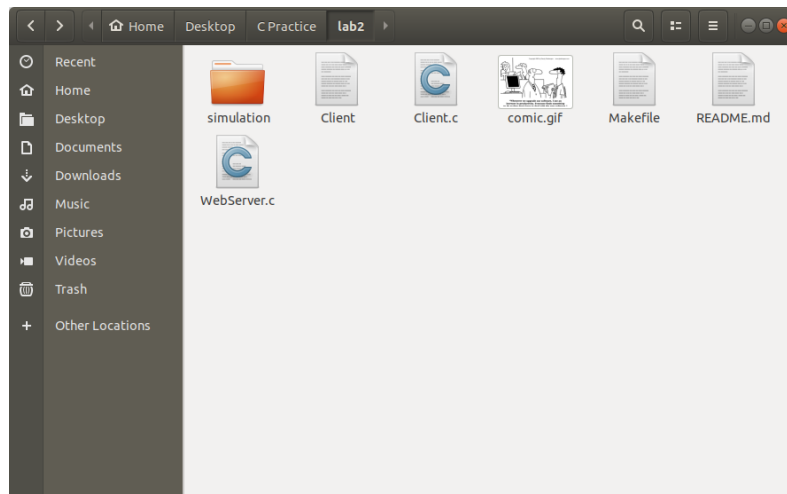
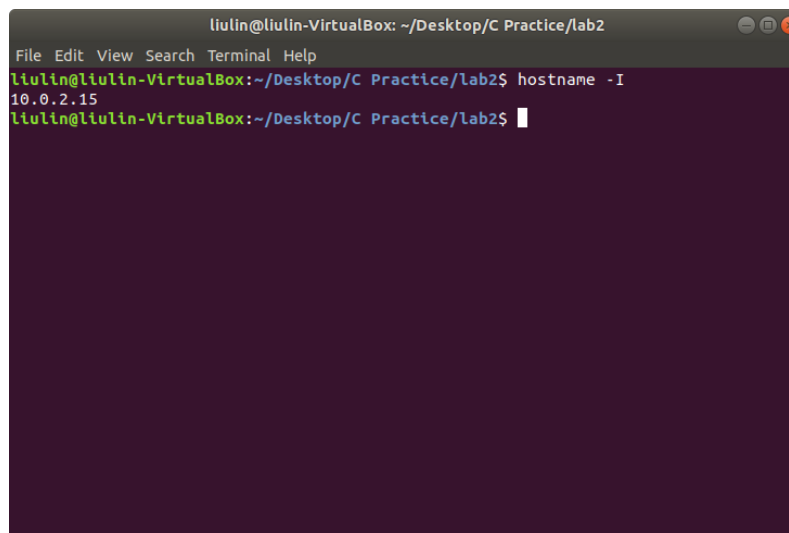


Steps to follow for the Project

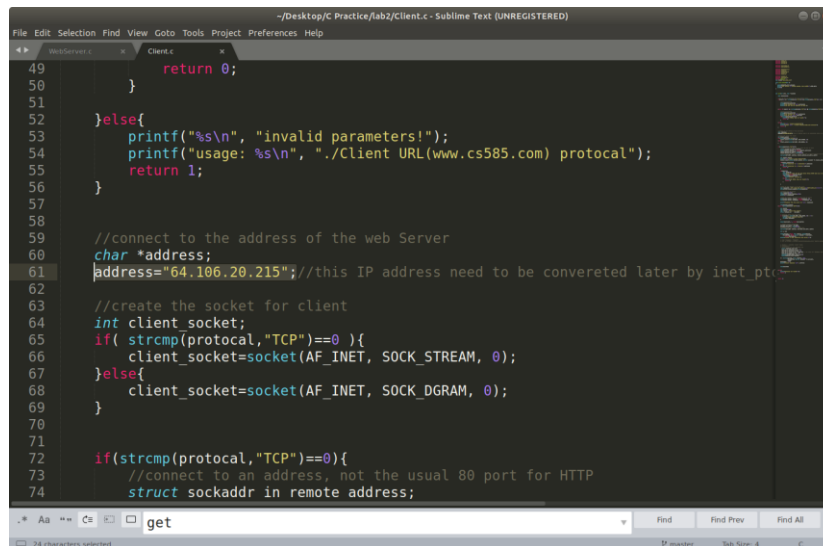
1) Clone the code and open the terminal in the project directory.



2) Get the IP address for the machine that runs the Server; by using the 'hostname -I' command.

