Assignment-1
Using command-line utilities for network debugging

Q1)

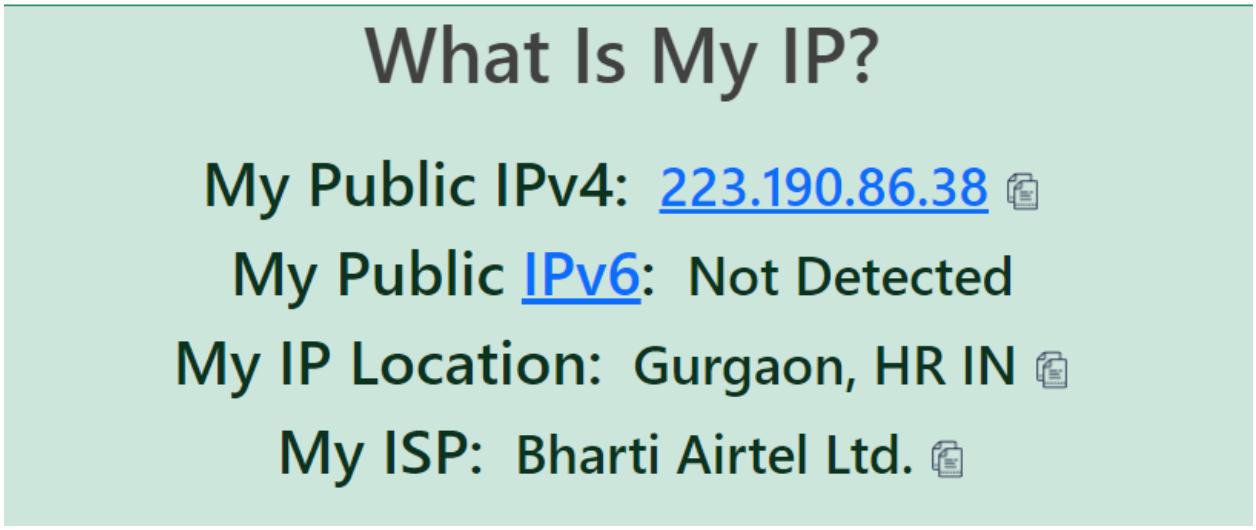
a)

```
gargdhawal05@Dhawal:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.24.232.90  netmask 255.255.240.0  broadcast 172.24.239.255
        inet6 fe80::215:5dff:febc:e162  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:bc:e1:62  txqueuelen 1000  (Ethernet)
        RX packets 5  bytes 310 (310.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 15  bytes 1082 (1.0 KB)
        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 4  bytes 591 (591.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 4  bytes 591 (591.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

- Inet corresponds to a private IPv4 address (172.24.232.90).
- Inet6 corresponds to a private IPv6 address (fe80::215:5dff:febc:e162).
- Ether corresponds to MAC address i.e (00:15:5d:bc:e1:62).

b)



- The public IPv4 address is 223.190.86.38.
- The IP address shown on `https://www.whatismyip.com` is different from the one obtained via `ifconfig` because the former is public IP assigned by ISP and is unique on the wider internet, while the latter is local IP unique within the private network and is used for internal communication.

Q2)

```
gargdhawal05@Dhawal:~$ sudo  ifconfig eth0 192.168.23.21
[sudo] password for gargdhawal05:
gargdhawal05@Dhawal:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.23.21  netmask 255.255.255.0  broadcast 192.168.23.255
        inet6 fe80::215:5dff:febc:e162  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:bc:e1:62  txqueuelen 1000  (Ethernet)
        RX packets 361  bytes 295838 (295.8 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 128  bytes 48289 (48.2 KB)
        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 16  bytes 1815 (1.8 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 16  bytes 1815 (1.8 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

gargdhawal05@Dhawal:~$ sudo ifconfig eth0 172.24.232.90
gargdhawal05@Dhawal:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.24.232.90  netmask 255.255.0.0  broadcast 172.24.255.255
        inet6 fe80::215:5dff:febc:e162  prefixlen 64  scopeid 0x20<link>
        ether 00:15:5d:bc:e1:62  txqueuelen 1000  (Ethernet)
        RX packets 396  bytes 301800 (301.8 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 128  bytes 48289 (48.2 KB)
```

- Original IP address: 172.24.232.90
- IP address change using command: sudo ifconfig <interface> <new ip_address>
- New IP address: 192.168.23.21
- IP address is again reverted to original IP address

Q3)

a)

