.

There are significant limitations on this method to avoid ambiguous outcomes such as adding 1 year to a leap day such as 2016-02-29.

A fully specified date can be offset by days or weeks, in the latter case all weeks have 7 days so this is always unambiguous.

Dates known only to week precision can only be offset by weeks.

Dates with month precision can be offset by months, years or centuries because every year has exactly the same number of months. The concept of February next year is always meaningful (unlike the meaning of 29th Feb next year or the similarly problematic week 53 next year).

Dates with year precision can be offset by years or centuries and, for completeness, dates with century precision can only be offset by centuries.

classmethod from_str(*src*, *base=None*)
Parses a *Date* instance from a *src* string.

classmethod from_string_format(*src*, *base=None*)
Similar to *from_str()* except that a tuple is returned, the first item is the resulting *Date* instance, the second is a string describing the format parsed. For example:

```
d,f=Date.from_string_format("1969-07-20")
# f is set to "YYYY-MM-DD".
```

get_calendar_string(*basic=False*, *truncation=0*)
Formats this date using calendar form, for example 1969-07-20

basic True/False, selects basic form, e.g., 19690720. Default is False

truncation One of the *Truncation* constants used to select truncated forms of the date. For example, if you specify *Truncation.Year* you'll get –07-20 or –0720. Default is *NoTruncation*.

Note that Calendar format only supports Century, Year and Month truncated forms.

get_ordinal_string(*basic=False*, *truncation=0*)
Formats this date using ordinal form, for example 1969-201

basic True/False, selects basic form, e.g., 1969201. Default is False

truncation One of the *Truncation* constants used to select truncated forms of the date. For example, if you specify *Truncation.Year* you'll get -201. Default is *NoTruncation*.

Note that ordinal format only supports century and year truncated forms.

get_week_string(*basic=False*, *truncation=0*)
Formats this date using week form, for example 1969-W29-7

basic True/False, selects basic form, e.g., 1969W297. Default is False

truncation One of the *Truncation* constants used to select truncated forms of the date. For example, if you specify *Truncation.Year* you'll get -W297. Default is *NoTruncation*.

Note that week format only supports century, decade, year and week truncated forms.

classmethod from_julian(*year*, *month*, *day*)
Constructs a *Date* from a year, month and day expressed in the Julian calendar.

get_julian_day()
Returns a tuple of: (year,month,day) representing the equivalent date in the Julian calendar.

leap_year()
leap_year returns True if this date is (in) a leap year and False otherwise.

Note that leap years fall on all years that divide by 4 except those that divide by 100 but including those that divide by 400.

complete()
Returns True if this date has a complete representation, i.e., does not use one of the reduced precision forms.

get_precision()
Returns one of the *Precision* constants representing the precision of this date.

class pyslet.iso8601.**Time**(*src=None*, *hour=None*, *minute=None*, *second=None*, *total_seconds=None*, *zdirection=None*, *zhour=None*, *zminute=None*, ***kwargs*)
Bases: pyslet.pep8.PEP8Compatibility, *pyslet.py2.UnicodeMixin*, *pyslet.py2.CmpMixin*

A class for representing ISO times

Values can represent times with reduced precision, for example:

```
Time(hour=20)
```

represents 8pm without a specific minute/seconds value.

There are a number of different forms of the constructor based on named parameters, the simplest is:

```
Time(hour=20, minute=17, second=40)
```

Indicate UTC (Zulu time) by providing a zone direction of 0:

```
Time(hour=20, minute=17, second=40, zdirection=0)
```

To indicate a UTC offset provide additional values for hours (and optionally minutes) with 1 or -1 for zdirection to indicate the direction of the shift. 1 indicates a more Easterly timezone, -1 indicates a more Westerly zone:

```
Time(hour=15, minute=17, second=40, zdirection=-1, zhour=5,
     zminute=0)
```

A UTC offset of 0 hours and minutes results in a value that compares as equal to the corresponding Zulu time but is formatted using an explicit offset by str() rather than using the canonical "Z" form.

You may also specify a total number of seconds past midnight (no zone):

Time(total_seconds=73060)

If total_seconds overflows an error is raised. To create a time from an arbitrary number of seconds and catch overflow use offset instead:

```
Time(total_seconds=159460)
# raises DateTimeError

t, overflow = Time().offset(seconds=159460)
# sets t to 20:40:17 and overflow=1
```

Time supports two representations of midnight: 00:00:00 and 24:00:00 in keeping with the ISO specification. These are considered equivalent by comparisons!

Truncated forms can be created directly from the base time, see *extend()* for more information.

Comparisons are dealt with in a similar way to Date in that times must have the same precision to be comparable. Although this behaviour is consistent it might seem strange at first as it rules out comparing 09:00:15 with 09:00 but, in effect, 09:00 is actually all times in the range 09:00:00-09:00:59.999....

Zones further complicate this method but the rule is very simple, we only ever compare times from the same zone (or if both have unspecified zones). There is one subtlety to this implementation. Times stored with a redundant +00:00 or -00:00 are treated the same as those with a zero zone direction (Zulu time).

Time objects are immutable and so can be used as the keys in dictionaries provided they all share the same precision.

Some older functions did allow modification but these have been deprecated. Use python -Wd to force warnings from these unsafe methods.

