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Distributed Systems

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Multithreaded Python HTTP Server

Description

This program accepts and processes HTTP requests in the role of an HTTP web server. Since the application is multi threaded, a new request to process the pages will be made as soon as the connection is authorized. The connection is kept open for three seconds before being cut off.

Using the HTTP/1.1 protocol, responses to HTTP requests are made. The application accepts input arguments for the server's port number and the document root. When a connection is made, the server creates a new thread for the client. The client sends requests for the HTML page and picture files one at a time. The socket is kept alive for three seconds after the connection. The connection analyzes the HTTP request, producing either an image or an HTML file as the output. If the user doesn't provide a clear filename, the index.html file is used by default.

How to run the file

You can use the below command to run the server.

```
$ python web_server.py -document_root ./scu -port 8080
```

Note:- Make sure you have below permissions for the robots.txt file

```
-r----- 1 root root 473 Feb 7 11:40 robots.txt
```

If the permission and ownership are missing, then the server will not raise a 403 error.

Make sure you run the script without using sudo.

```
sourabhdeshmukh ~/main ~/Documents/server/PythonHTTPServer python web_server.py -document_root ./scu -port 8080
Using directory ./scu and port 8080 for server.
Starting Server...
Access Server at http://localhost:8080/
```

The List of files submitted

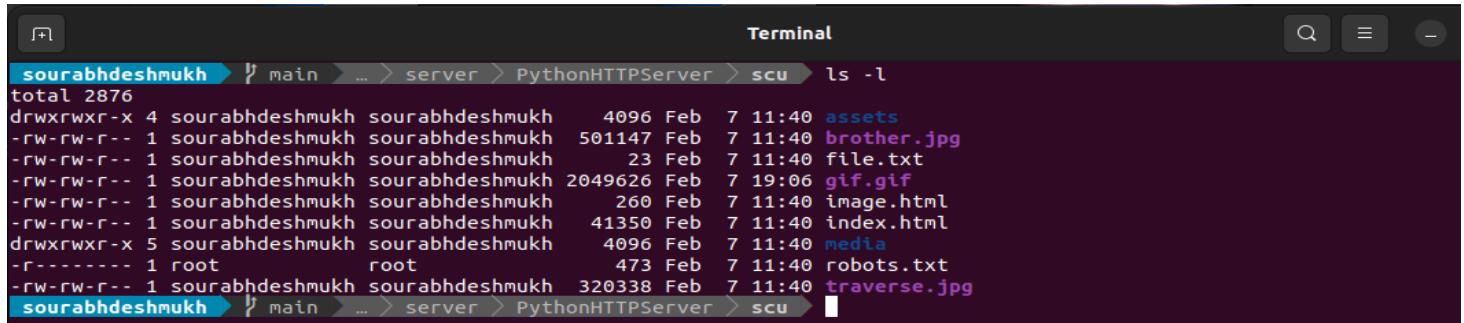
The zipped file contains the following files listed below the image.

```
sourabhdeshmukh ~/main ~/Documents/server/PythonHTTPServer ls -l
total 60
drwxrwxr-x 2 sourabhdeshmukh sourabhdeshmukh 4096 Feb 7 11:40 error
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 35149 Feb 7 11:39 LICENSE
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 50 Feb 7 11:39 README.md
drwxrwxr-x 4 sourabhdeshmukh sourabhdeshmukh 4096 Feb 7 11:40 scu
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 10195 Feb 7 17:58 web_server.py
sourabhdeshmukh ~/main ~/Documents/server/PythonHTTPServer ls -l error/*
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 190 Feb 7 11:40 error/400.html
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 184 Feb 7 11:40 error/403.html
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 173 Feb 7 11:40 error/404.html
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 195 Feb 7 11:40 error/500.html
sourabhdeshmukh ~/main ~/Documents/server/PythonHTTPServer ls -l scu/*/*/*
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 8669 Feb 7 11:40 scu/assets/images/favicons/android-chrome-192x192.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 6360 Feb 7 11:40 scu/assets/images/favicons/apple-touch-icon-114x114.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 6768 Feb 7 11:40 scu/assets/images/favicons/apple-touch-icon-120x120.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 8849 Feb 7 11:40 scu/assets/images/favicons/apple-touch-icon-144x144.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 9488 Feb 7 11:40 scu/assets/images/favicons/apple-touch-icon-152x152.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 11810 Feb 7 11:40 scu/assets/images/favicons/apple-touch-icon-180x180.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 2693 Feb 7 11:40 scu/assets/images/favicons/apple-touch-icon-57x57.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 2809 Feb 7 11:40 scu/assets/images/favicons/apple-touch-icon-60x60.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 3488 Feb 7 11:40 scu/assets/images/favicons/apple-touch-icon-72x72.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 3772 Feb 7 11:40 scu/assets/images/favicons/apple-touch-icon-76x76.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 1148 Feb 7 11:40 scu/assets/images/favicons/favicon-16x16.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 1793 Feb 7 11:40 scu/assets/images/favicons/favicon-32x32.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 6419 Feb 7 11:40 scu/assets/images/favicons/favicon-96x96.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 204 Feb 7 11:40 scu/assets/images/favicons/manifest.json
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 10799 Feb 7 11:40 scu/assets/images/favicons/mstile-144x144.png
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 2819 Feb 7 11:40 scu/assets/images/favicons/safari-pinned-tab.svg
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 52694 Feb 7 11:40 scu/media/institutional-pages/news-amp-events/20220518_Dori_Pina_JG_0899-1000x633.jpg
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 35187 Feb 7 11:40 scu/media/institutional-pages/news-amp-events/20220518_Dori_Pina_JG_0899-760x481.jpg
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 58358 Feb 7 11:40 scu/media/institutional-pages/news-amp-events/Sofia_Brunbaugh_20221028_JG_0053-1-760x480.jpg
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 59475 Feb 7 11:40 scu/media/institutional-pages/news-amp-events/unnamed-3-760x480.jpg
scu/media/institutional-pages/giving/images:
total 28
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 26150 Feb 7 11:40 campaign-banner.png

scu/media/offices/umc/web-design:
total 132
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 132900 Feb 7 11:40 crowd-ptc-NEW_0001_20211203_Soccer_Fans_4446.jpg

scu/media/scuedu/style-assets/javascript:
total 4
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 3394 Feb 7 11:40 lazyloading.js

scu/media/scuedu/style-assets/stylesheets:
total 12
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 4926 Feb 7 11:40 f.css
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 717 Feb 7 11:40 preloading.css
```



