HOWTO Fetch Internet Resources Using The urllib Package

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1 Introduction

Related Articles

You may also find useful the following article on fetching web resources with Python:

- Basic Authentication

  A tutorial on *Basic Authentication*, with examples in Python.

urllib.request is a Python module for fetching URLs (Uniform Resource Locators). It offers a very simple interface, in the form of the *urlopen* function. This is capable of fetching URLs using a variety of different protocols. It also offers a slightly more complex interface for handling common situations - like basic authentication, cookies, proxies and so on. These are provided by objects called handlers and openers.

urllib.request supports fetching URLs for many "URL schemes" (identified by the string before the `":"` in URL - for example `"ftp"` is the URL scheme of `"ftp://python.org/"`) using their associated network protocols (e.g. FTP, HTTP). This tutorial focuses on the most common case, HTTP.

For straightforward situations *urlopen* is very easy to use. But as soon as you encounter errors or non-trivial cases when opening HTTP URLs, you will need some understanding of the HyperText Transfer Protocol. The most comprehensive and authoritative reference to HTTP is **RFC 2616**. This is a technical document and not intended to be easy to read. This HOWTO aims to illustrate using *urllib*, with enough detail about HTTP to help you through. It is not intended to replace the `urllib.request` docs, but is supplementary to them.

2 Fetching URLs

The simplest way to use urllib.request is as follows:

```
import urllib.request
with urllib.request.urlopen('http://python.org/') as response:
   html = response.read()
```

If you wish to retrieve a resource via URL and store it in a temporary location, you can do so via the `shutil.copyfileobj()` and `tempfile.NamedTemporaryFile()` functions:

```
import shutil
import tempfile
import urllib.request

with urllib.request.urlopen('http://python.org/') as response:
    with tempfile.NamedTemporaryFile(delete=False) as tmp_file:
        shutil.copyfileobj(response, tmp_file)

with open(tmp_file.name) as html:
    pass
```

Many uses of urllib will be that simple (note that instead of an 'http:' URL we could have used a URL starting with 'ftp:', 'file:', etc.). However, it's the purpose of this tutorial to explain the more complicated cases, concentrating on HTTP.

HTTP is based on requests and responses - the client makes requests and servers send responses. urllib.request mirrors this with a `Request` object which represents the HTTP request you are making. In its simplest form you create a Request object that specifies the URL you want to fetch. Calling `urlopen` with this Request object returns a response object for the URL requested. This response is a file-like object, which means you can for example call `.read()` on the response:

```
import urllib.request

req = urllib.request.Request('http://python.org/')
with urllib.request.urlopen(req) as response:
   the_page = response.read()
```

Note that urllib.request makes use of the same Request interface to handle all URL schemes. For example, you can make an FTP request like so:

```
req = urllib.request.Request('ftp://example.com/')
```

In the case of HTTP, there are two extra things that Request objects allow you to do: First, you can pass data to be sent to the server. Second, you can pass extra information ("metadata") *about* the data or about the request itself, to the server - this information is sent as HTTP "headers". Let's look at each of these in turn.

2.1 Data

Sometimes you want to send data to a URL (often the URL will refer to a CGI (Common Gateway Interface) script or other web application). With HTTP, this is often done using what's known as a **POST** request. This is often what your browser does when you submit a HTML form that you filled in on the web. Not all POSTs have to come from forms: you can use a POST to transmit arbitrary data to your own application. In the common case of HTML forms, the data needs to be encoded in a standard way, and then passed to the Request object as the `data` argument. The encoding is done using a function from the `urllib.parse` library.

```
import urllib.parse
import urllib.request

url = 'http://www.someserver.com/cgi-bin/register.cgi'
values = {'name' : 'Michael Foord',
          'location' : 'Northampton',
          'language' : 'Python' }

data = urllib.parse.urlencode(values)
data = data.encode('ascii') # data should be bytes
req = urllib.request.Request(url, data)
with urllib.request.urlopen(req) as response:
   the_page = response.read()
```

Note that other encodings are sometimes required (e.g. for file upload from HTML forms - see HTML Specification, Form Submission for more details).