Instances can be converted directly to strings or unicode strings using the default, extended format. Other formats are supported through format specific methods.

hour = None
the hour, 0..24

minute = None
the minute, 0..59

second = None
the seconds, 0..60 (to include leap seconds)

zoffset = None
the difference in minutes to UTC

get_total_seconds()
Note that leap seconds are handled as if they were invisible, e.g., 23:00:60 returns the same total seconds as 23:00:59.

get_time()
Returns a tuple of (hour,minute,second).

Times with reduced precision will return None for second and or minute.

get_zone()
Returns a tuple of:

```
(zdirection,zoffset)
```

zdirection is defined as per Time's constructor, zoffset is a non-negative integer minute offset or None, if the zone is unspecified for this Time.

get_zone_offset()
Returns a single integer representing the zone offset (in minutes) or None if this time does not have a time zone offset.

get_zone3()
Returns a tuple of:

```
(zdirection, zhour, zminute)
```

These values are defined as per Time's constructor.

get_canonical_zone()
Returns a tuple of:

```
(zdirection, zhour, zminute)
```

These values are defined as per Time's constructor but zero offsets always return zdirection=0. If present, the zone is always returned with complete (minute) precision.

get_time_and_zone()
Returns a tuple of (hour,minute,second,zone direction,zone offset) as defined in get_time and get_zone.

extend(*hour=None*, *minute=None*, *second=None*)
Constructs a *Time* instance from an existing time, extended a (possibly) truncated hour/minute/second value.

The time zone is always copied if present. The result is a tuple of (<Time instance>,overflow) where overflow 0 or 1 indicating whether or not the time overflowed. For example:

```
# set base to 20:17:40Z
base=Time(hour=20,minute=17,second=40,zdirection=0)
t,overflow=base.extend(minute=37)
# t is 20:37:40Z, overflow is 0
t,overflow=base.extend(minute=7)
# t is 21:07:40Z, overflow is 0
t,overflow=base.extend(hour=19,minute=7)
# t is 19:07:40Z, overflow is 1
```

offset(*hours=0*, *minutes=0*, *seconds=0*)
Constructs a *Time* instance from an existing time and an offset number of hours, minutes and or seconds.

The time zone is always copied (if present). The result is a tuple of (<Time instance>,overflow) where overflow is 0 or 1 indicating whether or not the time overflowed. For example:

```
# set base to 20:17:40Z
base = Time(hour=20, minute=17, second=40, zdirection=0)
t, overflow = base.offset(minutes=37)
# t is 20:54:40Z, overflow is 0
t, overflow = base.offset(hours=4, minutes=37)
# t is 00:54:40Z, overflow is 1
```

with_zone(*zdirection*, *zhour=None*, *zminute=None*, ***kwargs*)
Replace time zone information

Constructs a new *Time* instance from an existing time but with the time zone specified. The time zone of the existing time is ignored. Pass *zdirection*=None to strip the zone information completely.

shift_zone(*zdirection*, *zhour=None*, *zminute=None*, ***kwargs*)
Constructs a *Time* instance from an existing time but shifted so that it is in the time zone specified. The return value is a tuple of:

```
(<Time instance>, overflow)
```

overflow is one of -1, 0 or 1 indicating if the time over- or under-flowed as a result of the time zone shift.

classmethod from_struct_time(*t*)
Constructs a zone-less *Time* from a struct_time, such as might be returned from time.gmtime() and related functions.

update_struct_time(*t*)
update_struct_time changes the hour, minute, second and isdst fields of t, a struct_time, to match the values in this time.

isdst is always set to -1

classmethod from_now()
Constructs a *Time* from the current local time.

classmethod from_str(*src*, *base=None*)
Constructs a *Time* instance from a string representation, truncated forms are returned as the earliest time on or after *base* and may have overflowed. See *from_string_format()* for more.

with_zone_string(*zone_str*)
Constructs a *Time* instance from an existing time but with the time zone parsed from *zone_str*. The time zone of the existing time is ignored.

with_zone_string_format(*zone_str*)
Constructs a *Time* instance from an existing time but with the time zone parsed from *zone_str*. The time zone of the existing time is ignored.

Returns a tuple of: (<Time instance>,format)

classmethod from_string_format(*src*, *base=None*)
Constructs a *Time* instance from a string representation, truncated forms are returned as the earliest time on or after *base*.

Returns a tuple of (<Time instance>,overflow,format) where overflow is 0 or 1 indicating whether or not a truncated form overflowed and format is a string representation of the format parsed, e.g., "hhmmss".

get_string(*basic=False*, *truncation=0*, *ndp=0*, *zone_precision=7*, *dp='.'*, ***kwargs*)
Formats this time, including zone, for example 20:17:40

basic True/False, selects basic form, e.g., 201740. Default is False

truncation One of the *Truncation* constants used to select truncated forms of the time. For example, if you specify *Truncation.Hour* you'll get -17:40 or -1740. Default is *NoTruncation*.

ndp Specifies the number of decimal places to display for the least significant component, the default is 0.

dp The character to use as the decimal point, the default is the *comma*, as per the ISO standard.

zone_precision One of *Precision.Hour* or *Precision.Complete* to control the precision of the zone offset.

Note that time formats only support Minute and Second truncated forms.

get_zone_string(*basic=False*, *zone_precision=7*, ***kwargs*)
Formats this time's zone, for example -05:00.

basic True/False, selects basic form, e.g., -0500. Default is False

zone_precision One of *Precision.Hour* or *Precision.Complete* to control the precision of the zone offset.

Times constructed with a zdirection value of 0 are always rendered using "Z" for Zulu time (the name is taken from the phonetic alphabet). To force use of the offset format you must construct the time with a non-zero value for zdirection.

complete()
Returns True if this date has a complete representation, i.e., does not use one of the reduced precision forms.