The screenshot shows a macOS Terminal window titled "Terminal". The command entered is "ls -l" in the directory "/main/.../server/PythonHTTPServer/scu". The output lists several files and a directory:

```
total 2876
drwxrwxr-x 4 sourabhdeshmukh sourabhdeshmukh 4096 Feb 7 11:40 assets
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 501147 Feb 7 11:40 brother.jpg
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 23 Feb 7 11:40 file.txt
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 2049626 Feb 7 19:06 gif.gif
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 260 Feb 7 11:40 image.html
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 41350 Feb 7 11:40 index.html
drwxrwxr-x 5 sourabhdeshmukh sourabhdeshmukh 4096 Feb 7 11:40 media
-r----- 1 root root 473 Feb 7 11:40 robots.txt
-rw-rw-r-- 1 sourabhdeshmukh sourabhdeshmukh 320338 Feb 7 11:40 traverse.jpg
```

Demonstrated Scenarios -

1. Default index.html scu page with URL <http://localhost:8080/>

The screenshot shows a web browser window displaying the Santa Clara University homepage. The URL in the address bar is <http://localhost:8080>. The page has a dark theme with a blurred background image of a person. At the top, there's a red header bar with links for 'ABOUT SCU', 'ACADEMICS', 'ADMISSION', 'ATHLETICS', 'CAMPUS LIFE', 'GIVING', 'GLOBAL', and 'NEWS & EVENTS'. Below the header, the main title 'SANTA CLARA UNIVERSITY' and the subtitle 'THE JESUIT UNIVERSITY IN SILICON VALLEY' are visible. A search bar is also present. The bottom half of the page contains the text 'Go Anywhere From Here'.

Below the browser window, the developer tools Network tab is open, showing network activity. The timeline shows several requests being made, including files like 'f.css', 'scu.js', and 'p.css?>1&k=gzb1rhy&ht=tk&f=139.140.175.176.6768...8480.18481.18482.18483&a=683'. The 'General' section of the Network tab details a request for the URL <http://localhost:8080/> with a status code of 200 OK, a remote address of 127.0.0.1:8080, and a referrer policy of strict-origin-when-cross-origin.