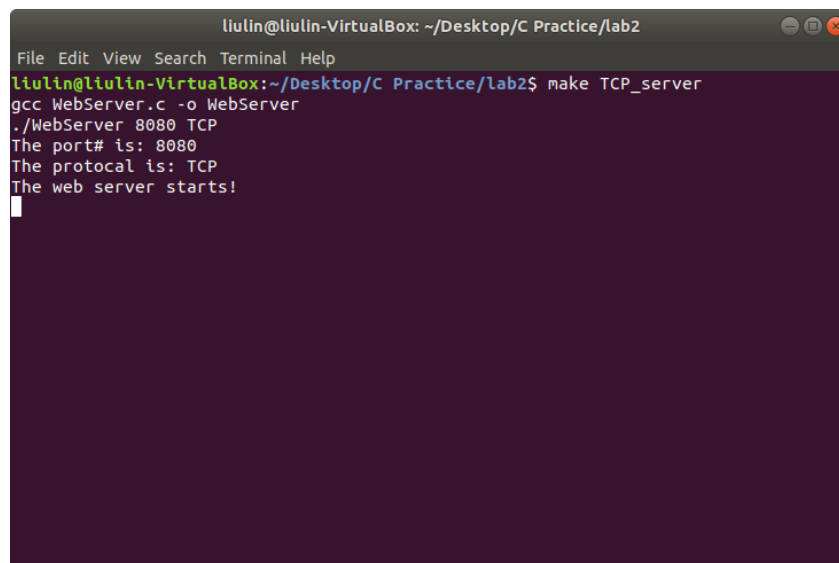


3) Open the 'Client.c' source code, go to line 61 and change the address String to the server IP address.



```
49         return 0;
50     }
51
52     }else{
53         printf("%s\n", "invalid parameters!");
54         printf("usage: %s\n", "./Client URL(www.cs585.com) protocol");
55         return 1;
56     }
57
58     //connect to the address of the web Server
59     char *address;
60     address="64.106.20.215";//this IP address need to be converted later by inet_pt
61
62     //create the socket for client
63     int client_socket;
64     if( strcmp(protocol,"TCP")==0 ){
65         client_socket=socket(AF_INET, SOCK_STREAM, 0);
66     }else{
67         client_socket=socket(AF_INET, SOCK_DGRAM, 0);
68     }
69
70
71     if(strcmp(protocol,"TCP")==0){
72         //connect to an address, not the usual 80 port for HTTP
73         struct sockaddr_in remote_address;
```

4) First, we implement the TCP part.
Go to the directory containing project, run ‘make TCP_server’ in the terminal to start a TCP server.



```
liulin@liulin-VirtualBox: ~/Desktop/C Practice/lab2
File Edit View Search Terminal Help
liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$ make TCP_server
gcc WebServer.c -o WebServer
./WebServer 8080 TCP
The port# is: 8080
The protocol is: TCP
The web server starts!
```

5) If some error message like “socket: Address already in use” showed up, then just close this terminal and do the above operation again until the “web server starts”. The whole process will be tried again.

```
liulin@liulin-VirtualBox: ~/Desktop/C Practice/lab2
File Edit View Search Terminal Help
liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$ make TCP_server
gcc WebServer.c -o WebServer
./WebServer 8080 TCP
The port# is: 8080
The protocol is: TCP
socket: Address already in use
Makefile:6: recipe for target 'TCP_server' failed
make: *** [TCP_server] Error 1
liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$
```

6) Open a new Terminal, also go to the directory containing project, run ‘make TCP_client’ to send the GET request to the server. This could be done in another machine, or in the same server machine.

```
liulin@liulin-VirtualBox: ~/Desktop/C Practice/lab2
File Edit View Search Terminal Help
liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$ make TCP_client
gcc Client.c -o Client
./Client www.cs585.com TCP
The protocol is: TCP
The URL is: www.cs585.com
begin to make connection
connection to 10.0.2.15 established
HTTP/1.1 200 OK
Content-Type: text/html; charset=UTF-8

<!DOCTYPE html>
<head>
<title>Lab 2: A Web Server Model</title>
</head>
<body>
<p>
<a href="http://www.unm.edu">University of New Mexico</a>
</p>
<h1> CS485/585 </h1>
<h2> Lab 2: A Web Server Model </h2>
<h3> Deadline: Octobor 13 </h3>
<p> Comic of the day! </p>
<CENTER><IMG SRC="comic.gif" ALIGN="BOTTOM"/> </CENTER>
</body>
Response from the server is: HTTP/1.1 200 OK
Content-Type: text/html; charset=UTF-8
```

7) Then we try the UDP part. Stop the TCP server by press ctrl+C in the terminal and run “make UDP_server”. Again, if any error messages show up then just close the terminal and try again.

```
liulin@liulin-VirtualBox: ~/Desktop/C Practice/lab2
File Edit View Search Terminal Help
liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$ make TCP_server
gcc WebServer.c -o WebServer
./WebServer 8080 TCP
The port# is: 8080
The protocol is: TCP
The web server starts!
new TCP Clnet connection!
Web Server: GET /lab2.html HTTP/1.0
HOST:cs585.org

closing
^CMakefile:6: recipe for target 'TCP_server' failed
make: *** [TCP_server] Interrupt

liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$ make UDP_server
gcc WebServer.c -o WebServer
./WebServer 8080 UDP
The port# is: 8080
The protocol is: UDP
```

