PES UNIVERSITY

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100-ft Ring Road, BSK Stage III Bangalore – 560 085, Karnataka, India

UE22EC351A – Computer Communication Networks

Project Level 1: Using "urllib" library to fetch web objects and perform Wireshark analysis

Submitted by

NAME: TUSHAR PRABHU

SRN: PES1UG22EC321

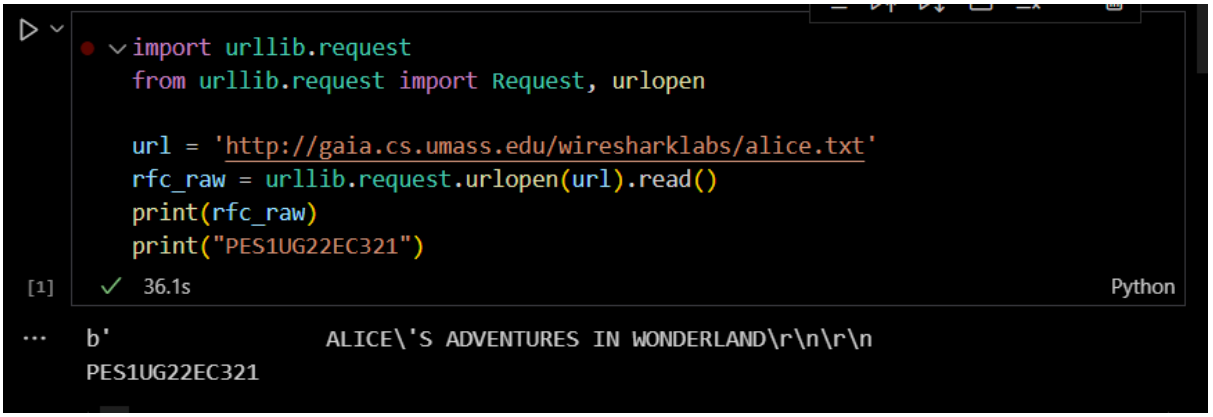
SECTION: F

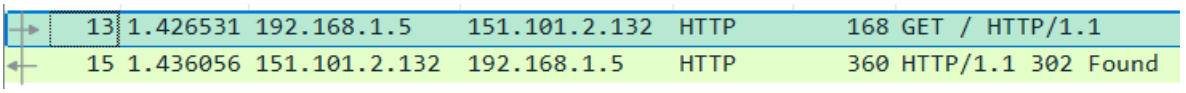
Introduction: “Urllib” is a Python standard library recommended for HTTP tasks. The standard library also has a low-level module called http. Although this offers access to almost all aspects of the protocol, it has not been designed for everyday use. For making requests and receiving responses, we employ the urllib.request module. Retrieving the contents of a URL is a straightforward process when done using urllib.

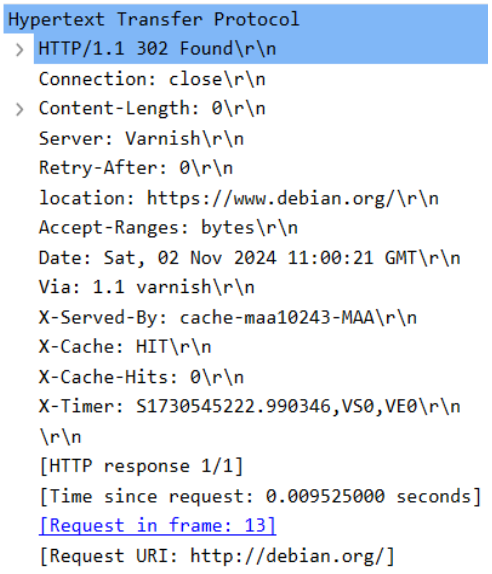
Objectives: To use urllib package to extract the details such as headers and content in requests and responses under HTTP. To appreciate the advantage over socket package when dealing with HTTP. To compare and verify the results with Wireshark.

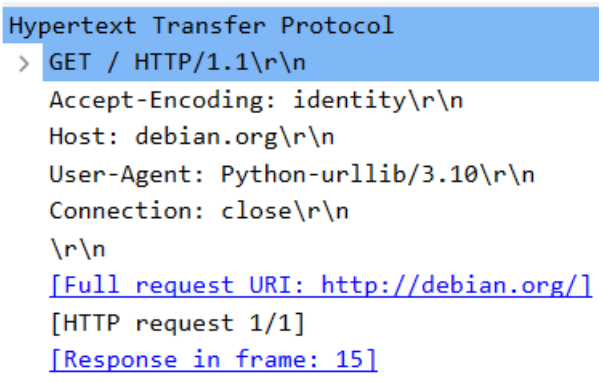
Request with urllib:

The urllib package is broken into several submodules for dealing with the different tasks that we may need to perform when working with HTTP. For making request and receiving responses, we employ the urllib.request module.