Name	Request URL	Status Code	Remote Address	Referrer Policy
collect?v=2&tid=G-KPFG4EBS18>m=45je32608_p=17294...ome%20-%20Santa%20Clara.	http://localhost:8080/	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
localhost	http://localhost:8080/	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
collect?v=2&tid=G-KPFG4EBS18>m=45je32608_p=17294...%20Clara%20University&en...	http://localhost:8080/	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
instant-notification.js	http://localhost:8080/instant-notification.js	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
1x1.png	http://localhost:8080/1x1.png	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
lwcw.js	http://localhost:8080/lwcw.js	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
all.css	http://localhost:8080/all.css	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
f.css	http://localhost:8080/f.css	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
scu.js	http://localhost:8080/scu.js	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
p.css?>1&k=gzb1rhy&ht=tk&f=139.140.175.176.6768...8480.18481.18482.18483&a=683.	http://localhost:8080/p.css?>1&k=gzb1rhy&ht=tk&f=139.140.175.176.6768...8480.18481.18482.18483&a=683.	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin
lazyloading.js	http://localhost:8080/lazyloading.js	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin

Request URL: <http://localhost:8080/>
 Request Method: GET
 Status Code: 200 OK
 Remote Address: 127.0.0.1:8080
 Referrer Policy: strict-origin-when-cross-origin

Content-Length: 41049
 Content-Type: text/html
 Date: Wed, 08 Feb 2023 02:15:01

2. Index.html scu page with URL <http://localhost:8080/index.html>

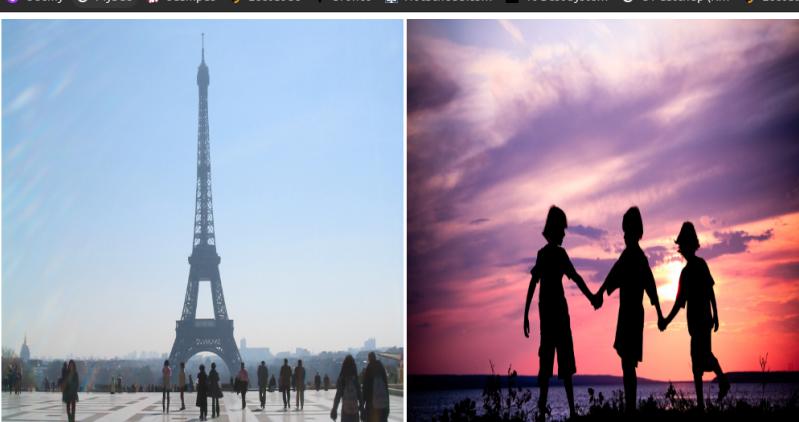
The screenshot shows a browser window displaying the Santa Clara University homepage. The URL in the address bar is <http://localhost:8080/index.html>. The page features a red header with the university's name and a navigation menu. Below the header, there is a large banner with two people and the text "Go Anywhere From Here". The browser's developer tools Network tab is open, showing a timeline of requests. One request for "index.html" is selected, showing details like Request URL, Request Method, Status Code, and Response Headers.

Name	Request URL	Request Method	Status Code	Remote Address	Referrer Policy
index.html	http://localhost:8080/index.html	GET	200 OK	127.0.0.1:8080	strict-origin-when-cross-origin

Response Headers

Content-Length	Content-Type	Date
41849	text/html	Wed, 08 Feb 2023 02:15:01

3. Image HTML page display with URL <http://localhost:8080/image.html>



The screenshot shows a web browser window with the title "Image". The address bar displays "localhost:8080/image.html". The main content area shows two images side-by-side: the Eiffel Tower against a blue sky and three children holding hands against a vibrant sunset.

Below the browser window is the Chrome DevTools Network tab. It lists four requests:

- image.html**: Request URL: http://localhost:8080/image.html, Status Code: 200 OK, Response Headers: Content-Length: 266, Content-Type: text/html, Date: Wed, 08 Feb 2023 02:15:01.
- traverse.jpg**: Request URL: http://localhost:8080/traverse.jpg, Status Code: 200 OK, Response Headers: Content-Type: image/jpeg.
- brother.jpg**: Request URL: http://localhost:8080/brother.jpg, Status Code: 200 OK, Response Headers: Content-Type: image/jpeg.
- favicon.ico**: Request URL: http://localhost:8080/favicon.ico, Status Code: 200 OK, Response Headers: Content-Type: image/x-icon.