8) Go to the client terminal, run “make UDP_client” command to initiate the UDP client. The parsed web page code will show here if connecting successfully.

```
liulin@liulin-VirtualBox: ~/Desktop/C Practice/lab2
File Edit View Search Terminal Help
liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$ make UDP_client
gcc Client.c -o Client
./Client www.cs585.com UDP
The protocol is: UDP
The URL is: www.cs585.com
Trying to make connection with server.
Server response: HTTP/1.1 200 OK
Content-Type: text/html; charset=UTF-8

<!DOCTYPE html>
<head>
<title>Lab 2: A Web Server Model</title>
</head>
<body>
<p>
<a href="http://www.unm.edu">University of New Mexico</a>
</p>
<h1> CS485/585 </h1>
<h2> Lab 2: A Web Server Model </h2>
<h3> Deadline: Octobor 13 </h3>
<p> Comic of the day! </p>
<CENTER><IMG SRC="comic.gif" ALIGN="BOTTOM"/> </CENTER>
</body>

liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$
```

9) For the UDP, it is possible that after a long time(5 seconds in our project), the message from server hasn't been received. In this case, a time out error will happen.

```
liulin@liulin-VirtualBox: ~/Desktop/C Practice/lab2
File Edit View Search Terminal Help
Response from the server is: HTTP/1.1 200 OK
Content-Type: text/html; charset=UTF-8

<!DOCTYPE html>
<head>
<title>Lab 2: A Web Server Model</title>
</head>
<body>
<p>
<a href="http://www.unm.edu">University of New Mexico</a>
</p>
<h1> CS485/585 </h1>
<h2> Lab 2: A Web Server Model </h2>
<h3> Deadline: Octobor 13 </h3>
<p> Comic of the day! </p>
<CENTER><IMG SRC="comic.gif" ALIGN="BOTTOM"/> </CENTER>
</body>

liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$ make UDP_client
gcc Client.c -o Client
./Client www.cs585.com UDP
The protocol is: UDP
The URL is: www.cs585.com
Trying to make connection with server.
UDP faliure, 5 seconds passed, time out!!!
liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$
```

10) The above operations are automated makefile operations. If you want to use more parameters, then run the gcc and ./ command as described in the assignment. Since we only have one page here, so we only have one legal URL which is “www.cs585.com”, other URL will result in 404 ERROR.

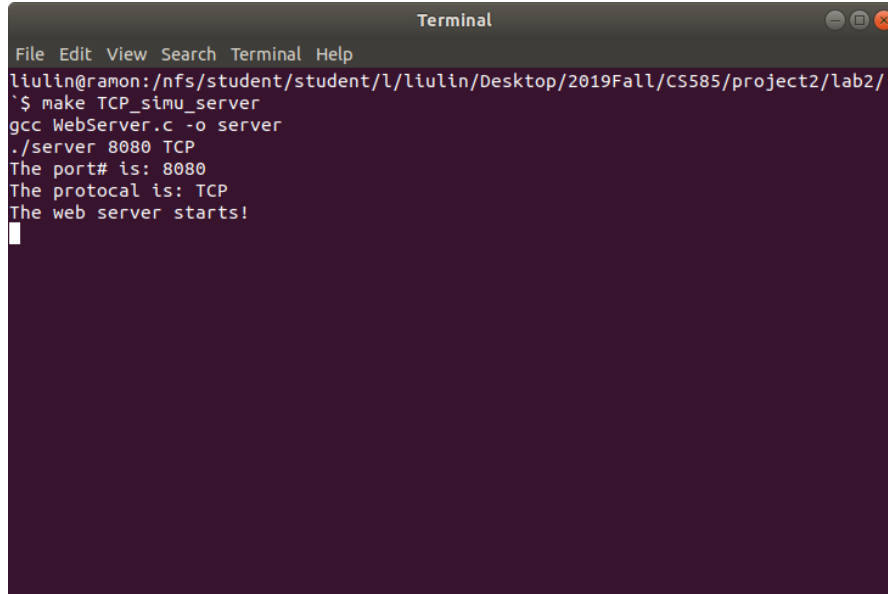
```
liulin@liulin-VirtualBox: ~/Desktop/C Practice/lab2
File Edit View Search Terminal Help
The URL is: www.cs585.com
Trying to make connection with server.
Server response: HTTP/1.1 200 OK
Content-Type: text/html; charset=UTF-8

<!DOCTYPE html>
<head>
<title>Lab 2: A Web Server Model</title>
</head>
<body>
<p>
<a href="http://www.unm.edu">University of New Mexico</a>
</p>
<h1> CS485/585 </h1>
<h2> Lab 2: A Web Server Model </h2>
<h3> Deadline: Octobor 13 </h3>
<p> Comic of the day! </p>
<CENTER><IMG SRC="comic.gif" ALIGN="BOTTOM"/> </CENTER>
</body>

liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$ ./Client www.unm.com UDP
The protocol is: UDP
The URL is: www.unm.com
404 ERROR, Page not found!
liulin@liulin-VirtualBox:~/Desktop/C Practice/lab2$
```

