CSE 232: Programming Assignment 1
Using command-line utilities for network debugging
Subham Maurya
2022510, CSE

Q1. [1 + 1]
a) Learn to use the **ifconfig** command, and figure out the IP address of your network interface. Put a screenshot.
b) Go to the webpage **https://www.whatismyip.com** and find out what IP is shown for your machine. Are they identical or different? Why?

Ans1.
a)
Commands used:

1. **Ifconfig -a**: used to figure out how many network interfaces are present in the device irrespective of whether they are up or down.
2. **Ifconfig**: used to find how many network interfaces are available/up.
3. **Ifconfig eth0**: used to find the IP address of network interface "eth0" in the device.

The IP of my network is 172.27.89.9

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.27.89.9  netmask 255.255.240.0  broadcast 172.27.95.255
        inet6 fe80::215:5dff:fe19:df23  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:19:df:23  txqueuelen 1000  (Ethernet)
        RX packets 16  bytes 3472 (3.4 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 12  bytes 936 (936.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

b)
The IP address of the device as shown on https://www.whatismyip.com is 103.25.231.126

What Is My IP?

My Public IPv4: 103.25.231.126

My Public IPv6: Not Detected

My IP Location: Noida, UP IN

My ISP: Indraprastha Institute of Information Technology Delhi

This IP shown on the website(103.25.231.126) is different from the IP found using ifconfig command(172.27.89.9).
Reason: ifconfig shows the IP address used inside the local network, while the website shows the IP address used to communicate with the internet.

Q.2. [1+1+1]
a) Change the IP address of your network interface using the command line. Put a screenshot that shows the change. Revert to the original IP address.

Ans2.
a)
Initial IP address (172.27.89.9):

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.27.89.9  netmask 255.255.240.0  broadcast 172.27.95.255
        inet6 fe80::215:5dff:fe19:df23  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:19:df:23  txqueuelen 1000  (Ethernet)
        RX packets 100  bytes 21168 (21.1 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 14  bytes 1076 (1.0 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

Changing the IP address (172.27.89.9 to 111.111.1.111):

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ sudo ifconfig eth0 111.111.1.111 netmask 255.255.240.0
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 111.111.1.111  netmask 255.255.240.0  broadcast 111.111.15.255
        inet6 fe80::215:5dff:fe19:df23  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:19:df:23  txqueuelen 1000  (Ethernet)
        RX packets 108  bytes 22904 (22.9 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 14  bytes 1076 (1.0 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

Reverting to the original IP address (111.111.1.111 to 172.27.89.9):

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ sudo ifconfig eth0 172.27.89.9 netmask 255.255.240.0
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.27.89.9  netmask 255.255.240.0  broadcast 172.27.95.255
        inet6 fe80::215:5dff:fe19:df23  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:19:df:23  txqueuelen 1000  (Ethernet)
        RX packets 108  bytes 22904 (22.9 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 14  bytes 1076 (1.0 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

Q.3. [4]

a) Use "netcat" to set up a TCP client/server connection between your VM and host machine. If you are not using a VM, you can set up the connection with localhost. Put a screenshot. [1+1]

b) Determine the state of this TCP connection(s) at the client node. Put a screenshot. [1+1]

Ans3.

a)

Establishing server-side connection using port number 8000:

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.27.89.9  netmask 255.255.240.0  broadcast 172.27.95.255
        inet6 fe80::215:5dff:fe19:df23  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:19:df:23  txqueuelen 1000  (Ethernet)
        RX packets 205  bytes 39194 (39.1 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 36  bytes 2580 (2.5 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

subham22510@Subham-Maurya:/mnt/c/Users/PC$ nc -l -p 8000
```

Establishing TCP connection between server and client using server IP address and port number:

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ nc 172.27.89.9 8000
```

Sending Message from Client Node and Receiving from Server Node:

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ifconfig eth0
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.27.89.9  netmask 255.255.240.0  broadcast 172.27.95.255
        inet6 fe80::215:5dff:fe19:df23  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:19:df:23  txqueuelen 1000  (Ethernet)
        RX packets 205  bytes 39194 (39.1 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 36  bytes 2580 (2.5 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

subham22510@Subham-Maurya:/mnt/c/Users/PC$ nc -l -p 8000
Hello from client node.
```

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ nc 172.27.89.9 8000
Hello from client node.
```

b)

The TCP connection state on the client side is determined by using netstat command along with the port number parameter.