(Whether or not a time is complete refers only to the precision of the time value, it says nothing about the presence or absence of a time zone offset.)

get_precision()
Returns one of the *Precision* constants representing the precision of this time.

with_precision(*precision*, *truncate=False*)
Constructs a *Time* instance from an existing time but with the precision specified by *precision*.

precision is one of the *Precision* constants, only hour, minute and complete precision are valid.

truncate is True/False indicating whether or not the time value should be truncated so that all values are integers. For example:

```
        t = Time(hour=20, minute=17, second=40)
        tm = t.with_precision(Precision.Minute, False)
        print tm.get_string(ndp=3)
        #   20:17,667
        tm=t.with_precision(Precision.Minute, True)
        print tm.get_string(ndp=3)
        #   20:17,000
```

class pyslet.iso8601.**TimePoint**(*src=None*, *date=None*, *time=None*)

Bases: pyslet.pep8.PEP8Compatibility, *pyslet.py2.UnicodeMixin*, *pyslet.py2.CmpMixin*

A class for representing ISO timepoints

TimePoints are constructed from a date and a time (which may or may not have a time zone), for example:

```
TimePoint(date=Date(year=1969,month=7,day=20),
          time=Time(hour=20,minute=17,second=40,zdirection=0))
```

If the date is missing then the date origin is used, Date() or 0001-01-01. Similarly, if the time is missing then the time origin is used, Time() or 00:00:00

Times may be given with reduced precision but the date must be complete. In other words, there is no such thing as a timepoint with, month precision, use Date instead.

When comparing TimePoint instances we deal with partially specified TimePoints in the same way as *Time*. However, unlike the comparison of Time instances, we reduce all TimePoints with time-zones to a common zone before doing a comparison. As a result, TimePoints which are equal but are expressed in different time zones will still compare equal.

Instances can be converted directly to strings or unicode strings using the default, extended calendar format. Other formats are supported through format specific methods.

get_calendar_time_point()

Returns a tuple representing the calendar date

The result is:

```
(century, year, month, day, hour, minute, second)
```

get_ordinal_time_point()

Returns a tuple representing the ordinal date

The result is:

```
(century, year, ordinal_day, hour, minute, second)
```

get_week_day_time_point()

Returns a tuple representing the week day

The result is:

```
(century, decade, year, week, weekday, hour, minute,
 second)
```

get_zone()

Returns a tuple representing the zone

The result is (zdirection, zoffset)

See *Time.get_zone()* for details.

with_zone(*zdirection*, *zhour=None*, *zminute=None*, ***kwargs*)
Constructs a *TimePoint* instance from an existing TimePoint but with the time zone specified. The time zone of the existing TimePoint is ignored.

shift_zone(*zdirection*, *zhour=None*, *zminute=None*, ***kwargs*)
Shifts time zone

Constructs a *TimePoint* instance from an existing TimePoint but shifted so that it is in the time zone specified.

update_struct_time(*t*)
Outputs the TimePoint in struct_time format

Changes the year, month, date, hour, minute and second fields of t, t must be a mutable list arranged in the same order as struct_time.

classmethod from_struct_time(*t*)
Constructs an instance from a struct_time

In other words, constructs an instance from the object returned from time.gmtime() and related functions.

classmethod from_str(*src*, *base=None*, *tdesignators='T'*)
Constructs a TimePoint from a string representation. Truncated forms are parsed with reference to *base*.

classmethod from_string_format(*src*, *base=None*, *tdesignators='T'*, ***kwargs*)
Creates an instance from a string

Similar to *from_str()* except that a tuple is returned, the first item is the resulting *TimePoint* instance, the second is a string describing the format parsed. For example:

```
tp, f = TimePoint.from_string_format("1969-07-20T20:40:17")
# f is set to "YYYY-MM-DDTmm:hh:ss".
```

get_calendar_string(*basic=False*, *truncation=0*, *ndp=0*, *zone_precision=7*, *dp='.'*, *tdesignator='T'*, ***kwargs*)
Formats this TimePoint using calendar form

For example '1969-07-20T20:17:40'

basic True/False, selects basic form, e.g., 19690720T201740. Default is False

truncation One of the *Truncation* constants used to select truncated forms of the date. For example, if you specify *Truncation.Year* you'll get –07-20T20:17:40 or –0720T201740. Default is *NoTruncation*. Note that Calendar format only supports Century, Year and Month truncated forms, the time component cannot be truncated.

ndp*, *dp* and *zone_precision As specified in *Time.get_string()*

get_ordinal_string(*basic=0*, *truncation=0*, *ndp=0*, *zone_precision=7*, *dp='.'*, *tdesignator='T'*, ***kwargs*)
Formats this TimePoint using ordinal form

For example '1969-201T20:17:40'

basic True/False, selects basic form, e.g., 1969201T201740. Default is False

truncation One of the *Truncation* constants used to select truncated forms of the date. For example, if you specify *Truncation.Year* you'll get -201T20-17-40. Default is *NoTruncation*. Note that ordinal format only supports century and year truncated forms, the time component cannot be truncated.

ndp*, *dp* and *zone_precision As specified in *Time.get_string()*

get_week_string(*basic=0*, *truncation=0*, *ndp=0*, *zone_precision=7*, *dp='.'*, *tdesignator='T'*, ***kwargs*)
Formats this TimePoint using week form

For example '1969-W29-7T20:17:40'

basic True/False, selects basic form, e.g., 1969W297T201740. Default is False

truncation One of the *Truncation* constants used to select truncated forms of the date. For example, if you specify *Truncation.Year* you'll get -W297T20-17-40. Default is *NoTruncation*. Note that week format only supports century, decade, year and week truncated forms, the time component cannot be truncated.

ndp*, *dp* and *zone_precision As specified in *Time.get_string()*

classmethod from_unix_time(*unix_time*)
Constructs a TimePoint from *unix_time*, the number of seconds since the time origin. The resulting time is in UTC.