If you do not pass the `data` argument, urllib uses a **GET** request. One way in which GET and POST requests differ is that POST requests often have "side-effects": they change the state of the system in some way (for example by placing an order with the website for a hundredweight of tinned spam to be delivered to your door). Though the HTTP standard makes it clear that POSTs are intended to *always* cause side-effects, and GET requests *never* to cause side-effects, nothing prevents a GET request from having side-effects, nor a POST requests from having no side-effects. Data can also be passed in an HTTP GET request by encoding it in the URL itself.

This is done as follows:

```
>>> import urllib.request
>>> import urllib.parse
>>> data = {}
>>> data['name'] = 'Somebody Here'
>>> data['location'] = 'Northampton'
```

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```
>>> data['language'] = 'Python'
>>> url_values = urllib.parse.urlencode(data)
>>> print(url_values)  # The order may differ from below.
name=Somebody+Here&language=Python&location=Northampton
>>> url = 'http://www.example.com/example.cgi'
>>> full_url = url + '?' + url_values
>>> data = urllib.request.urlopen(full_url)
```

Notice that the full URL is created by adding a `?` to the URL, followed by the encoded values.

2.2 Headers

We'll discuss here one particular HTTP header, to illustrate how to add headers to your HTTP request.

Some websites[1] dislike being browsed by programs, or send different versions to different browsers[2]. By default urllib identifies itself as `Python-urllib/x.y` (where `x` and `y` are the major and minor version numbers of the Python release, e.g. `Python-urllib/2.5`), which may confuse the site, or just plain not work. The way a browser identifies itself is through the `User-Agent` header[3]. When you create a Request object you can pass a dictionary of headers in. The following example makes the same request as above, but identifies itself as a version of Internet Explorer[4].

```
import urllib.parse
import urllib.request

url = 'http://www.someserver.com/cgi-bin/register.cgi'
user_agent = 'Mozilla/5.0 (Windows NT 6.1; Win64; x64)'
values = {'name': 'Michael Foord',
          'location': 'Northampton',
          'language': 'Python' }
headers = {'User-Agent': user_agent}

data = urllib.parse.urlencode(values)
data = data.encode('ascii')
req = urllib.request.Request(url, data, headers)
with urllib.request.urlopen(req) as response:
   the_page = response.read()
```

The response also has two useful methods. See the section on *info and geturl* which comes after we have a look at what happens when things go wrong.

3 Handling Exceptions

urlopen raises `URLError` when it cannot handle a response (though as usual with Python APIs, built-in exceptions such as `ValueError`, `TypeError` etc. may also be raised).

`HTTPError` is the subclass of `URLError` raised in the specific case of HTTP URLs.

The exception classes are exported from the `urllib.error` module.

[1] Google for example.

[2] Browser sniffing is a very bad practice for website design - building sites using web standards is much more sensible. Unfortunately a lot of sites still send different versions to different browsers.

[3] The user agent for MSIE 6 is *'Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.1; SV1; .NET CLR 1.1.4322)'*

[4] For details of more HTTP request headers, see Quick Reference to HTTP Headers.

3.1 URLError

Often, URLError is raised because there is no network connection (no route to the specified server), or the specified server doesn't exist. In this case, the exception raised will have a 'reason' attribute, which is a tuple containing an error code and a text error message.

e.g.

```
>>> req = urllib.request.Request('http://www.pretend_server.org')
>>> try: urllib.request.urlopen(req)
... except urllib.error.URLError as e:
...     print(e.reason)
...
(4, 'getaddrinfo failed')
```

3.2 HTTPError

Every HTTP response from the server contains a numeric "status code". Sometimes the status code indicates that the server is unable to fulfil the request. The default handlers will handle some of these responses for you (for example, if the response is a "redirection" that requests the client fetch the document from a different URL, urllib will handle that for you). For those it can't handle, urlopen will raise an `HTTPError`. Typical errors include '404' (page not found), '403' (request forbidden), and '401' (authentication required).

See section 10 of **RFC 2616** for a reference on all the HTTP error codes.

The `HTTPError` instance raised will have an integer 'code' attribute, which corresponds to the error sent by the server.

Error Codes

Because the default handlers handle redirects (codes in the 300 range), and codes in the 100–299 range indicate success, you will usually only see error codes in the 400–599 range.

`http.server.BaseHTTPRequestHandler.responses` is a useful dictionary of response codes in that shows all the response codes used by **RFC 2616**. The dictionary is reproduced here for convenience