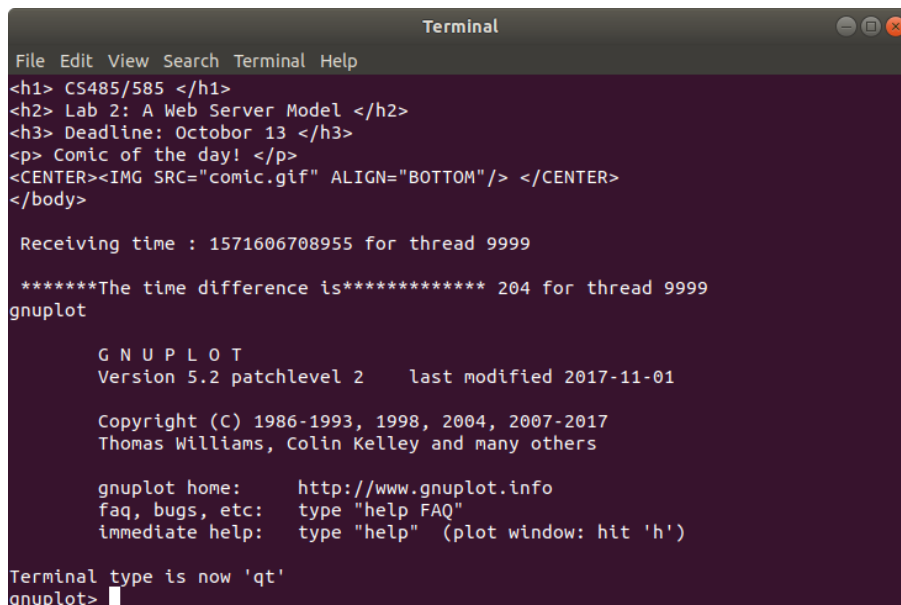
Steps to follow for the simulation part

1) Open terminal and go to the simulation directory in the project. Run “make TCP_simu_server”, again if the TCP server does not start successfully, close the terminal and run the command again.



```
Terminal
File Edit View Search Terminal Help
liulin@ramon:/nfs/student/student/l/liulin/Desktop/2019Fall/CS585/project2/lab2/
`$ make TCP_simu_server
gcc WebServer.c -o server
./server 8080 TCP
The port# is: 8080
The protocol is: TCP
The web server starts!
```

2) Open a another terminal in the same directory, then run”make TCP_simu_client”, the simulation will start automatically. After the simulation, the gnuplot function will be called to draw the graph.



```
Terminal
File Edit View Search Terminal Help
<h1> CS485/585 </h1>
<h2> Lab 2: A Web Server Model </h2>
<h3> Deadline: Octobor 13 </h3>
<p> Comic of the day! </p>
<CENTER><IMG SRC="comic.gif" ALIGN="BOTTOM"/> </CENTER>
</body>

Receiving time : 1571606708955 for thread 9999

*****The time difference is***** 204 for thread 9999
gnuplot

G N U P L O T
Version 5.2 patchlevel 2    last modified 2017-11-01

Copyright (C) 1986-1993, 1998, 2004, 2007-2017
Thomas Williams, Colin Kelley and many others

gnuplot home:    http://www.gnuplot.info
faq, bugs, etc:  type "help FAQ"
immediate help:  type "help" (plot window: hit 'h')

Terminal type is now 'qt'
gnuplot>
```