Headers **Preview** **Response** **Initiator** **Timing** **Cookies**

General

Request URL: <http://localhost:8080/image.html>
 Request Method: GET
 Status Code: 200 OK
 Remote Address: 127.0.0.1:8080
 Referrer Policy: strict-origin-when-cross-origin

Response Headers

Content-Length: 266
 Content-Type: text/html
 Date: Wed, 08 Feb 2023 02:15:01

4. Single image display using URL <http://localhost:8080/traverse.jpg>

Screenshot of a browser window showing the image at <http://localhost:8080/traverse.jpg>. The image is a photograph of the Eiffel Tower in Paris, France, viewed from the Trocadero Gardens. The browser's developer tools Network tab is open, showing the request for 'traverse.jpg'. The request details show a 200 OK status code, GET method, and a Date header of 'Wed, 08 Feb 2023 02:15:01'.

Name	Headers	Preview	Response	Initiator	Timing	Cookies
traverse.jpg	General Request URL: http://localhost:8080/traverse.jpg Request Method: GET Status Code: 200 OK Remote Address: 127.0.0.1:8080 Referrer Policy: strict-origin-when-cross-origin					
favicon.ico	Response Headers Accept-Ranges: bytes Content-Type: image/jpeg Date: Wed, 08 Feb 2023 02:15:01					

Network tab details:

- Request URL: http://localhost:8080/traverse.jpg
- Request Method: GET
- Status Code: 200 OK
- Remote Address: 127.0.0.1:8080
- Referrer Policy: strict-origin-when-cross-origin

Response Headers:

- Accept-Ranges: bytes
- Content-Type: image/jpeg
- Date: Wed, 08 Feb 2023 02:15:01

Screenshot of the browser's developer tools Network tab for the 'traverse.jpg' request. The Headers section is selected, showing the following details:

General

- Request URL: <http://localhost:8080/traverse.jpg>
- Request Method: GET
- Status Code: 200 OK
- Remote Address: 127.0.0.1:8080
- Referrer Policy: strict-origin-when-cross-origin

Response Headers

- Accept-Ranges: bytes
- Content-Type: image/jpeg
- Date: Wed, 08 Feb 2023 02:15:01

5. Single gif display using URL <http://localhost:8080/gif.gif>

Screenshot of a web browser showing a GIF of a cat. The browser's developer tools Network tab is open, showing the request for 'gif.gif'.

The Network tab details:

- Name:** gif.gif
- Request URL:** http://localhost:8080/gif.gif
- Request Method:** GET
- Status Code:** 200 OK
- Remote Address:** 127.0.0.1:8080
- Referrer Policy:** strict-origin-when-cross-origin
- Response Headers:**
 - Accept-Ranges: bytes
 - Content-Type: image/gif
 - Date: Wed, 08 Feb 2023 02:29:36

6. Single png display using URL <http://localhost:8080/png.png>

The screenshot shows a browser window displaying a cluster of colorful balloons (red, yellow, blue, green) against a white background. The browser's Network tab is open, showing the request for 'png.png' with a status of 200 OK. The response headers include 'Accept-Ranges: bytes', 'Content-Type: image/png', and a 'Date' header. Below the browser, a detailed view of the request and response is provided.

Request Details:

- Request URL:** http://localhost:8080/png.png
- Request Method:** GET
- Status Code:** 200 OK
- Remote Address:** 127.0.0.1:8080
- Referrer Policy:** strict-origin-when-cross-origin

Response Headers:

- Accept-Ranges: bytes
- Content-Type: image/png
- Date: Wed, 08 Feb 2023 02:29:36

7. Text file display using URL <http://localhost:8080/file.txt>

Screenshot of a browser window showing the content of a text file at <http://localhost:8080/file.txt>. The page displays the single line "This is my text file."

Below the browser, the Network tab of the developer tools is open, showing the request for "file.txt". The "General" section of the response details is expanded, showing the following information:

- Request URL:** http://localhost:8080/file.txt
- Request Method:** GET
- Status Code:** 200 OK
- Remote Address:** 127.0.0.1:8080
- Referrer Policy:** strict-origin-when-cross-origin

The "Response Headers" section shows the following headers:

- Content-Length: 23
- Content-Type: text/plain
- Date: Wed, 08 Feb 2023 02:15:01

8. HTTP Code 404 File not found

The screenshot shows a browser window with a 404 Not Found error page. The URL in the address bar is `localhost:8080/filenotfound.txt`. The page displays the standard 404 error message: "404" and "NOT FOUND". Below the browser window is the Network tab of the developer tools. The timeline shows a single request to `filenotfound.txt` taking approximately 650ms. The request details show it was a GET request for `http://localhost:8080/filenotfound.txt` with a status code of 404 Not Found. The response headers include Content-Length: 173, Content-Type: text/html, and Date: Wed, 08 Feb 2023 02:15:01.