```
gargdhawal05@Dhawal:~$ nc -l -p 1230
hi
i am dhawal garg
```

Server is set up using the command: nc -l -p <port number>

```
gargdhawal05@Dhawal:~$ nc localhost 1230
hi
i am dhawal garg
```

Client is set up using the command: nc <localhost> <port address>

b)

```
gargdhawal05@Dhawal:~$ netstat -t
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 localhost:52186         localhost:1230          ESTABLISHED
tcp        0      0 localhost:1230          localhost:52186         ESTABLISHED
```

The TCP connection is successfully established and active, allowing for communication between the two endpoints (`localhost:52186` and `localhost:1230`).

Q4)

a)

Step 1: We first get the authoritative name server of the host “google.in” using the following command: nslookup -query=soa google.com (Here type=’soa’).

```
gargdhawal05@Dhawal:~$ nslookup -query=soa google.com
Server:         10.255.255.254
Address:        10.255.255.254#53

Non-authoritative answer:
google.com
        origin = ns1.google.com
        mail addr = dns-admin.google.com
        serial = 666268564
        refresh = 900
        retry = 900
        expire = 1800
        minimum = 60

Authoritative answers can be found from:
google.com      nameserver = ns2.google.com.
google.com      nameserver = ns3.google.com.
google.com      nameserver = ns4.google.com.
google.com      nameserver = ns1.google.com.
ns1.google.com  internet address = 216.239.32.10
ns1.google.com  has AAAA address 2001:4860:4802:32::a
ns4.google.com  internet address = 216.239.38.10
ns4.google.com  has AAAA address 2001:4860:4802:38::a
ns3.google.com  internet address = 216.239.36.10
ns3.google.com  has AAAA address 2001:4860:4802:36::a
ns2.google.com  internet address = 216.239.34.10
ns2.google.com  has AAAA address 2001:4860:4802:34::a
```

I obtained 4 authoritative names:

- ns1.google.com
- ns2.google.com
- ns3.google.com
- ns4.google.com

Step 2: Now we will use these authoritative names to get authoritative responses from the host server using the following command: nslookup google.in <authoritative name>.
The address of each authoritative response represents its IP address.

```
gargdhawal05@Dhawal:~$ nslookup google.in ns1.google.com
Server:         ns1.google.com
Address:        216.239.32.10#53

Name:   google.in
Address: 142.250.194.100
Name:   google.in
Address: 2404:6800:4002:821::2004

gargdhawal05@Dhawal:~$ nslookup google.in ns2.google.com
Server:         ns2.google.com
Address:        216.239.34.10#53

Name:   google.in
Address: 142.250.194.100
Name:   google.in
Address: 2404:6800:4002:821::2004

gargdhawal05@Dhawal:~$ nslookup google.in ns3.google.com
Server:         ns3.google.com
Address:        216.239.36.10#53

Name:   google.in
Address: 142.250.194.100
Name:   google.in
Address: 2404:6800:4002:821::2004

gargdhawal05@Dhawal:~$ nslookup google.in ns4.google.com
Server:         ns4.google.com
Address:        216.239.38.10#53

Name:   google.in
Address: 142.250.194.100
Name:   google.in
Address: 2404:6800:4002:821::2004
```

b)

```
gargdhawal05@Dhawal:~$ nslookup -debug google.in
Server:         10.255.255.254
Address:        10.255.255.254#53

------------
    QUESTIONS:
        google.in, type = A, class = IN
    ANSWERS:
    ->  google.in
        internet address = 172.217.167.36
        ttl = 233
    AUTHORITY RECORDS:
    ADDITIONAL RECORDS:
------------
Non-authoritative answer:
Name:   google.in
Address: 172.217.167.36
------------
    QUESTIONS:
        google.in, type = AAAA, class = IN
    ANSWERS:
    ->  google.in
        has AAAA address 2404:6800:4002:825::2004
        ttl = 233
    AUTHORITY RECORDS:
    ADDITIONAL RECORDS:
------------
Name:   google.in
Address: 2404:6800:4002:825::2004
```

Time to Live(TTL) value for caching DNS records is 233 seconds for “google.in”. After 233 seconds this entry would expire.

Q5)
a)
Number of intermediate hosts:11

Intermediate Host Number	Average Latency (ms)	IP Address
1	1.315	172.24.224.1
2	2.739	192.168.1.1
3	6.993	223.182.79.255
4	7.271	122.187.30.5
5	17.850	116.119.109.8
6	8.878	72.14.222.116
7	*	*
8	9.738	172.253.67.98
9	9.260	192.178.82.232
10	9.057	192.178.83.225
11	10.297	142.250.194.164