3) Input these commands to the gnuplot command line to draw the TCP latency time graph:
set xlabel "Number of connections"
set ylabel "Latency in milliseconds"
plot 'latency_per_connnections_tcp.txt' w l

```
Terminal
File Edit View Search Terminal Help
<p> Comic of the day! </p>
<CENTER><IMG SRC="comic.gif" ALIGN="BOTTOM"/> </CENTER>
</body>

Receiving time : 1571606708955 for thread 9999

*****The time difference is***** 204 for thread 9999
gnuplot

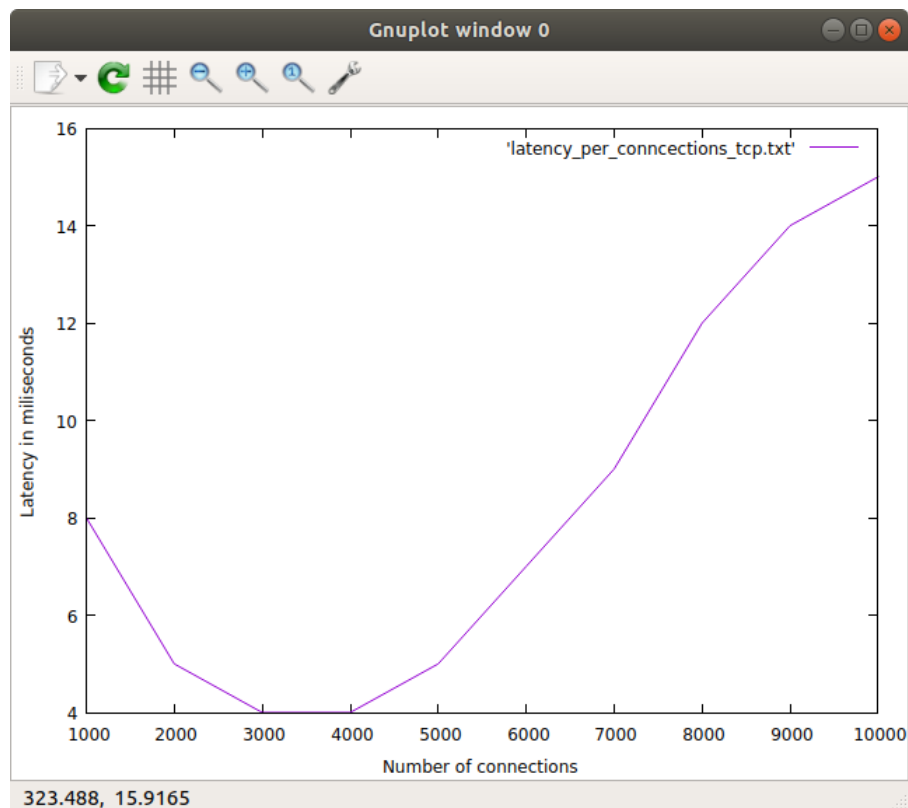
  G N U P L O T
  Version 5.2 patchlevel 2   last modified 2017-11-01

  Copyright (C) 1986-1993, 1998, 2004, 2007-2017
  Thomas Williams, Colin Kelley and many others

  gnuplot home:      http://www.gnuplot.info
  faq, bugs, etc:   type "help FAQ"
  immediate help:   type "help" (plot window: hit 'h')

Terminal type is now 'qt'
gnuplot> set xlabel "Number of connections"
gnuplot> set ylabel "Latency in milliseconds"
gnuplot> plot 'latency_per_connections_tcp.txt' w l
gnuplot>
```

4) The output graph is like this



5) Stop the TCP server and TCP client gnuplot by ctrl+c (or just close the terminal and open a new one)
Start the UDP server by “make UDP_simu_server”

```
Terminal
File Edit View Search Terminal Help
liulin@ramon:/nfs/student/student/l/liulin/Desktop/2019Fall/CS585/project2/lab2/
'$ make UDP_simu_server
gcc WebServer.c -o server
./server 8080 UDP
The port# is: 8080
The protocol is: UDP
UDP part
█
```