```
# Table mapping response codes to messages; entries have the
# form {code: (shortmessage, longmessage)}.
responses = {
    100: ('Continue', 'Request received, please continue'),
    101: ('Switching Protocols',
          'Switching to new protocol; obey Upgrade header'),

    200: ('OK', 'Request fulfilled, document follows'),
    201: ('Created', 'Document created, URL follows'),
    202: ('Accepted',
          'Request accepted, processing continues off-line'),
    203: ('Non-Authoritative Information', 'Request fulfilled from cache'),
    204: ('No Content', 'Request fulfilled, nothing follows'),
    205: ('Reset Content', 'Clear input form for further input.'),
    206: ('Partial Content', 'Partial content follows.'),

    300: ('Multiple Choices',
          'Object has several resources -- see URI list'),
    301: ('Moved Permanently', 'Object moved permanently -- see URI list'),
    302: ('Found', 'Object moved temporarily -- see URI list'),
```

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```
    303: ('See Other', 'Object moved -- see Method and URL list'),
    304: ('Not Modified',
          'Document has not changed since given time'),
    305: ('Use Proxy',
          'You must use proxy specified in Location to access this '
          'resource.'),
    307: ('Temporary Redirect',
          'Object moved temporarily -- see URI list'),

    400: ('Bad Request',
          'Bad request syntax or unsupported method'),
    401: ('Unauthorized',
          'No permission -- see authorization schemes'),
    402: ('Payment Required',
          'No payment -- see charging schemes'),
    403: ('Forbidden',
          'Request forbidden -- authorization will not help'),
    404: ('Not Found', 'Nothing matches the given URI'),
    405: ('Method Not Allowed',
          'Specified method is invalid for this server.'),
    406: ('Not Acceptable', 'URI not available in preferred format.'),
    407: ('Proxy Authentication Required', 'You must authenticate with '
          'this proxy before proceeding.'),
    408: ('Request Timeout', 'Request timed out; try again later.'),
    409: ('Conflict', 'Request conflict.'),
    410: ('Gone',
          'URI no longer exists and has been permanently removed.'),
    411: ('Length Required', 'Client must specify Content-Length.'),
    412: ('Precondition Failed', 'Precondition in headers is false.'),
    413: ('Request Entity Too Large', 'Entity is too large.'),
    414: ('Request-URI Too Long', 'URI is too long.'),
    415: ('Unsupported Media Type', 'Entity body in unsupported format.'),
    416: ('Requested Range Not Satisfiable',
          'Cannot satisfy request range.'),
    417: ('Expectation Failed',
          'Expect condition could not be satisfied.'),

    500: ('Internal Server Error', 'Server got itself in trouble'),
    501: ('Not Implemented',
          'Server does not support this operation'),
    502: ('Bad Gateway', 'Invalid responses from another server/proxy.'),
    503: ('Service Unavailable',
          'The server cannot process the request due to a high load'),
    504: ('Gateway Timeout',
          'The gateway server did not receive a timely response'),
    505: ('HTTP Version Not Supported', 'Cannot fulfill request.'),
    }
```

When an error is raised the server responds by returning an HTTP error code *and* an error page. You can use the `HTTPError` instance as a response on the page returned. This means that as well as the code attribute, it also has read, geturl, and info, methods as returned by the `urllib.response` module:

```
>>> req = urllib.request.Request('http://www.python.org/fish.html')
>>> try:
...     urllib.request.urlopen(req)
... except urllib.error.HTTPError as e:
```