This method uses python's gmtime(0) to obtain the time origin, it isn't necessarily the Unix base time of 1970-01-01.

get_unixtime()
Returns a unix time value representing this time point.

classmethod from_now()
Constructs a TimePoint from the current local date and time.

classmethod from_now_utc()
Constructs a TimePoint from the current UTC date and time.

complete()
Test for complete precision

Returns True if this TimePoint has a complete representation, i.e., does not use one of the reduced precision forms

(Whether or not a TimePoint is complete refers only to the precision of the time value, it says nothing about the presence or absence of a time zone offset.)

get_precision()
Returns one of the *Precision* constants representing the precision of this TimePoint.

with_precision(*precision*, *truncate*)
Return new instance with *precision*

Constructs a *TimePoint* instance from an existing TimePoint but with the precision specified by *precision*. For more details see *Time.with_precision()*

class pyslet.iso8601.**Duration**(*value=None*)
Bases: pyslet.pep8.PEP8Compatibility

A class for representing ISO durations

6.9.1 Supporting Constants

class pyslet.iso8601.**Truncation**
Defines constants to use when formatting to truncated forms.

No = 0
constant for no truncation

Century = 1
constant for truncating to century

Decade = 2
constant for truncating to decade

Year = 3
constant for truncating to year

Month = 4
constant for truncating to month

Week = 5
constant for truncating to week

Hour = 6
constant for truncating to hour

Minute = 7
constant for truncating to minute

pyslet.iso8601.**NoTruncation = 0**
a synonym for Truncation.No

class pyslet.iso8601.**Precision**
Defines constants for representing reduced precision.

Century = 1
constant for century precision

Year = 2
constant for year precision

Month = 3
constant for month precision

Week = 4
constant for week precision

Hour = 5
constant for hour precision

Minute = 6
constant for minute precision

Complete = 7
constant for complete representations

6.9.2 Utility Functions

pyslet.iso8601.**leap_year**(*year*)
leap_year returns True if *year* is a leap year and False otherwise.

Note that leap years famously fall on all years that divide by 4 except those that divide by 100 but including those that divide by 400.

pyslet.iso8601.**day_of_week**(*year*, *month*, *day*)
day_of_week returns the day of week 1-7

1 being Monday for the given year, month and day

pyslet.iso8601.**week_count**(*year*)
Week count returns the number of calendar weeks in a year.

Most years have 52 weeks of course, but if the year begins on a Thursday or a leap year begins on a Wednesday then it has 53.

pyslet.iso8601.**get_local_zone**()
Returns the number of minutes ahead of UTC we are

This is calculated by comparing the return result of the time module's gmtime and localtime methods.

6.10 Unicode Characters

6.10.1 Utility Functions

pyslet.unicode5.**detect_encoding**(*magic*)
Detects text encoding

magic A string of bytes

Given a byte string this function looks at (up to) four bytes and returns a best guess at the unicode encoding being used for the data.

It returns a string suitable for passing to Python's native decode method, e.g., 'utf-8'. The default is 'utf-8', an encoding which will also work if the data is plain ASCII.

6.10.2 Character Classes

class pyslet.unicode5.**CharClass**(**args*)
Bases: *pyslet.py2.UnicodeMixin*

Represents a class of unicode characters.

A class of characters is represented internally by a list of character ranges that define the class. This is efficient because most character classes are defined in blocks of characters.

For the constructor, multiple arguments can be provided.

String arguments add all characters in the string to the class. For example, CharClass('abcxyz') creates a class comprising two ranges: a-c and x-z.

Tuple/List arguments can be used to pass pairs of characters that define a range. For example, CharClass(('a','z')) creates a class comprising the letters a-z.

Instances of CharClass can also be used in the constructor to add an existing class.

Instances support Python's repr function:

```
>>> c = CharClass('abcxyz')
>>> print repr(c)
CharClass((u'a',u'c'), (u'x',u'z'))
```

The string representation of a CharClass is a python regular expression suitable for matching a single character from the CharClass:

```
>>> print str(c)
[a-cx-z]
```

classmethod ucd_category(*category*)
Returns the character class representing the Unicode category.

You must *not* modify the returned instance, if you want to derive a character class from one of the standard Unicode categories then you should create a copy by passing the result of this class method to the CharClass constructor, e.g. to create a class of all general controls and the space character:

```
c=CharClass(CharClass.ucd_category(u"Cc"))
c.add_char(u" ")
```

classmethod ucd_block(*block_name*)
Returns the character class representing the Unicode block.

You must not modify the returned instance, if you want to derive a character class from one of the standard Unicode blocks then you should create a copy by passing the result of this class method to the CharClass constructor, e.g. to create a class combining all Basic Latin characters and those in the Latin-1 Supplement:

```
c=CharClass(CharClass.ucd_block(u"Basic Latin"))
c.add_class(CharClass.ucd_block(u"Latin-1 Supplement")
```

format_re()
Create a representation of the class suitable for putting in [] in a python regular expression

add_range(*a*, *z*)
Adds a range of characters from a to z to the class

subtract_range(*a*, *z*)
Subtracts a range of characters from the character class

add_char(*c*)
Adds a single character to the character class

subtract_char(*c*)
Subtracts a single character from the character class

add_class(*c*)
Adds all the characters in c to the character class

This is effectively a union operation.

subtract_class(*c*)
Subtracts all the characters in c from the character class

negate()
Negates this character class

test(*c*)
Test a unicode character.