6) Start the simulation of UDP client latency time by “make UDP_simu_client”, also sometimes congestion or timeout error will happen and in this case the automated simulation process will stop and gunplot does not show up. In this case, close and reopen all the terminals and run the commands all over again.

```
Terminal
File Edit View Search Terminal Help
The average latency for 100 connections is 6.000000 milliseconds
The average latency for 200 connections is 6.000000 milliseconds
The average latency for 300 connections is 5.000000 milliseconds
The average latency for 400 connections is 4.000000 milliseconds
The average latency for 500 connections is 5.000000 milliseconds
The average latency for 600 connections is 5.000000 milliseconds
The average latency for 700 connections is 5.000000 milliseconds
The average latency for 800 connections is 5.000000 milliseconds
The average latency for 900 connections is 6.000000 milliseconds
The average latency for 1000 connections is 7.000000 milliseconds
gnuplot

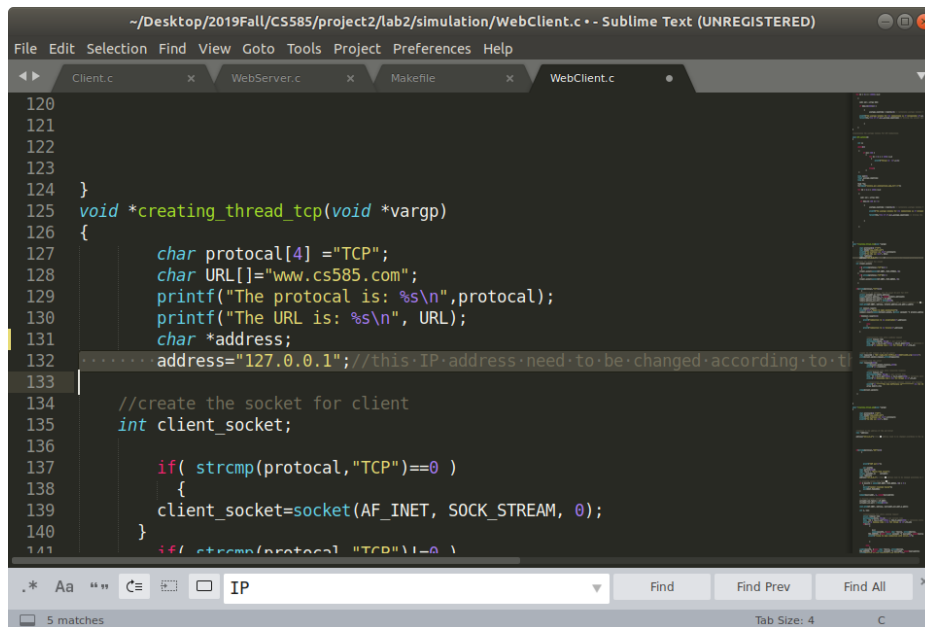
  G N U P L O T
  Version 5.2 patchlevel 2   last modified 2017-11-01

  Copyright (C) 1986-1993, 1998, 2004, 2007-2017
  Thomas Williams, Colin Kelley and many others

  gnuplot home:      http://www.gnuplot.info
  faq, bugs, etc:   type "help FAQ"
  immediate help:   type "help" (plot window: hit 'h')

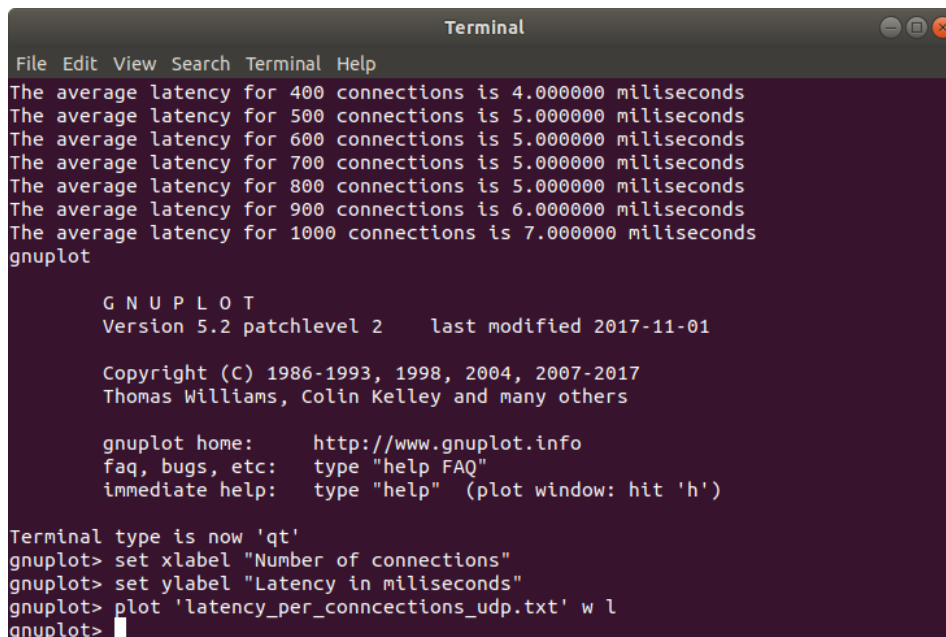
Terminal type is now 'qt'
gnuplot> █
```

7) If you are not running the client and server in the same machine. The IP address for the WebClient.c to connect should change to the server IP address, in line 132 of WebClient.c. (run hostname -I in server to get this address)



```
~/Desktop/2019Fall/CS585/project2/lab2/simulation/WebClient.c - Sublime Text (UNREGISTERED)
File Edit Selection Find View Goto Tools Project Preferences Help
Client.c WebServer.c Makefile WebClient.c
120
121
122
123
124 }
125 void *creating_thread_tcp(void *vargp)
126 {
127     char protocol[4] = "TCP";
128     char URL[] = "www.cs585.com";
129     printf("The protocol is: %s\n", protocol);
130     printf("The URL is: %s\n", URL);
131     char *address;
132     address = "127.0.0.1"; //this IP address need to be changed according to t
133
134     //create the socket for client
135     int client_socket;
136
137     if( strcmp(protocol, "TCP") == 0 )
138     {
139         client_socket = socket(AF_INET, SOCK_STREAM, 0);
140     }
141     if( strcmp(protocol, "TCP") != 0 )
142     {
143         client_socket = socket(AF_INET, SOCK_DGRAM, 0);
144     }
145 }
```