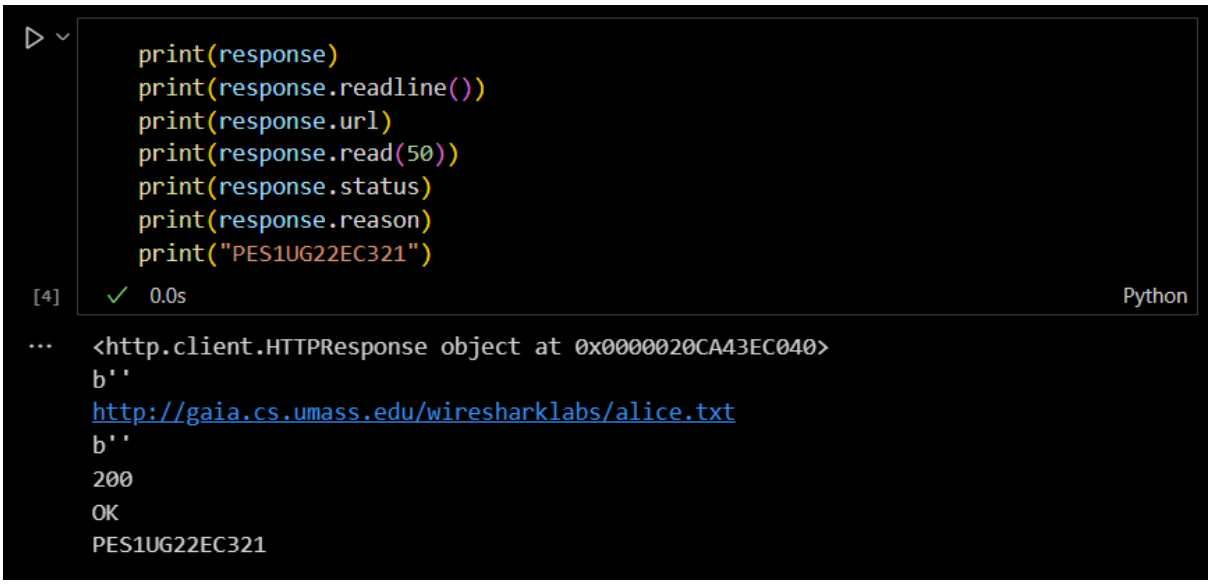








We are sending a request and receiving a response from ' http://gaia.cs.umass.edu/wiresharklabs/alice.txt.org'using urlopen in the above example. Response.url prints the URL accessed . Readline reads the first line of the Html response



The response.readlines() reads the content line-by-line and response.read(50) reads the first 50 bytes of the Html response.

Status Code:

Status codes are integers that tell how the request went, different codes convey different meanings.

The status code 200 indicates the request was successful.

Handling HTTP and URL Errors

Status codes help us to see whether our response was successful or not. Any code in the 200 range indicates a success, whereas any code in either the 400 range or the 500 range indicates failure. Status codes should always be checked so that our program can respond appropriately if something goes wrong. The urllib package helps us in checking the status codes by raising an exception if it encounters a problem.

```python
try:
    urlopen('http://www.ietf.org/rfc/rfc0.txt')
except urllib.error.HTTPError as e:
    print('status', e.code)
    print('reason', e.reason)
    print('url', e.url)
print("PES1UG22EC321")
```

[5] ✓ 1.9s Python

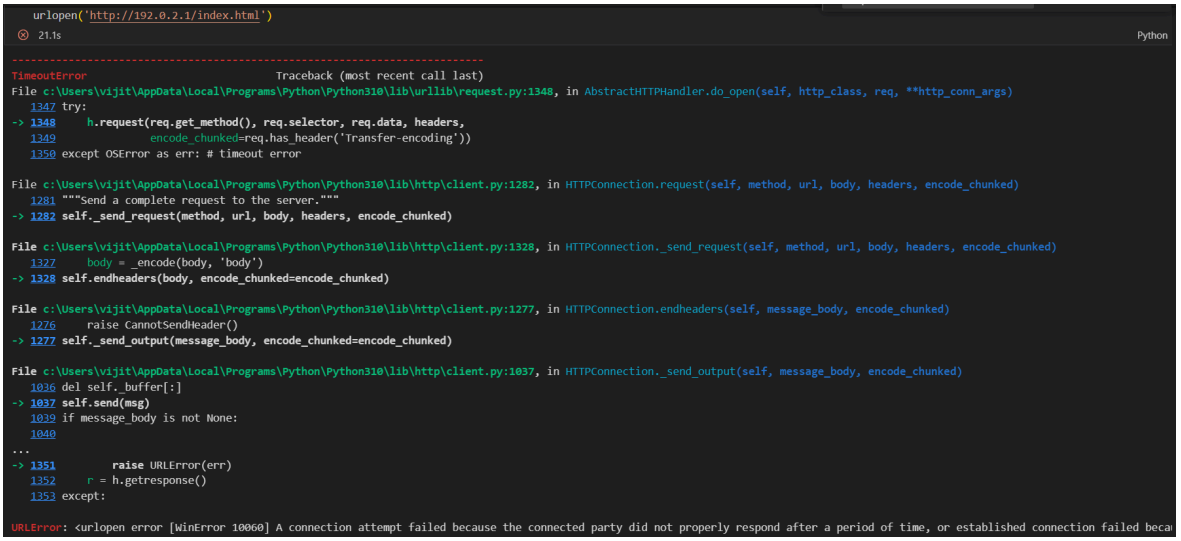
```
status 404
reason Not Found
url https://www.ietf.org/rfc/rfc0.txt
PES1UG22EC321
```

```
114 1.409945 192.168.1.5   104.16.44.99   HTTP   182 GET /rfc/rfc0.txt HTTP/1.1
121 1.437218 104.16.44.99   192.168.1.5   HTTP   574 HTTP/1.1 301 Moved Permanently  (text/html)
```

```
Hypertext Transfer Protocol
> HTTP/1.1 301 Moved Permanently\r\n
  Date: Sat, 02 Nov 2024 11:35:42 GMT\r\n
  Content-Type: text/html\r\n
> Content-Length: 167\r\n
  Connection: close\r\n
  Cache-Control: max-age=3600\r\n
  Expires: Sat, 02 Nov 2024 12:35:42 GMT\r\n
  Location: https://www.ietf.org/rfc/rfc0.txt\r\n
  Vary: Accept-Encoding\r\n
  Server: cloudflare\r\n
  CF-RAY: 8dc3d29bdb001d18-BLR\r\n
  alt-svc: h3=":443"; ma=86400\r\n
  \r\n
  [HTTP response 1/1]
  [Time since request: 0.027273000 seconds]
  [Request in frame: 114]
  [Request URI: http://www.ietf.org/rfc/rfc0.txt]
  File Data: 167 bytes
```

```
Line-based text data: text/html (7 lines)
  <html>\r\n
  <head><title>301 Moved Permanently</title></head>\r\n
  <body>\r\n
  <center><h1>301 Moved Permanently</h1></center>\r\n
  <hr><center>cloudflare</center>\r\n
  </body>\r\n
  </html>\r\n
```