Returns True if the character is in the class.

If c is None, False is returned.

6.10.3 Parsing Text and Binary Data

class pyslet.unicode5.**BasicParser**(*source*)
Bases: pyslet.pep8.PEP8Compatibility

An abstract class for parsing character strings or binary data

source Can be either a string of characters or a string of bytes.

BasicParser instances can parse either characters or bytes but not both simultaneously, you must choose on construction by passing an appropriate str (Python 2: unicode), bytes or bytearray object.

Binary mode is suitable for parsing data described in terms of OCTETS, such as many IETF and internet standards. When passing string literals to parsing methods in binary mode use the binary string literal form:

```
parser.match(b':')
```

Methods that return the parsed data in its original form will also return bytes objects in binary mode.

Methods are named according to the type of operation they perform.

match_* Returns a boolean True or False depending on whether or not a syntax production is matched at the current location. The state of the parser is unchanged. This type of method is only used for very simple productions, e.g., *match_digit()*.

parse_* Attempts to parse a syntax element returning an appropriate object as the result or None if the production is not present. The position of the parser is only changed if the element was parsed successfully. This type of method is intended for fairly simple productions, e.g., *parse_integer()*. More complex productions are implemented using require_* methods but the general *parse_production()* can be used to enable more complex look-ahead scenarios.

require_* Parses a syntax production, returning an appropriate object as the result. If the production is not matched a `ParserError` is raised.

On success, the position of the parser points to the first character after the parsed production ready to continue parsing. On failure, the parser is positioned at the point at which the exception was raised.

When deriving your own sub-classes you will normally use the require_* pattern to extend the parser.

Compatibility note: if you are attempting to use the same source for both Python 2 and 3 then you may not be able to rely on the parser mode:

```
>>> from pyslet.unicode5 import BasicParser
>>> p = BasicParser("hello")
>>> p.raw
```

The above interpreter session will print True in Python 2 and False in Python 3. This is just another manifestation of the changes to string handling between the two releases. If you are dealing with ASCII data you can ignore the issue, otherwise you should consider using one of the various techniques for forcing strings to be interpreted as unicode when running in Python 2. The most important thing is consistency between the type of object you pass to the constructor and those that you pass to the various parsing methods. You may find the *pyslet.py2.ul()* and/or *pyslet.py2.u8()* functions useful for forcing text mode.

raw = None
True if parser is working in binary mode.

src = None
the string being parsed

pos = None
the position of the current character

the_char = None
The current character or None if the parser is positioned outside the src string.

In binary mode this will be a byte, which is an integer in Python 3 but a character in Python 2. In text mode it is a (unicode) character.

setpos(*new_pos*)
Sets the position of the parser to *new_pos*

Useful for saving the parser state and returning later:

```
save_pos = parser.pos
#
# do some look-ahead parsing
#
parser.setpos(save_pos)
```

next_char()
Points the parser at the next character.

Updates *pos* and *the_char*.

parser_error(*production=None*)
Raises an error encountered by the parser

See `ParserError` for details.

If production is None then the previous error is re-raised. If multiple errors have been raised previously the one with the most advanced parser position is used. This is useful in situations where there are multiple alternative productions, none of which can be successfully parsed. It allows parser methods to catch the exception from the last possible choice and raise an error relating to the closest previous match. For example:

```
def require_abc(self):
    result = p.parse_production(p.require_a)
    if result is None:
        result = p.parse_production(p.require_b)
    if result is None:
        result = p.parse_production(p.require_c)
    if result is None:
        # will raise the most advanced error raised during
        # the three previous methods
        p.parser_error()
    else:
        return result
```

See *parse_production()* for more details on this pattern.

The position of the parser is always set to the position of the error raised.

require_production(*result*, *production=None*)
Returns *result* if not None or raises ParserError.

result The result of a parse_* type method.

production Optional string used to customise the error message.

This method is intended to be used as a conversion function allowing any parse_* method to be converted into a require_* method. E.g.:

```
p = BasicParser("hello")
num = p.require_production(p.parse_integer(), "Number")

ParserError: Expected Number at [0]
```

require_production_end(*result*, *production=None*)
Returns *result* if not None and parsing is complete.

This method is similar to *require_production()* except that it enforces the constraint that the entire source must have been parsed. Essentially, it just calls *require_end()* before returning *result*.

parse_production(*require_method*, **args*, ***kwargs*)
Executes the bound method *require_method*.

require_method A bound method that will be called with *args

args The positional arguments to pass to require_method

kwargs The keyword arguments to pass to require_method

This method is intended to be used as a conversion function allowing any require_* method to be converted into a parse_* method for the purposes of look-ahead.

If successful the result of the method is returned. If any ValueError (including `ParserError`) is raised, the exception is caught, the parser rewound and None is returned.

peek(*nchars*)
Returns the next *nchars* characters or bytes.