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ netstat -tn | grep 8000
tcp        0      0 172.27.89.9:36640       172.27.89.9:8000        ESTABLISHED
tcp        0      0 172.27.89.9:8000        172.27.89.9:36640       ESTABLISHED
```

In the above image, I'm using two terminals on the same device where the first terminal is acting as server-side and the second terminal is acting as client-side. As, the port number of server-side is 8000. Therefore, the first line of the image represents the TCP connection status from client-side while the second line of the image represents the TCP connection status from server-side.

Q.4. nslookup ([2+1] + [1+1])
a) Get an authoritative result for "google.in" using nslookup. Put a screenshot. Explain how you did it.
b) Find out the time to live for any website on the local DNS. Put a screenshot. Explain in words (with unit) after how much time this entry would expire from the local DNS server.

Ans4.
a)
To find the authoritative result for "google.in" using nslookup, an authoritative nameserver of "google.in" is required otherwise it will fetch the data from the cached DNS.

Hence, we can use -type=ns parameter along with the nslookup command to get the authoritative nameservers for google.in

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ nslookup -type=ns google.in
Server:         172.27.80.1
Address:        172.27.80.1#53

Non-authoritative answer:
google.in       nameserver = ns4.google.com.
google.in       nameserver = ns3.google.com.
google.in       nameserver = ns2.google.com.
google.in       nameserver = ns1.google.com.

Authoritative answers can be found from:
```

Now, we can see that there are four authoritative nameserver for google.in namely ns1.google.com, ns2.google.com, ns3.google.com and ns4.google.com. So, we can use any one of then to find the authoritative result for google.in. For simplicity, we are using ns1.google.com as the nameserver.

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ nslookup google.in ns1.google.com
Server:         ns1.google.com
Address:        216.239.32.10#53

Name:   google.in
Address: 142.250.195.4
Name:   google.in
Address: 2404:6800:4002:826::2004
```

b)
After 0 seconds the entry would expire from the local DNS server.

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ nslookup -debug google.in
Server:         172.27.80.1
Address:        172.27.80.1#53

------------
    QUESTIONS:
        google.in, type = A, class = IN
    ANSWERS:
    ->  google.in
        internet address = 142.250.195.4
        ttl = 0
    AUTHORITY RECORDS:
    ADDITIONAL RECORDS:
------------
Non-authoritative answer:
Name:   google.in
Address: 142.250.195.4
------------
    QUESTIONS:
        google.in, type = AAAA, class = IN
    ANSWERS:
    ->  google.in
        has AAAA address 2404:6800:4002:82b::2004
        ttl = 0
    AUTHORITY RECORDS:
    ADDITIONAL RECORDS:
------------
Name:   google.in
Address: 2404:6800:4002:82b::2004
```

Q.5. [13]
a) Run the command, traceroute google.in. How many intermediate hosts do you see? What are the IP addresses? Compute the average latency to each intermediate host. Put a screenshot. [1+2+1]
Note that some of the intermediate hosts might not be visible; their IP addresses
will come as "***", ignore those hosts for this assignment.
b) Send 50 ping messages to google.in, Determine the average latency. Put a screenshot. [1]
c) Add up the ping latency of all the intermediate hosts obtained in (a) and compare with (b). Are they matching, explain? [1+1]

d) Take the maximum ping latency amongst the intermediate hosts (in (a)) and compare it with (b). Are they matching, explain? [1+1]
e) You may see multiple entries for a single hop while using the traceroute command. What do these entries mean? [1]

f) Send 50 ping messages to stanford.edu, Determine the average latency. Put a screenshot. [1]

g) Run the command, traceroute stanford.edu. Compare the number of hops between google.in and stanford.edu (between the traceroute result of google.in and stanford.edu). [1]

h) Can you explain the reason for the latency difference between google.in and stanford.edu (see (b) & (f))? [1]

Ans5.

a)

There are 8 intermediate hosts(excluding source and destination machine) whose IP addresses and the average latency are:

- **172.27.80.1:** **[source machine, Hence excluded]**
1) **192.168.32.254:** **(17.561 ms + 17.540 ms + 17.521 ms) / 3 = 17.541 ms**
2) **192.168.1.99:** **(4.611 ms + 4.593 ms + 4.573 ms) / 3 = 4.592 ms**
3) **103.25.231.1:** **(4.630 ms + 4.603 ms + 4.165 ms) / 3 = 4.466 ms**
4) ******* **[Hidden IP Address]**
5) **10.119.234.162:** **(9.253 ms + 7.448 ms + 7.411 ms) / 3 = 8.037 ms**
6) **72.14.194.160:** **(7.390 ms + 32.470 ms + 6.154 ms) / 3 = 15.338 ms**
7) **142.251.54.111:** **(51.943 ms + 29.916 ms + 29.900 ms) / 3 = 37.253 ms**
8) **142.251.54.87:** **(33.633 ms + 33.198 ms + 33.150 ms) / 3 = 33.327 ms**
- **142.250.193.4:** **[Destination machine, Hence excluded]**