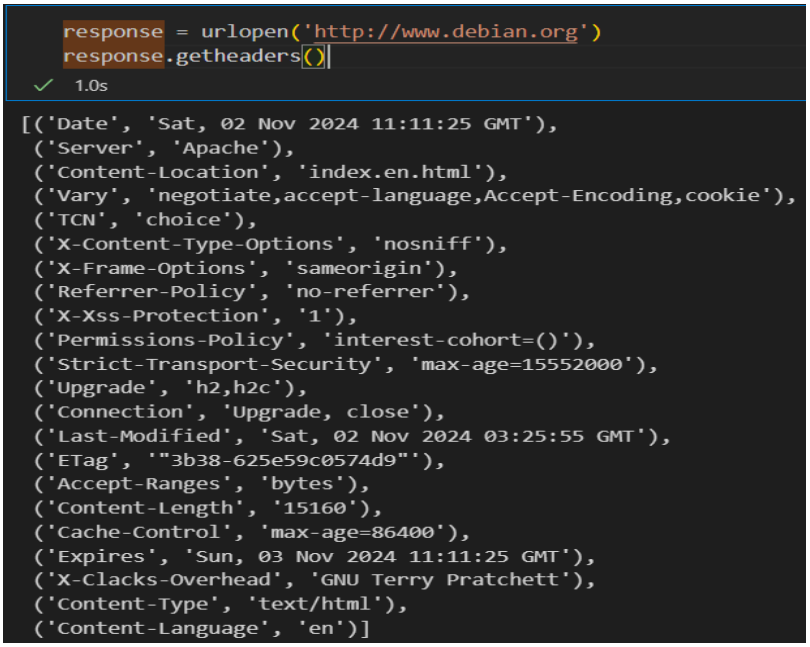
The code attempts to open a URL by using urlopen('http://www.ietf.org/rfc/rfc0.txt'), which targets the specified web address. If accessing the URL leads to an HTTP error, such as a 404 Not Found, 403 Forbidden, or 500 Internal Server Error, the program triggers an HTTPError exception. In the event of an HTTPError, the code catches the exception and displays relevant error information, including the HTTP status code (e.g., 404), the reason phrase corresponding to that code (e.g., "Not Found"), and the URL that caused the error.

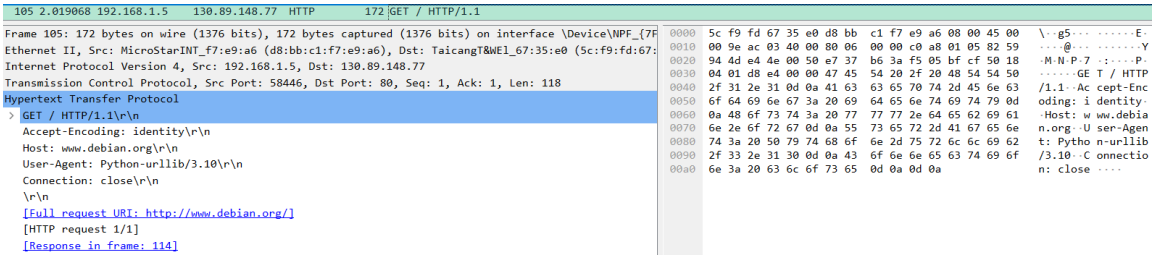


In this instance, we have asked for index.html from the 192.0.2.1. host. The 192.0.2.0/24 IP address range is reserved to be used by documentation only, so you will never encounter a host using the preceding IP address. Hence the TCP connection times out and socket raises a timeout exception, which urllib catches, re-wraps, and re-raises for us. HTTPError occurs when the request reaches the server, but the server returnsan error (e.g., 404 Not Found). URLError occurs if the request cannot connect to the server (e.g., connection timeout).