If there are less than nchars remaining then a shorter string is returned.

match_end()
True if all of *src* has been parsed

require_end(*production='end'*)
Tests that all of *src* has been parsed

There is no return result.

match(*match_string*)
Returns true if *match_string* is at the current position

parse(*match_string*)
Parses *match_string*

Returns *match_string* or None if it cannot be parsed.

require(*match_string*, *production=None*)
Parses and requires *match_string*

match_string The string to be parsed

production Optional name of production, defaults to match_string itself.

For consistency, returns match_string on success.

match_insensitive(*lower_string*)
Returns true if *lower_string* is matched (ignoring case).

lower_string must already be a lower-cased string.

parse_insensitive(*lower_string*)
Parses *lower_string* ignoring case in the source.

lower_string Must be a lower-cased string

Advances the parser to the first character after lower_string. Returns the matched string which may differ in case from lower_string.

parse_until(*match_string*)
Parses up to but not including *match_string*.

Advances the parser to the first character *of* match_string. If match_string is not found (or is None) then all the remaining characters in the source are parsed.

Returns the parsed text, even if empty. Never returns None.

match_one(*match_chars*)
Returns true if one of *match_chars* is at the current position

parse_one(*match_chars*)
Parses one of *match_chars*.

match_chars A *string* of characters or bytes

Returns the character (or byte) or None if no match is found.

Warning: in binary mode, this method will return a single byte value, the type of which will differ in Python 2. In Python 3, bytes are integers, in Python 2 they are binary strings of length 1. You can use the function `py2.byte()` to help ensure your source works on both platforms, for example:

```
from .py2 import byte
c = parser.parse_one(b"+-")
if c == byte(b"+"):
    # do plus thing...
elif c:
    # must be minus...
else:
    # do something else...
```

match_digit()
Returns true if the current character is a digit

Only ASCII digits are considered, in binary mode byte values 0x30 to 0x39 are matched.

parse_digit()
Parses a digit character.

Returns the digit character/byte, or None if no digit is found. Like *match_digit()* only ASCII digits are parsed.

parse_digit_value()
Parses a single digit value.

Returns the digit value, or None if no digit is found. Like *match_digit()* only ASCII digits are parsed.

parse_digits(*min*, *max=None*)
Parses a string of digits

min The minimum number of digits to parse. There is a special cases where min=0, in this case an empty string may be returned.

max (default None) The maximum number of digits to parse, or None there is no maximum.

Returns the string of digits or None if no digits can be parsed. Like *parse_digit()*, only ASCII digits are considered.

parse_integer(*min=None*, *max=None*, *max_digits=None*)
Parses an integer (or long).

min (optional, defaults to None) A lower bound on the acceptable integer value, the result will always be >= min on success

max (optional, defaults to None) An upper bound on the acceptable integer value, the result will always be <= max on success

max_digits (optional, defaults to None) The limit on the number of digits, i.e., the field width.

If a suitable integer can't be parsed then None is returned. This method only processes ASCII digits.

Warning: in Python 2 the result may be of type long.

match_hex_digit()
Returns true if the current character is a hex-digit

Only ASCII digits are considered, letters can be either upper or lower case. In binary mode byte values 0x30 to 0x39, 0x41-0x46 and 0x61-0x66 are matched.

parse_hex_digit()
Parses a hex-digit.

Returns the digit, or None if no digit is found. See *match_hex_digit()* for which characters/bytes are considered hex-digits.

parse_hex_digits(*min*, *max=None*)
Parses a string of hex-digits

min The minimum number of hex-digits to parse. There is a special cases where min=0, in this case an empty string may be returned.

max (default None) The maximum number of hex-digits to parse, or None there is no maximum.

Returns the string of hex-digits or None if no digits can be parsed. See *match_hex_digit()* for which characters/bytes are considered hex-digits.

6.11 File System Abstraction

The purpose of this module is to provide an abstraction over the top the native file system, potentially allowing alternative implementations to be provided in the future. This module was particularly developed with operating environments where access to the file system is limited or not-allowed. Pyslet modules that use these classes to access the file system can be easily repointed at some other implementation.

class pyslet.vfs.**VirtualFilePath**(**args*)
Bases: object

Abstract class representing a virtual file system

Instances represent paths within a file system. You can't create an instance of VirtualFilePath directly, instead you must create instances using a class derived from it. (Do not call the __init__ method of VirtualFilePath from your derived classes.)

All instances are created from one or more strings, either byte strings or unicode strings, or existing instances. In the case of byte strings the encoding is assumed to be the default encoding of the file system. If multiple arguments are given then they are joined to make a single path using *join()*.

Instances can be converted to either binary or character strings, use *to_bytes()* for the former. Note that the builtin str function returns a binary string in Python 2, not a character string.

Instances are immutable, and can be used as keys in dictionaries. Instances must be from the same file system to be comparable, the unicode representation is used.

An empty path is False, other paths are True. You can also compare a file path with a string (or unicode string) which is first converted to a file path instance.

fs_name = None
The name of the file system, must be overridden by derived classes.

The purpose of providing a name for a file system is to enable file systems to be mapped onto the authority (host) component of a file URL.

supports_unicode_filenames = False
Indicates whether this file system supports unicode file names natively. In general, you don't need to worry about this as all methods that accept strings will accept either type of string and convert to the native representation.

When creating derived classes you must also override *sep*, *curdir*, *pardir*, *ext*, *drive_sep* (if applicable) and *empty* with the correct string types.

supports_unc = False
Indicates whether this file system supports UNC paths.