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```
...     print(e.code)
...     print(e.read())
...
404
b'<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
  "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">\n\n\n<html
  ...
  <title>Page Not Found</title>\n
  ...
```

3.3 Wrapping it Up

So if you want to be prepared for `HTTPError` *or* `URLError` there are two basic approaches. I prefer the second approach.

Number 1

```
from urllib.request import Request, urlopen
from urllib.error import URLError, HTTPError
req = Request(someurl)
try:
    response = urlopen(req)
except HTTPError as e:
    print('The server couldn\'t fulfill the request.')
    print('Error code: ', e.code)
except URLError as e:
    print('We failed to reach a server.')
    print('Reason: ', e.reason)
else:
    # everything is fine
```

Note: The `except HTTPError` *must* come first, otherwise `except URLError` will *also* catch an `HTTPError`.

Number 2

```
from urllib.request import Request, urlopen
from urllib.error import URLError
req = Request(someurl)
try:
    response = urlopen(req)
except URLError as e:
    if hasattr(e, 'reason'):
        print('We failed to reach a server.')
        print('Reason: ', e.reason)
    elif hasattr(e, 'code'):
        print('The server couldn\'t fulfill the request.')
        print('Error code: ', e.code)
else:
    # everything is fine
```

4 info and geturl

The response returned by urlopen (or the `HTTPError` instance) has two useful methods `info()` and `geturl()` and is defined in the module `urllib.response`.

- **geturl** - this returns the real URL of the page fetched. This is useful because `urlopen` (or the opener object used) may have followed a redirect. The URL of the page fetched may not be the same as the URL requested.
- **info** - this returns a dictionary-like object that describes the page fetched, particularly the headers sent by the server. It is currently an `http.client.HTTPMessage` instance.

Typical headers include 'Content-length', 'Content-type', and so on. See the Quick Reference to HTTP Headers for a useful listing of HTTP headers with brief explanations of their meaning and use.

5 Openers and Handlers

When you fetch a URL you use an opener (an instance of the perhaps confusingly named `urllib.request.OpenerDirector`). Normally we have been using the default opener - via `urlopen` - but you can create custom openers. Openers use handlers. All the "heavy lifting" is done by the handlers. Each handler knows how to open URLs for a particular URL scheme (http, ftp, etc.), or how to handle an aspect of URL opening, for example HTTP redirections or HTTP cookies.

You will want to create openers if you want to fetch URLs with specific handlers installed, for example to get an opener that handles cookies, or to get an opener that does not handle redirections.

To create an opener, instantiate an `OpenerDirector`, and then call `.add_handler(some_handler_instance)` repeatedly.

Alternatively, you can use `build_opener`, which is a convenience function for creating opener objects with a single function call. `build_opener` adds several handlers by default, but provides a quick way to add more and/or override the default handlers.

Other sorts of handlers you might want to can handle proxies, authentication, and other common but slightly specialised situations.

`install_opener` can be used to make an `opener` object the (global) default opener. This means that calls to `urlopen` will use the opener you have installed.

Opener objects have an `open` method, which can be called directly to fetch urls in the same way as the `urlopen` function: there's no need to call `install_opener`, except as a convenience.

6 Basic Authentication

To illustrate creating and installing a handler we will use the `HTTPBasicAuthHandler`. For a more detailed discussion of this subject – including an explanation of how Basic Authentication works - see the Basic Authentication Tutorial.

When authentication is required, the server sends a header (as well as the 401 error code) requesting authentication. This specifies the authentication scheme and a 'realm'. The header looks like: `WWW-Authenticate: SCHEME realm="REALM"`.

e.g.