HTTP headers:

Headers are the lines of protocol-specific information that appear at the beginning of the raw message that is sent over the TCP connection. The getheaders() method returns a list of response headers, which contain metadata such as server information and content type. It displays a list of headers as (name, value) pairs.





Customizing Requests with Headers:

```
req = Request('http://www.debian.org')
req.add_header('Accept-Language', 'sv')
print('Headers we added: ', req.header_items())
print("PES1UG22EC321")
```

[6] ✓ 0.0s Ruby

```
Headers we added:  [('Accept-language', 'sv')]
PES1UG22EC321
```

The above code adds the Accept-Language header to request content in Swedish. If the server supports it, it returns the content in the requested language. It displays the first 5 lines of content in Swedish.

```
headers = {'Accept-Language': 'sv', 'Connection': 'keep-alive'}
req = Request('http://www.debian.org', headers=headers)
print('Headers we added: ', req.header_items())

response = urlopen(req)
print('Headers urlopen() added: ', req.header_items())
print('Server\'s response: ', response.readlines()[:5])
print("PES1UG22EC321")
```

[7] ✓ 3.5s Ruby

```
Headers we added:  [('Accept-language', 'sv'), ('Connection', 'keep-alive')]
Headers urlopen() added:  [('Host', 'www.debian.org'), ('User-agent', 'Python-urlli
Server's response:  [b'<!DOCTYPE html>\n', b'<html lang="sv">\n', b'<head>\n', b'
PES1UG22EC321
```

The above code is used to view the headers present in the request and creates a Request object for the Debian homepage, adding headers directly during initialization. Headers are supplied as a dictionary to the Request object constructor as the headers keyword argument. In this way we can add multiple headers in one go, by adding more entries to the dictionary.

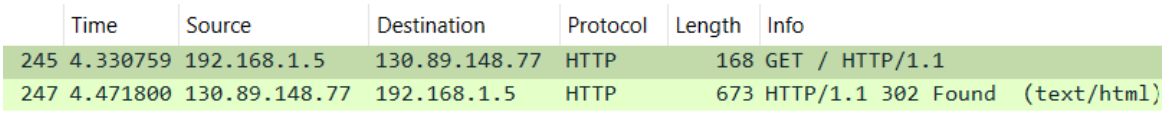
Content Compression:

The Accept-Encoding request header and the Content-Encoding response header work together to temporarily encode the body of a response for efficient transmission over the network, primarily for compression purposes. The process begins when the client sends a request that lists acceptable encodings in the Accept-Encoding header. The server then selects a supported encoding method and applies it to the response body. Subsequently, the server sends the response back to the client, indicating the chosen encoding method in the Content-Encoding header. Finally, the client decodes the response body using the specified encoding method, enabling reduced data transfer and improved performance.

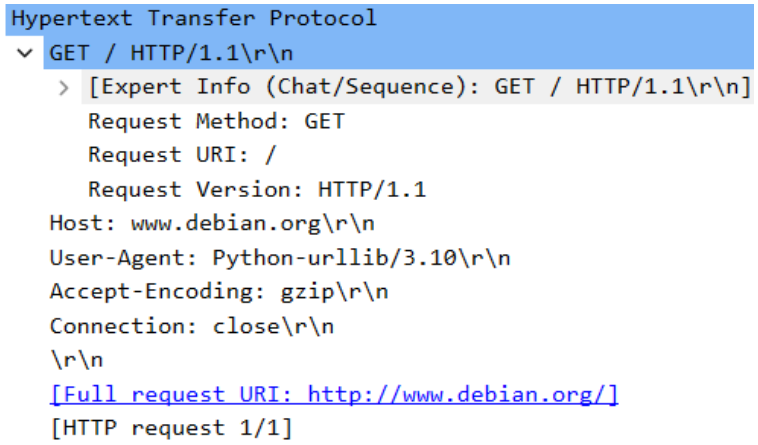
```
# Example 1: Using gzip encoding

req = Request('http://www.debian.org')
req.add_header('Accept-Encoding', 'gzip')
response = urlopen(req)
print('The encoding supported by server is ', response.getheader('Content-Encoding'))
print("PES1UG22EC321")
```