8) Input these commands to the gnuplot command line to draw the UDP latency time graph:
set xlabel "Number of connections"
set ylabel "Latency in miliseconds"
plot 'latency_per_connnections_udp.txt' w l



```
Terminal
File Edit View Search Terminal Help
The average latency for 400 connections is 4.000000 milliseconds
The average latency for 500 connections is 5.000000 milliseconds
The average latency for 600 connections is 5.000000 milliseconds
The average latency for 700 connections is 5.000000 milliseconds
The average latency for 800 connections is 5.000000 milliseconds
The average latency for 900 connections is 6.000000 milliseconds
The average latency for 1000 connections is 7.000000 milliseconds
gnuplot

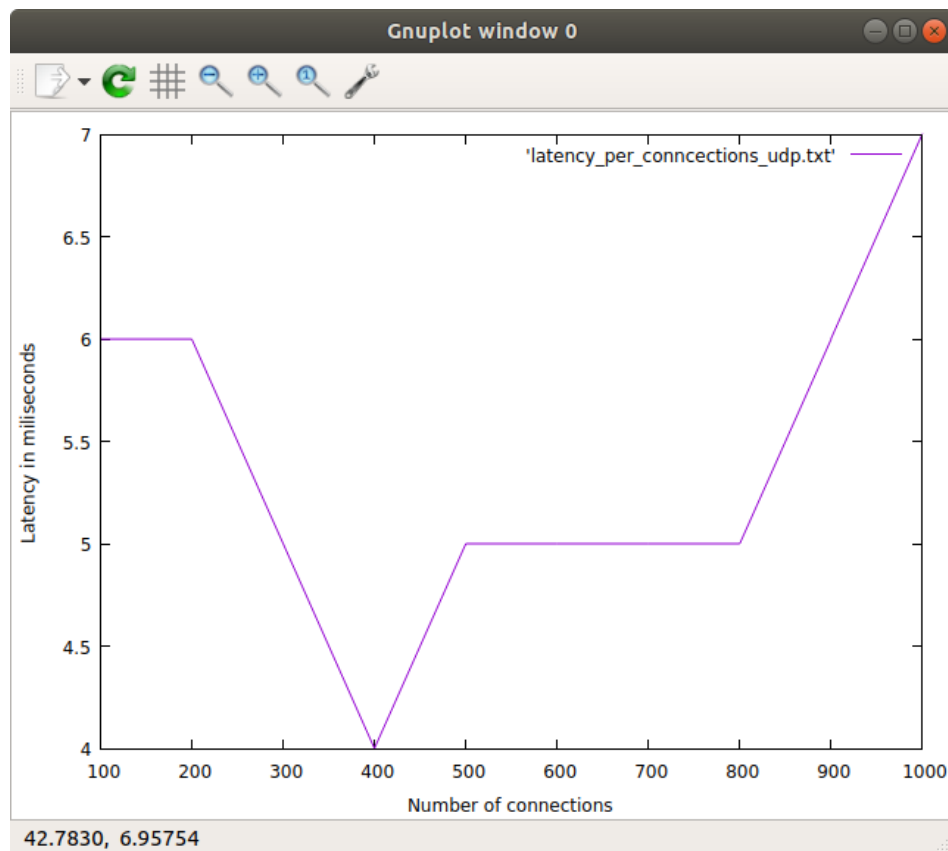
G N U P L O T
Version 5.2 patchlevel 2    last modified 2017-11-01

Copyright (C) 1986-1993, 1998, 2004, 2007-2017
Thomas Williams, Colin Kelley and many others

gnuplot home:      http://www.gnuplot.info
faq, bugs, etc:    type "help FAQ"
immediate help:    type "help" (plot window: hit 'h')

Terminal type is now 'qt'
gnuplot> set xlabel "Number of connections"
gnuplot> set ylabel "Latency in miliseconds"
gnuplot> plot 'latency_per_connnections_udp.txt' w l
gnuplot>
```

9) The graph for a UDP simulation looks like this



NOTE:

we only did the simulation up to 1,000 because the linux has an upper bound on how many UDP client socket a user can create simultaneously. 1,000 is a safe number in our case. We tried some larger numbers and a socket creation error will show.

```
Terminal
File Edit View Search Terminal Help

socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files

socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files
socket creation failed: Too many open files
Sending time : 1571608911517 for thread 1199 socket creation failed: Too many open files

socket creation failed: Too many open files
Trying to make connection with server.
Makefile:19: recipe for target 'UDP_simu_client' failed
make: *** [UDP_simu_client] Error 1
liulin@ramon:/nfs/student/student/l/liulin/Desktop/2019Fall/CS585/project2/lab2/
'$
```

10) For the successful time of UDP connections simulation, run “make UDP_simu_response”, in this section, in order to make more connections, we are not requesting the whole web-page from the server,

we are just sending a “hello” message to the server and get a “hello back” message from the server. So that we can run more simulations. For most of the time, we can not do as many as 10,000 times. But we can go to more than 9,000 times.

```
Terminal
File Edit View Search Terminal Help
Response -1 for thread 9977
Response -1 for thread 9978
Response -1 for thread 9979
Response -1 for thread 9980
Response -1 for thread 9981
Response -1 for thread 9982
Response -1 for thread 9983
Response -1 for thread 9984
Response -1 for thread 9985
Response -1 for thread 9986
Response -1 for thread 9987
Response -1 for thread 9988
Response -1 for thread 9989
Response -1 for thread 9990
Response -1 for thread 9991
Response -1 for thread 9992
Response -1 for thread 9993
Response -1 for thread 9994
Response 1571611104172 for thread 9995
socket creation failed: Too many open files
Makefile:24: recipe for target 'UDP_simu_response' failed
make: *** [UDP_simu_response] Error 1
liulin@ramon:/nfs/student/student/l/liulin/Desktop/2019Fall/CS585/project2/lab2/
simulation$
```