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ traceroute google.in
traceroute to google.in (142.250.193.4), 30 hops max, 60 byte packets
 1  Subham-Maurya.mshome.net (172.27.80.1)  0.703 ms  0.605 ms  0.560 ms
 2  192.168.32.254 (192.168.32.254)  17.561 ms  17.540 ms  17.521 ms
 3  vpn.iiitd.edu.in (192.168.1.99)  4.611 ms  4.593 ms  4.573 ms
 4  103.25.231.1 (103.25.231.1)  4.630 ms  4.603 ms  4.165 ms
 5  * * *
 6  10.119.234.162 (10.119.234.162)  9.253 ms  7.448 ms  7.411 ms
 7  72.14.194.160 (72.14.194.160)  7.390 ms 72.14.195.56 (72.14.195.56)  32.470 ms 72.14.194.160 (72.14.194.160)  6.154 ms
 8  142.251.54.111 (142.251.54.111)  51.943 ms 192.178.80.159 (192.178.80.159)  29.916 ms  29.900 ms
 9  142.251.54.87 (142.251.54.87)  33.633 ms  33.198 ms  33.150 ms
10  del11s14-in-f4.1e100.net (142.250.193.4)  45.378 ms  45.351 ms  46.628 ms
```

b) The average latency of sending 50 ping to google.in is 48.156ms.

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ping -c 50 google.in
PING google.in (142.250.193.4) 56(84) bytes of data.
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=1 ttl=111 time=45.0 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=2 ttl=111 time=58.8 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=3 ttl=111 time=45.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=4 ttl=111 time=47.5 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=5 ttl=111 time=48.0 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=6 ttl=111 time=45.9 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=7 ttl=111 time=51.9 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=8 ttl=111 time=45.0 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=9 ttl=111 time=56.4 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=10 ttl=111 time=46.2 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=11 ttl=111 time=49.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=12 ttl=111 time=46.4 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=13 ttl=111 time=53.2 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=14 ttl=111 time=48.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=15 ttl=111 time=46.7 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=16 ttl=111 time=45.2 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=17 ttl=111 time=46.3 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=18 ttl=111 time=46.6 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=19 ttl=111 time=45.5 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=20 ttl=111 time=46.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=21 ttl=111 time=63.4 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=22 ttl=111 time=49.9 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=23 ttl=111 time=45.9 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=24 ttl=111 time=46.7 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=25 ttl=111 time=46.3 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=26 ttl=111 time=45.4 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=27 ttl=111 time=64.3 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=28 ttl=111 time=45.0 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=29 ttl=111 time=45.2 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=30 ttl=111 time=46.5 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=31 ttl=111 time=45.3 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=32 ttl=111 time=45.9 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=33 ttl=111 time=48.6 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=34 ttl=111 time=45.8 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=35 ttl=111 time=45.4 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=36 ttl=111 time=45.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=37 ttl=111 time=48.3 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=38 ttl=111 time=48.3 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=39 ttl=111 time=46.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=40 ttl=111 time=47.3 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=41 ttl=111 time=45.7 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=42 ttl=111 time=49.3 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=43 ttl=111 time=49.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=44 ttl=111 time=45.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=45 ttl=111 time=53.7 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=46 ttl=111 time=46.4 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=47 ttl=111 time=46.6 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=48 ttl=111 time=48.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=49 ttl=111 time=50.1 ms
64 bytes from del11s14-in-f4.1e100.net (142.250.193.4): icmp_seq=50 ttl=111 time=45.8 ms

--- google.in ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49077ms
rtt min/avg/max/mdev = 44.986/48.156/64.322/4.314 ms
```

c)
The sum of latencies obtained in part (a) = 116.008 ms
Average latency obtained in part (b) = 48.165 ms.

Therefore, the answers in (a) and (b) are different.
Reason: Traceroute measures the round-trip time (RTT) for each hop along the path,
summing up the latencies to reflect the time taken to reach each intermediate hop. In

contrast, Ping measures the RTT directly to the final destination, without accounting for the individual hops in between.

d)
The maximum ping latency amongst the immediate host in (a) is 51.943ms.
Average latency in (b) = 48.165 ms.

Therefore, the answers in (a) and (b) are different.
Reason: The maximum latency is the time taken to reach a destination node and return back to source node while the ping command provides RTT value to the directly final destination which is generally lower than the maximum latency between hops.

e)
The hops number 7 and 8 in the image shown in part (a) shows the same.
The multiple time entries in `traceroute` reflect the three probe packets sent to each hop, showing the Round Trip Time (RTT) for each packet. Differences in RTT occur because each packet may take a slightly different path due to network conditions or routing changes.

f) The average latency of stanford.edu is 349.613 ms.