[8] ✓ 2.1s Ruby

```
The encoding supported by server is  gzip
PES1UG22EC321
```

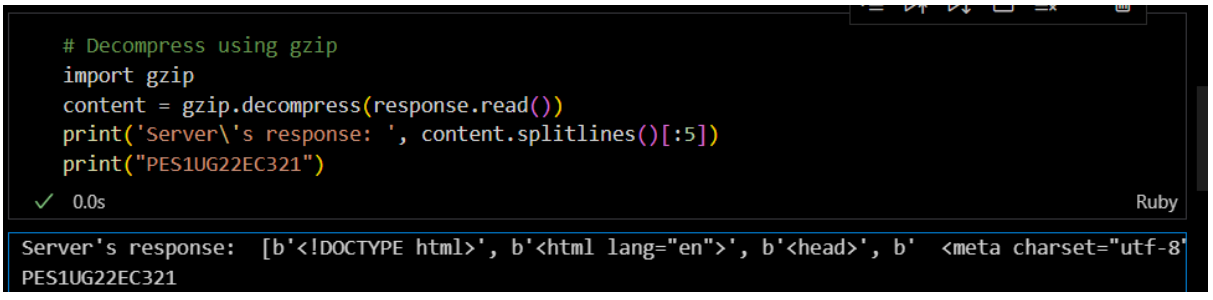


	Time	Source	Destination	Protocol	Length	Info
245	4.330759	192.168.1.5	130.89.148.77	HTTP	168	GET / HTTP/1.1
247	4.471800	130.89.148.77	192.168.1.5	HTTP	673	HTTP/1.1 302 Found (text/html)



```
Hypertext Transfer Protocol
GET / HTTP/1.1\r\n
  [Expert Info (Chat/Sequence): GET / HTTP/1.1\r\n]
    Request Method: GET
    Request URI: /
    Request Version: HTTP/1.1
  Host: www.debian.org\r\n
  User-Agent: Python-urllib/3.10\r\n
  Accept-Encoding: gzip\r\n
  Connection: close\r\n
  \r\n
  [Full request URI: http://www.debian.org/]
  [HTTP request 1/1]
```

Decompressing Gzip



```
# Decompress using gzip
import gzip
content = gzip.decompress(response.read())
print('Server\'s response: ', content.splitlines()[:5])
print("PES1UG22EC321")
```

✓ 0.0s Ruby

```
Server's response:  [b'<!DOCTYPE html>', b'<html lang="en">', b'<head>', b'  <meta charset="utf-8'
PES1UG22EC321
```

```
Hypertext Transfer Protocol
 HTTP/1.1 302 Found\r\n
    [Expert Info (Chat/Sequence): HTTP/1.1 302 Found\r\n]
    Response Version: HTTP/1.1
    Status Code: 302
    [Status Code Description: Found]
    Response Phrase: Found
  Date: Sat, 02 Nov 2024 11:57:30 GMT\r\n
  Server: Apache\r\n
  X-Content-Type-Options: nosniff\r\n
  X-Frame-Options: sameorigin\r\n
  Referrer-Policy: no-referrer\r\n
  X-Xss-Protection: 1\r\n
  Permissions-Policy: interest-cohort=()\r\n
  Location: https://www.debian.org/\r\n
  Content-Length: 271\r\n
  Connection: close\r\n
  Content-Type: text/html; charset=iso-8859-1\r\n
  \r\n
  [HTTP response 1/1]
  [Time since request: 0.141041000 seconds]
  [Request in frame: 245]
  [Request URI: http://www.debian.org/]
  File Data: 271 bytes
Line-based text data: text/html (9 lines)
  <!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">\n
  <html><head>\n
  <title>302 Found</title>\n
  </head><body>\n
  <h1>Found</h1>\n
  <p>The document has moved <a href="https://www.debian.org/">here</a>.</p>\n
  <hr>\n
  <address>Apache Server at www.debian.org Port 80</address>\n
  </body></html>\n
```