UNC paths are of the general form:

```
\\ComputerName\SharedFolder\Resource
```

This format is used in Microsoft Windows. See *is_unc()* for details.

supports_drives = False
Indicates whether this file system supports 'drives', i.e., is Windows-like in having drive letters that may prefix paths.

codec = 'utf-8'
The codec used by this file system

This codec is used to convert between byte strings and unicode strings. The default is utf-8.

sep = '/'
The path separator used by this file system

This is either a character or byte string, depending on the setting of *supports_unicode_filenames*.

curdir = '.'
The path component that represents the current directory

pardir = '..'
The path component that represents the parent directory

ext = '.'
The extension character

drive_sep = ':'
The drive separator

empty = ''
An empty path string (for use with join)

classmethod getcwd()
Returns an instance representing the working directory.

classmethod getcroot()
Returns an instance representing the current root.

UNIX users will find this odd but in other file systems there are multiple roots. Rather than invent an abstract concept of the root of roots we just accept that there can be more than one. (We might struggle to perform actions like *listdir()* on the root of roots.)

The current root is determined by stripping back the current working directory until it can no longer be split.

classmethod mkdtemp(*suffix=''*, *prefix=''*)
Creates a temporary directory in the file system

Returns an instance representing the path to the new directory.

Similar to Python's tempfile.mkdtemp, like that function the caller is responsible for cleaning up the directory, which can be done with *rmtree()*.

classmethod path_str(*arg*)
Converts a single argument to the correct string type

File systems can use either binary or character strings and we convert between them using *codec*. This method takes either type of string or an existing instance and returns a path string of the correct type.

path = None
the path, either character or binary string

to_bytes()
Returns the binary string representation of the path.

join(**components*)
Returns a new instance by joining path components

Starting with the current instance, this method appends each component, returning a new instance representing the joined path. If components contains an absolute path then previous components, including the instance's path, are discarded.

For details see Python's os.path.join function.

For the benefit of derived classes a default implementation is provided.

split()
Splits a path

Returns a tuple of two instances (head, tail) where tail is the last path component and head is everything leading up to it.

For details see Python's os.path.split.

splitext()
Splits an extension from a path

Returns a tuple of (root, ext) where root is an instance containing just the root file path and ext is a string of characters (or bytes) representing the orignal path's extension.

For details see Python's os.path.splitext.

splitdrive()
Splits a drive designation

Returns a tuple of two instances (drive, tail) where drive is either a drive specification or is empty.

Default implementation uses the *drive_sep* to determine if the first path component is a drive.

splitunc()
Splits a UNC path

Returns a tuple of two instances (mount, path) where mount is an instance representing the UNC mount point or an instance representing the empty path if this isn't a UNC path.

Default implementation checks for a double separator at the start of the path and at least one more separator.

abspath()
Returns an absolute path instance.

realpath()
Returns a real path, with any symbolic links removed.

The default implementation normalises the path using *normpath()* and *normcase()*.

normpath()
Returns a normalised path instance.

normcase()
Returns a case-normalised path instance.

The default implementation returns the path unchanged.

is_unc()
Returns True if this path is a UNC path.

UNC paths contain a host designation, a path cannot contain a drive specification and also be a UNC path.

Default implementation calls *splitunc()* and returns True if the unc component is non-empty.

is_single_component()
Returns True if this path is a single, non-root, component.

E.g., tests that the path does not contain a slash (it may be empty)

is_empty()
Returns True if this path is empty

is_dirlike()
Returns True if this is a directory-like path.

E.g., test that the path ends in a slash (last component is empty).

is_root()
Returns True if this is a root path.

E.g., tests if it consists of just one or more slashes only (not counting any drive specification in file systems that support them).

isabs()
Returns True if the path is an absolute path.

stat()
Return information about the path.

exists()
Returns True if this is existing item in the file system.

isfile()
Returns True if this is a regular file in the file system.

isdir()
Returns True if this is a directory in the file system.

open(*mode='r'*)
Returns an open file-like object from this path.

copy(*dst*)
Copies a file to dst path like Python's shutil.copy.

Note that you can't copy between file system implementations.

move(*dst*)
Moves a file to dst path like Python's os.rename.

remove()
Removes a file.

listdir()
List directory contents

Returns a list containing path instances of the entries in the directory.

chdir()
Changes the current working directory to this path

mkdir()
Creates a new directory at this path.

If an item at this path already exists OSError is raised. This method ignores any trailing separator.

makedirs()
Recursive directory creation function.

Like mkdir(), but makes all intermediate-level directories needed to contain the leaf directory.

The default implementation repeatedly uses a combination of split and mkdir.

walk()
A generator function that walks the file system

Similar to os.walk. For each directory in the tree rooted at this path (including this path itself), it yields a 3-tuple of:

```
(dirpath, dirnames, filenames)
```

dirpath is an instance, dirnames and filename are lists of path instances.

rmtree(*ignore_errors=False*)
Removes the tree rooted at this directory

ignore_errors can be used to ignore any errors from the file system.

6.11.1 Accessing the Local File System

class pyslet.vfs.**OSFilePath**(**path*)
Bases: *pyslet.vfs.VirtualFilePath*

A concrete implementation mapping to Python's os modules

In most cases the methods map straightforwardly to functions in os and os.path.

fs_name = ''
An empty string.