11) After the simulation ends, run “gnuplot” to start the graph process

```
Terminal
File Edit View Search Terminal Help
Command 'gunplot' not found, did you mean:
  command 'gnuplot' from deb gnuplot-nox
  command 'gnuplot' from deb gnuplot-qt
  command 'gnuplot' from deb gnuplot-x11
Try: apt install <deb name>
liulin@ramon:/nfs/student/student/l/liulin/Desktop/2019Fall/CS585/project2/lab2/
simulation$ gnuplot

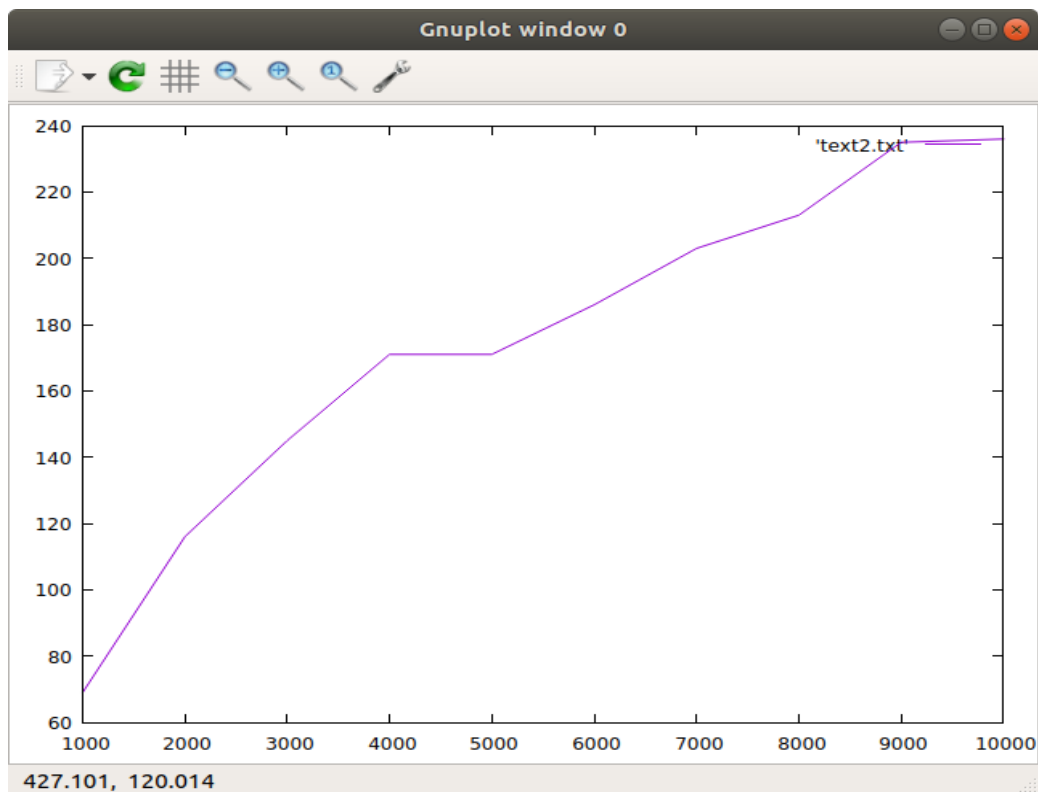
      G N U P L O T
      Version 5.2 patchlevel 2      last modified 2017-11-01

      Copyright (C) 1986-1993, 1998, 2004, 2007-2017
      Thomas Williams, Colin Kelley and many others

      gnuplot home:      http://www.gnuplot.info
      faq, bugs, etc:    type "help FAQ"
      immediate help:    type "help" (plot window: hit 'h')

Terminal type is now 'qt'
gnuplot>
```

12) Input these commands into gnuplot:
set xlabel "Number of connections"
set ylabel "Number of successful responses in UDP"
plot 'text2.txt' w l The graph is like this:



13) Also in this part, if you are not running this process in the same machine, then the server IP address should change manually, in the UDP.c file, line 98.

```
~/Desktop/2019Fall/CS585/project2/lab2/simulation/UDP.c - Sublime Text (UNREGISTERED)
File Edit Selection Find View Goto Tools Project Preferences Help
Client.c x UDP.c x WebServer.c x Makefile x
88 printf("The protocol is: %s\n", protocol);
89 printf("The URL is: %s\n", URL);
90
91
92
93
94
95 //connect to the address of the web Server
96 char *address;
97
98 address="127.0.0.1"; //this IP address needs to get changed according to the
99
100
101
102
103
104
105 if(strcmp(protocol, "UDP")==0)
106 {
107
108
109
110
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115
116
117
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121
122
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