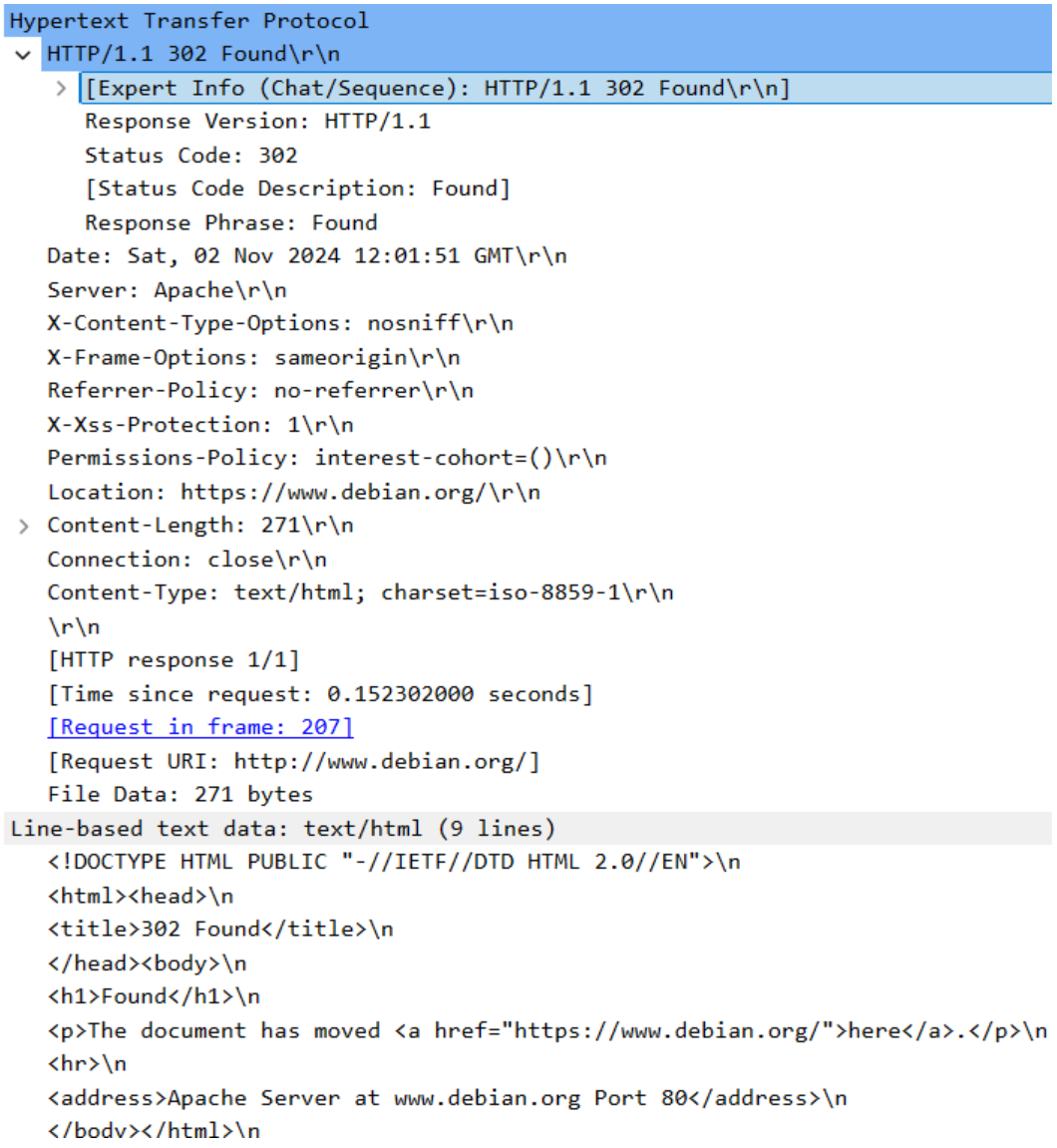
The Accept-Encoding header requests gzip-compressed content. The response is decoded using the gzip module to access readable content. Displays the content-encoding type and the first few lines of decompressed content.

```ruby
# Example 1: Using gzip encoding

req = Request('http://www.debian.org')
req.add_header('Accept-Encoding', 'gzip')
response = urlopen(req)
print('The encoding supported by server is ', response.getheader('Content-Encoding'))
print("PES1UG22EC321")
```

[8] ✓ 2.1s Ruby

```
The encoding supported by server is  gzip
PES1UG22EC321
```

No.	Time	Source	Destination	Protocol	Length	Info
207	3.092793	192.168.1.5	130.89.148.77	HTTP	172	GET / HTTP/1.1
216	3.245095	130.89.148.77	192.168.1.5	HTTP	673	HTTP/1.1 302 Found (text/html)



Multiple Values

To tell the serve that we can accept more than one encoding, add more values to the Accept-Encoding header and separate them by commas.

Multiple encoding Preferences

Multiple encodings are specified, with q values indicating preference.gzip is preferred, followed by deflate with lower priority, and identity with the lowest.

```ruby
# Example 2: Sending multiple encodings with priority specified by q in [0,1]
req = Request('http://www.debian.org')
encodings = 'deflate;q=0.8, gzip, identity;q=0.0'
req.add_header('Accept-Encoding', encodings)
response = urlopen(req)
print('The encoding supported by server is ', response.getheader('Content-Encoding'))
print('The content type returned by server is ', response.getheader('Content-Type'))
print('The content length (in bytes) returned by server is ', response.getheader('Content-Leng
print('The object was last modified at the server at ', response.getheader('Last-Modified'))
print("PES1UG22EC321")
```

✓ 2.5s Ruby

```
The encoding supported by server is  gzip
The content type returned by server is  text/html
The content length (in bytes) returned by server is  4085
The object was last modified at the server at  Sat, 02 Nov 2024 03:25:55 GMT
PES1UG22EC321
```