```
WWW-Authenticate: Basic realm="cPanel Users"
```

The client should then retry the request with the appropriate name and password for the realm included as a header in the request. This is 'basic authentication'. In order to simplify this process we can create an instance of `HTTPBasicAuthHandler` and an opener to use this handler.

The `HTTPBasicAuthHandler` uses an object called a password manager to handle the mapping of URLs and realms to passwords and usernames. If you know what the realm is (from the authentication header sent by the server), then you can use a `HTTPPasswordMgr`. Frequently one doesn't care what the realm is. In that case, it is convenient to use `HTTPPasswordMgrWithDefaultRealm`. This allows you to specify a default username and password for a URL. This will be supplied in the absence of you providing an alternative combination for a specific realm. We indicate this by providing `None` as the realm argument to the `add_password` method.

The top-level URL is the first URL that requires authentication. URLs "deeper" than the URL you pass to .add_password() will also match.

```
# create a password manager
password_mgr = urllib.request.HTTPPasswordMgrWithDefaultRealm()

# Add the username and password.
# If we knew the realm, we could use it instead of None.
top_level_url = "http://example.com/foo/"
password_mgr.add_password(None, top_level_url, username, password)

handler = urllib.request.HTTPBasicAuthHandler(password_mgr)

# create "opener" (OpenerDirector instance)
opener = urllib.request.build_opener(handler)

# use the opener to fetch a URL
opener.open(a_url)

# Install the opener.
# Now all calls to urllib.request.urlopen use our opener.
urllib.request.install_opener(opener)
```

Note: In the above example we only supplied our `HTTPBasicAuthHandler` to `build_opener`. By default openers have the handlers for normal situations – `ProxyHandler` (if a proxy setting such as an `http_proxy` environment variable is set), `UnknownHandler`, `HTTPHandler`, `HTTPDefaultErrorHandler`, `HTTPRedirectHandler`, `FTPHandler`, `FileHandler`, `DataHandler`, `HTTPErrorProcessor`.

`top_level_url` is in fact *either* a full URL (including the 'http:' scheme component and the hostname and optionally the port number) e.g. `"http://example.com/"` *or* an "authority" (i.e. the hostname, optionally including the port number) e.g. `"example.com"` or `"example.com:8080"` (the latter example includes a port number). The authority, if present, must NOT contain the "userinfo" component - for example `"joe:password@example.com"` is not correct.

7 Proxies

urllib will auto-detect your proxy settings and use those. This is through the `ProxyHandler`, which is part of the normal handler chain when a proxy setting is detected. Normally that's a good thing, but there are occasions when it may not be helpful[5]. One way to do this is to setup our own `ProxyHandler`, with no proxies defined. This is done using similar steps to setting up a Basic Authentication handler:

```
>>> proxy_support = urllib.request.ProxyHandler({})
>>> opener = urllib.request.build_opener(proxy_support)
>>> urllib.request.install_opener(opener)
```

Note: Currently `urllib.request` *does not* support fetching of `https` locations through a proxy. However, this can be enabled by extending urllib.request as shown in the recipe[6].

Note: `HTTP_PROXY` will be ignored if a variable `REQUEST_METHOD` is set; see the documentation on `getproxies()`.

---

8 Sockets and Layers

The Python support for fetching resources from the web is layered. urllib uses the `http.client` library, which in turn uses the socket library.

As of Python 2.3 you can specify how long a socket should wait for a response before timing out. This can be useful in applications which have to fetch web pages. By default the socket module has *no timeout* and can hang. Currently, the socket timeout is not exposed at the http.client or urllib.request levels. However, you can set the default timeout globally for all sockets using

```
import socket
import urllib.request

# timeout in seconds
timeout = 10
socket.setdefaulttimeout(timeout)

# this call to urllib.request.urlopen now uses the default timeout
# we have set in the socket module
req = urllib.request.Request('http://www.voidspace.org.uk')
response = urllib.request.urlopen(req)
```

---

[5] In my case I have to use a proxy to access the internet at work. If you attempt to fetch *localhost* URLs through this proxy it blocks them. IE is set to use the proxy, which urllib picks up on. In order to test scripts with a localhost server, I have to prevent urllib from using the proxy.

[6] urllib opener for SSL proxy (CONNECT method): ASPN Cookbook Recipe.

9 Footnotes

This document was reviewed and revised by John Lee.

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