The file system name affects the way URIs are interpreted, an empty string is consistent with the use of file:/// to reference the local file system.

supports_unicode_filenames = False
Copied from os.path

That means you won't know ahead of time whether paths are expected as binary or unicode strings. In most cases it won't matter as the methods will convert as appropriate but it does affect the type of the static path constants defined below.

supports_unc = False
Automatically determined from os.path

Tests if os.path has defined splitunc.

supports_drives = False
Automatically determined

The method chosen is straight out of the documentation for os.path. We join the segments "C:" and "foo" and check to see if the result contains the path separator or not.

codec = 'ANSI_X3.4-1968'
as returned by sys.getfilesystemencoding()

sep = '/'
copied from os.sep

curdir = '.'
copied from os.curdir

pardir = '..'
copied from os.pardir

ext = '.'
copied from os.extsep

drive_sep = ':'
always set to ':'

Correctly set to either binary or character string depending on the setting of *supports_unicode_filenames*.

empty = ''
Set to the empty string

Uses either a binary or character string depending on the setting of *supports_unicode_filenames*.

6.11.2 Misc Definitions

class pyslet.vfs.**ZipHooks**
Bases: object

Context manager for compatibility with zipfile

The zipfile module allows you to write either a string or the contents of a named file to a zip archive. This class monkey-patches the builtin open function and os.stat with versions that support *VirtualFilePath* objects allowing us to copy the contents of a virtual represented file path directly to a zip archive without having to load it into memory first.

For more information on this approach see this blog post.

This implementation uses a lock on the class attributes to ensure thread safety.

As currently implemented, Pyslet does not contain a full implementation of *VirtualFilePath* so this class is provided in readiness for a more comprehensive implementation based on pyslet.blockstore.StreamStore.

- genindex
- modindex
- search

CHAPTER 7

Welcome to Pyslet

Note: You are reading documentation for the pyslet-0.6.20160201 release of Pyslet to PyPi. The latest version, corresponding to the GitHub master is available here

Pyslet is a Python package for Standards in Learning Education and Training (LET). It implements a number of LET-specific standards, including IMS QTI, Content Packaging and Basic LTI. It also includes support for some general standards, including the data access standard OData (see http://www.odata.org).

Pyslet was originally written to be the engine behind the QTI migration tool but it can be used independently as a support module for your own Python applications.

Full documentation is hosted at http://pyslet.readthedocs.org

Pyslet currently supports Python 2.6 and 2.7, see docs for details.

7.1 Distribution

Pyslet is developed on GitHub: https://github.com/swl10/pyslet but it can be downloaded and installed from the popular PyPi package distribution site: https://pypi.python.org/pypi/pyslet using *pip*.

While Pyslet is being actively developed the version on PyPi may lag a few months behind the master branch on GitHub. The unittests are fairly comprehensive and are automatically run against the master branch using TravisCI: Users of older Python builds (e.g., the current Python 2.6 installed on OS X as of August 2014) should be aware that pip may well fail to install itself or other modules due to a failure to connect to the PyPi repository. Fixing this is hard and installing from source is recommended instead if you are afflicted by this issue.

7.1.1 Installing from Source

The Pyslet package contains a setup.py script so you can install it by downloading the compressed archive, uncompressing it and then running the following command inside the package:

```
python setup.py install
```

7.1.2 Current Status & Road Map

Pyslet is going through a transition process at the moment as the QTI migration tool that drives its development is gradually moving towards being distributed as an LTI tool rather than a desktop application.

The OData support is fairly robust, it is used to run the Cambridge Weather OData service which can be found at http://odata.pyslet.org/weather

What's next?

- MySQL shim for the OData SQL storage model (90% complete and functional)
- Improved support for LTI to take it beyond 'basic' (60% complete)
- Python 3 support (10% complete)

I'm also slowly transforming the code for better PEP-8 compliance as reported by the fantastic flake8. For important information about how this affects existing Pyslet users see the What's New? section of the documentation or the CHANGES.rst file in the distribution package.

I also write about Pyslet on my blog: http://swl10.blogspot.co.uk/search/label/Pyslet

7.1.3 Feedback

The best way to get something changed is to create an issue or Pull request on GitHub, however, my contact details are available there on my profile page if you just want to drop me an email with a suggestion or question.

7.1.4 License

Pyslet is distributed under the 'New' BSD license: http://opensource.org/licenses/BSD-3-Clause, this decision was inherited from the early days of the code. Although Copyright to much of the source is owned by the author personally earlier parts are owned by the University of Cambridge and are marked as such.

Pyslet is written and maintained by the main author on a spare time basis and is not connected to my current employer.

7.1.5 Acknowledgements

Some historical information is available on the QTI Migration tool's Google Code project: https://code.google.com/p/qtimigration/

Some of the code was written almost 20 years ago and it owes a lot to the University of Cambridge and, in particular, to the team I worked with at UCLES (aka Cambridge Assessment) who were instrumental in getting this project started.

7.2 Format of the Documentation

The documentation has been written using ReStructuredText, a simple format created as part of the docutils package on SourceForge. The documentation files you are most likely reading have been generated using Sphinx. Parts of the documentation are auto-generated from the Python source files to make it easier to automatically discover the documentation using other tools capable of reading Python docstrings. However, this requires that the docstrings be written using ReStructuredText too, which means there is some additional markup for python-cross referencing in the code that may not be interpretable by other system (see below for details).

- ReStructuredText Primer: http://docutils.sourceforge.net/docs/user/rst/quickstart.html
  - Quick Reference: http://docutils.sourceforge.net/docs/user/rst/quickref.html
  - Sphinx: http://sphinx.pocoo.org/
    - Autodoc externsion: http://sphinx.pocoo.org/ext/autodoc.html
    - Python-cross references: http://sphinx.pocoo.org/domains.html#python-roles

p

Symbols

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