Above image shows Reading Content-Type and Charset

```
101 1.446237 192.168.1.5    194.177.211.2… HTTP       172 GET / HTTP/1.1
112 1.620934 194.177.211.2… 192.168.1.5    HTTP       673 HTTP/1.1 302 Found  (text/html)
```

```
Hypertext Transfer Protocol
  HTTP/1.1 302 Found\r\n
    [Expert Info (Chat/Sequence): HTTP/1.1 302 Found\r\n]
    Response Version: HTTP/1.1
    Status Code: 302
    [Status Code Description: Found]
    Response Phrase: Found
  Date: Sat, 02 Nov 2024 12:08:12 GMT\r\n
  Server: Apache\r\n
  X-Content-Type-Options: nosniff\r\n
  X-Frame-Options: sameorigin\r\n
  Referrer-Policy: no-referrer\r\n
  X-Xss-Protection: 1\r\n
  Permissions-Policy: interest-cohort=()\r\n
  Location: https://www.debian.org/\r\n
  Content-Length: 271\r\n
  Connection: close\r\n
  Content-Type: text/html; charset=iso-8859-1\r\n
  \r\n
  [HTTP response 1/1]
  [Time since request: 0.174697000 seconds]
  [Request in frame: 101]
  [Request URI: http://www.debian.org/]
  File Data: 271 bytes
```

```
Line-based text data: text/html (9 lines)
  <!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">\n
  <html><head>\n
  <title>302 Found</title>\n
  </head><body>\n
  <h1>Found</h1>\n
  <p>The document has moved <a href="https://www.debian.org/">here</a>.</p>\n
  <hr>\n
  <address>Apache Server at www.debian.org Port 80</address>\n
  </body></html>\n
```

The Content-Type header informs the client of the content type (e.g.,text/html). The charset parameter provides the encoding (UTF-8 in this case), which is used to decode the content.

```ruby
# Example 3: To see the charset returned along with Content-Type
response = urlopen('http://www.python.org')
format, params = response.getheader('Content-Type').split(';')
print(format)
print(params)
charset = params.split('=')[1]
print(charset)
print('The HTML file returned by the server after decoding as per charset is given by \n', response.read().decode(cha
print("PES1UG22EC321")
```

[12] ✓ 1.8s Ruby

```
text/html
 charset=utf-8
utf-8
The HTML file returned by the server after decoding as per charset is given by
 <!doctype html>
<!--[if lt IE 7]>   <html class="no-js ie6 lt-ie7 lt-ie8 lt-ie9">   <![endif]-->
<!--[if IE 7]>      <html class="no-js ie7 lt-ie8 lt-ie9">          <![endif]-->
<!--[if IE 8]>      <html class="no-js ie8 lt-ie9">                 <![endif]-->
<!--[if gt IE 8]><!--><html class="no-js" lang="en" dir="ltr">  <!--<![endif]-->

<head>
    <!-- Google tag (gtag.js) -->
    <script async src="https://www.googletagmanager.com/gtag/js?id=G-TF35YF9CVH"></script>
    <script>
      window.dataLayer = window.dataLayer || [];
      function gtag(){dataLayer.push(arguments);}
      gtag('js', new Date());
      gtag('config', 'G-TF35YF9CVH');
    </script>
    <!-- Plausible.io analytics -->
    <script defer data-domain="python.org" src="https://plausible.io/js/script.js"></script>

    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
...
</body>
</html>

PES1UG22EC321
```

51	1.382902	192.168.1.5	151.101.156.2…	HTTP	172	GET / HTTP/1.1
53	1.393694	151.101.156.2…	192.168.1.5	HTTP	445	HTTP/1.1 301 Moved Permanently

```
Hypertext Transfer Protocol
  HTTP/1.1 301 Moved Permanently\r\n
    [Expert Info (Chat/Sequence): HTTP/1.1 301 Moved Permanently\r\n]
    Response Version: HTTP/1.1
    Status Code: 301
    [Status Code Description: Moved Permanently]
    Response Phrase: Moved Permanently
  Connection: close\r\n
  Content-Length: 0\r\n
  Server: Varnish\r\n
  Retry-After: 0\r\n
  Location: https://www.python.org/\r\n
  Accept-Ranges: bytes\r\n
  Date: Sat, 02 Nov 2024 12:12:52 GMT\r\n
  Via: 1.1 varnish\r\n
  X-Served-By: cache-maa10250-MAA\r\n
  X-Cache: HIT\r\n
  X-Cache-Hits: 0\r\n
  X-Timer: S1730549572.329229,VS0,VE0\r\n
  Strict-Transport-Security: max-age=63072000; includeSubDomains; preload\r\n
  \r\n
  [HTTP response 1/1]
  [Time since request: 0.010792000 seconds]
  [Request in frame: 51]
  [Request URI: http://www.python.org/]
```

User Agents

Any client that communicates using HTTP can be referred to as a user agent. RFC 7231 suggests that user agents should use the User-Agent header to identify themselves in every request.

```python
# To see the user-agent
req = Request('http://www.python.org')
urlopen(req)
print('The user agent is ', req.get_header('User-agent'))
print("PES1UG22EC321")
```