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ping -c 50 stanford.edu
PING stanford.edu (171.67.215.200) 56(84) bytes of data.
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=1 ttl=236 time=370 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=2 ttl=236 time=313 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=3 ttl=236 time=315 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=4 ttl=236 time=432 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=5 ttl=236 time=326 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=6 ttl=236 time=322 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=7 ttl=236 time=317 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=8 ttl=236 time=555 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=9 ttl=236 time=302 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=10 ttl=236 time=305 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=11 ttl=236 time=376 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=12 ttl=236 time=311 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=13 ttl=236 time=334 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=14 ttl=236 time=335 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=15 ttl=236 time=348 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=16 ttl=236 time=330 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=17 ttl=236 time=409 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=18 ttl=236 time=332 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=19 ttl=236 time=332 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=20 ttl=236 time=331 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=21 ttl=236 time=329 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=22 ttl=236 time=334 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=23 ttl=236 time=492 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=24 ttl=236 time=293 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=25 ttl=236 time=410 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=26 ttl=236 time=320 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=27 ttl=236 time=317 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=28 ttl=236 time=370 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=29 ttl=236 time=315 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=30 ttl=236 time=316 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=31 ttl=236 time=326 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=32 ttl=236 time=351 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=33 ttl=236 time=403 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=34 ttl=236 time=387 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=35 ttl=236 time=404 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=36 ttl=236 time=360 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=37 ttl=236 time=319 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=38 ttl=236 time=319 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=39 ttl=236 time=300 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=40 ttl=236 time=316 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=41 ttl=236 time=313 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=42 ttl=236 time=310 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=43 ttl=236 time=335 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=44 ttl=236 time=333 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=45 ttl=236 time=309 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=46 ttl=236 time=589 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=47 ttl=236 time=306 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=48 ttl=236 time=301 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=49 ttl=236 time=374 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=50 ttl=236 time=331 ms

--- stanford.edu ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49701ms
rtt min/avg/max/mdev = 293.439/349.613/589.370/59.962 ms
```

g)
Number of hops in google.in = 10
Number of hops in stanford.edu = 30

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ traceroute stanford.edu
traceroute to stanford.edu (171.67.215.200), 30 hops max, 60 byte packets
 1  Subham-Maurya.mshome.net (172.27.80.1)  0.620 ms  0.492 ms  0.466 ms
 2  192.168.16.67 (192.168.16.67)  6.878 ms  6.919 ms  6.589 ms
 3  * * *
 4  * * *
 5  * * *
 6  * * *
 7  * * *
 8  * * *
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

h)
The latency difference between google.in and stanford.edu depends on several factors.
Some of them are listed below:

1. Number of Intermediate Hops.
2. Routing.
2. Geographical Distance.
3. Network Infrastructure.
4. Server Load and Performance.

Q.6. [2+1] Make your ping command fail for 127.0.0.1 (with 100% packet loss). Explain how
you do it. Put a screenshot that it failed.

Ans6.

To make the ping command fail for 127.0.0.1, we will perform the following:
1. Find the name of the network interface corresponding to IP 127.0.0.1 using ifconfig command.
2. Use ifconfig command again and down/deactivate the network interface with IP 127.0.0.1.
3. Now, send ping command for IP 127.0.0.1, this will 100% fail because the network interface corresponding to this IP is deactivated above.

```
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.27.84.153  netmask 255.255.240.0  broadcast 172.27.95.255
        inet6 fe80::215:5dff:fe19:d157  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:19:d1:57  txqueuelen 1000  (Ethernet)
        RX packets 131920  bytes 172314996 (172.3 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 62927  bytes 4241568 (4.2 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

subham22510@Subham-Maurya:/mnt/c/Users/PC$ sudo ifconfig lo down
[sudo] password for subham22510:
subham22510@Subham-Maurya:/mnt/c/Users/PC$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.27.84.153  netmask 255.255.240.0  broadcast 172.27.95.255
        inet6 fe80::215:5dff:fe19:d157  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:19:d1:57  txqueuelen 1000  (Ethernet)
        RX packets 131920  bytes 172314996 (172.3 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 62927  bytes 4241568 (4.2 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

subham22510@Subham-Maurya:/mnt/c/Users/PC$ ping 127.0.0.1
PING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.
^C
--- 127.0.0.1 ping statistics ---
11 packets transmitted, 0 received, 100% packet loss, time 10407ms
```