Name	Headers	Preview	Response	Initiator	Timing	Cookies
filenotfound.txt	Request URL: http://localhost:8080/filenotfound.txt Request Method: GET Status Code: 404 Not Found Remote Address: 127.0.0.1:8080 Referrer Policy: strict-origin-when-cross-origin				50 ms - 650 ms	
favicon.ico						

Request Headers:

- Content-Length: 173
- Content-Type: text/html
- Date: Wed, 08 Feb 2023 02:15:01

9. HTTP Code 400 Unexpected Error

The screenshot shows a browser window with a 400 Bad Request error page. The URL is `localhost:8080/README.md`. The developer tools Network tab is open, showing a single request to `localhost:8080/README.md`. The request took 600ms. The response status is 400 Bad Request, and the response body contains the text "Unexpected Error :(

Name	Type	Size	Time
README.md	Text	190 B	600 ms
favicon.ico	Image	0 B	600 ms

Request Headers:

- Request URL: http://localhost:8080/README.md
- Request Method: GET
- Status Code: 400 Bad Request
- Remote Address: 127.0.0.1:8080
- Referrer Policy: strict-origin-when-cross-origin

Response Headers:

- Content-Length: 190
- Content-Type: text/html
- Date: Wed, 08 Feb 2023 02:15:01

10. HTTP Code 403 Forbidden

The screenshot shows a browser window with the URL `localhost:8080/robots.txt`. The page displays a large red "403" and the text "Forbidden !!!". Below the page, the browser's developer tools are open, specifically the Network tab. The Network tab shows two requests: "robots.txt" and "favicon.ico". The "robots.txt" request is expanded, showing details like Request URL: `http://localhost:8080/robots.txt`, Request Method: GET, Status Code: 403 Forbidden, and Response Headers including Content-Length: 184 and Content-Type: text/html.

Name	Type	Status	Request URL	Request Method	Response Headers
robots.txt	Text	403	<code>http://localhost:8080/robots.txt</code>	GET	Content-Length: 184 Content-Type: text/html Date: Wed, 08 Feb 2023 02:15:01
favicon.ico	Image	200	<code>http://localhost:8080/favicon.ico</code>	GET	

11.Headers - Content-Type, Time, and Date

```
sourabhdeshmukh ~/main ~/Documents/server/PythonHTTPServer curl -v localhost:8080 | top
* Trying 127.0.0.1:8080...
% Total    % Received % Xferd  Average Speed   Time     Time      Current
          Dload  Upload Total   Spent    Left  Speed
0       0     0      0      0      0 --:--:-- --:--:-- --:--:-- 0* Connected to localhost (127.0.0.1) port 8080 (#0)
> GET / HTTP/1.1
> Host: localhost:8080
> User-Agent: curl/7.81.0
> Accept: */*
>
* Mark bundle as not supporting multiuse
< HTTP/1.1 200 OK
< Content-Type: text/html
< Content-Length: 41049
< Date: Wed, 08 Feb 2023 02:29:36
<
{ [41049 bytes data]
100 41049 100 41049 0 0 27.3M 0 --:--:-- --:--:-- --:--:-- 39.1M
* Connection #0 to host localhost left intact.
top: failed to get
```

12. Thread Connection logs

```
sourabhdeshmukh ~/main ~/Documents/server/PythonHTTPServer python web_server.py -document_root ./scu -port 8080
Using directory ./scu and port 8080 for server.
Starting Server...
Access Server at http://localhost:8080/
[<_MainThread(MainThread, started 140087837978624)>, <Thread(Thread-1 (keepConnectionAlive), started 140087818094144)>
[<_MainThread(MainThread, started 140087837978624)>, <Thread(Thread-2 (keepConnectionAlive), started 140087818094144)>
[<_MainThread(MainThread, started 140087837978624)>, <Thread(Thread-2 (keepConnectionAlive), started 140087818094144)>, <Thread(Thread-3 (keepConnectionAlive), started 140087740331584)>]
[<_MainThread(MainThread, started 140087837978624)>, <Thread(Thread-3 (keepConnectionAlive), started 140087740331584)>, <Thread(Thread-4 (keepConnectionAlive), started 140087818094144)>]
[<_MainThread(MainThread, started 140087837978624)>, <Thread(Thread-5 (keepConnectionAlive), started 140087740331584)>]
```