[13] ✓ 1.5s

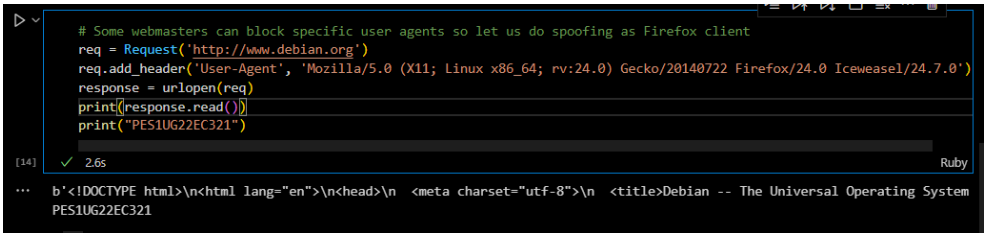
```
The user agent is  Python-urllib/3.10
PES1UG22EC321
```

```
27 1.562905 192.168.1.5    151.101.156.2… HTTP        172 GET / HTTP/1.1
29 1.573025 151.101.156.2… 192.168.1.5    HTTP        445 HTTP/1.1 301 Moved Permanently
```

```
Hypertext Transfer Protocol
  GET / HTTP/1.1\r\n
    [Expert Info (Chat/Sequence): GET / HTTP/1.1\r\n]
    Request Method: GET
    Request URI: /
    Request Version: HTTP/1.1
  Accept-Encoding: identity\r\n
  Host: www.python.org\r\n
  User-Agent: Python-urllib/3.10\r\n
  Connection: close\r\n
  \r\n
  [Full request URI: http://www.python.org/]
  [HTTP request 1/1]
  [Response in frame: 29]
```

```
Hypertext Transfer Protocol
  HTTP/1.1 301 Moved Permanently\r\n
    [Expert Info (Chat/Sequence): HTTP/1.1 301 Moved Permanently\r\n]
    Response Version: HTTP/1.1
    Status Code: 301
    [Status Code Description: Moved Permanently]
    Response Phrase: Moved Permanently
  Connection: close\r\n
  Content-Length: 0\r\n
  Server: Varnish\r\n
  Retry-After: 0\r\n
  Location: https://www.python.org/\r\n
  Accept-Ranges: bytes\r\n
  Date: Sat, 02 Nov 2024 12:15:01 GMT\r\n
  Via: 1.1 varnish\r\n
  X-Served-By: cache-maa10234-MAA\r\n
  X-Cache: HIT\r\n
  X-Cache-Hits: 0\r\n
  X-Timer: S1730549702.856490,VS0,VE0\r\n
  Strict-Transport-Security: max-age=63072000; includeSubDomains; preload\r\n
  \r\n
  [HTTP response 1/1]
  [Time since request: 0.010120000 seconds]
  [Request in frame: 27]
  [Request URI: http://www.python.org/]
```

Webmasters often inspect the user agents of requests to gather insights for various purposes, such as classifying website visits for statistical analysis, blocking clients with specific user agent strings, and sending alternative versions of resources to user agents known to have issues—like bugs in CSS interpretation or lack of support for languages like JavaScript. However, these practices can hinder access to desired content. To circumvent such restrictions, users can modify their user agent to mimic that of a well-known browser, a technique referred to as spoofing.




```
22 1.460789 192.168.1.5    130.89.148.77  HTTP      238 GET / HTTP/1.1
24 1.600205 130.89.148.77  192.168.1.5    HTTP      673 HTTP/1.1 302 Found  (text/html)
```

```
Hypertext Transfer Protocol
GET / HTTP/1.1\r\n
  [[Expert Info (Chat/Sequence): GET / HTTP/1.1\r\n]
    Request Method: GET
    Request URI: /
    Request Version: HTTP/1.1
Accept-Encoding: identity\r\n
Host: www.debian.org\r\n
User-Agent: Mozilla/5.0 (X11;Linux x86_64; rv:24.0) Gecko/20140722 Firefox/24.0 Iceweasel/24 7.0\r\n
Connection: close\r\n
\r\n
[Full request URI: http://www.debian.org/]
[HTTP request 1/1]
[Response in frame: 24]
```

```
Hypertext Transfer Protocol
HTTP/1.1 302 Found\r\n
  [Expert Info (Chat/Sequence): HTTP/1.1 302 Found\r\n]
    Response Version: HTTP/1.1
    Status Code: 302
    [Status Code Description: Found]
    Response Phrase: Found
Date: Sat, 02 Nov 2024 12:19:47 GMT\r\n
Server: Apache\r\n
X-Content-Type-Options: nosniff\r\n
X-Frame-Options: sameorigin\r\n
Referrer-Policy: no-referrer\r\n
X-Xss-Protection: 1\r\n
Permissions-Policy: interest-cohort=()\r\n
Location: https://www.debian.org/\r\n
Content-Length: 271\r\n
Connection: close\r\n
Content-Type: text/html; charset=iso-8859-1\r\n
\r\n
[HTTP response 1/1]
[Time since request: 0.139416000 seconds]
[Request in frame: 22]
[Request URI: http://www.debian.org/]
File Data: 271 bytes
Line-based text data: text/html (9 lines)
<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">\n
<html><head>\n
<title>302 Found</title>\n
</head><body>\n
<h1>Found</h1>\n
<p>The document has moved <a href="https://www.debian.org/">here</a>.</p>\n
<hr>\n
<address>Apache Server at www.debian.org Port 80</address>\n
</body></html>\n
```

Conclusion: The python codes have been executed and the HTTP packets have been captured. In conclusion, using the urllib package to handle HTTP requests and responses provides a more efficient and user-friendly approach compared to the socket package.