```
gargdhawal05@Dhawal:~$ traceroute google.in
traceroute to google.in (142.250.194.164), 30 hops max, 60 byte packets
 1  172.24.224.1 (172.24.224.1)  1.577 ms  1.197 ms  1.172 ms
 2  192.168.1.1 (192.168.1.1)  3.509 ms  3.679 ms  3.341 ms
 3  223.182.79.255 (223.182.79.255)  6.854 ms  6.798 ms  7.326 ms
 4  nsg-corporate-5.30.187.122.airtel.in (122.187.30.5)  7.323 ms  7.286 ms nsg-corporate-9.30.187.122.airtel.in (122.18
7.30.9)  7.181 ms
 5  116.119.109.8 (116.119.109.8)  7.437 ms 182.79.208.13 (182.79.208.13)  8.859 ms 116.119.109.8 (116.119.109.8)  34.23
0 ms
 6  72.14.222.116 (72.14.222.116)  9.153 ms  9.139 ms  8.344 ms
 7  * * *
 8  172.253.67.98 (172.253.67.98)  9.747 ms 142.251.52.198 (142.251.52.198)  9.736 ms 172.253.67.100 (172.253.67.100)  1
0.068 ms
 9  192.178.82.232 (192.178.82.232)  9.948 ms 192.178.82.238 (192.178.82.238)  8.915 ms  8.907 ms
10  192.178.83.225 (192.178.83.225)  10.169 ms 192.178.83.221 (192.178.83.221)  9.680 ms 216.239.54.93 (216.239.54.93)
9.823 ms
11  del12s06-in-f4.1e100.net (142.250.194.164)  10.802 ms  9.306 ms  10.783 ms
```

b)

Average Latency: 9.613 ms

```
gargdhawal05@Dhawal:~$ ping -c 50 google.in
PING google.in (142.250.194.164) 56(84) bytes of data.
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=1 ttl=59 time=9.54 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=2 ttl=59 time=9.12 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=3 ttl=59 time=9.13 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=4 ttl=59 time=8.75 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=5 ttl=59 time=8.84 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=6 ttl=59 time=8.55 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=7 ttl=59 time=8.33 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=8 ttl=59 time=9.95 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=9 ttl=59 time=9.09 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=10 ttl=59 time=9.88 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=11 ttl=59 time=9.28 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=12 ttl=59 time=8.51 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=13 ttl=59 time=8.95 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=14 ttl=59 time=9.61 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=15 ttl=59 time=9.52 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=16 ttl=59 time=9.50 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=17 ttl=59 time=8.87 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=18 ttl=59 time=9.27 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=19 ttl=59 time=9.43 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=20 ttl=59 time=9.03 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=21 ttl=59 time=9.76 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=22 ttl=59 time=9.50 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=23 ttl=59 time=9.63 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=24 ttl=59 time=8.99 ms
```

```
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=25 ttl=59 time=9.50 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=26 ttl=59 time=8.91 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=27 ttl=59 time=9.06 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=28 ttl=59 time=9.65 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=29 ttl=59 time=11.8 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=30 ttl=59 time=8.77 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=31 ttl=59 time=8.56 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=32 ttl=59 time=9.65 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=33 ttl=59 time=8.47 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=34 ttl=59 time=8.71 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=35 ttl=59 time=9.33 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=36 ttl=59 time=9.32 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=37 ttl=59 time=10.4 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=38 ttl=59 time=8.91 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=39 ttl=59 time=10.1 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=40 ttl=59 time=10.8 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=41 ttl=59 time=9.31 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=42 ttl=59 time=8.56 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=43 ttl=59 time=9.48 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=44 ttl=59 time=9.23 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=45 ttl=59 time=8.18 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=46 ttl=59 time=14.4 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=47 ttl=59 time=9.64 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=48 ttl=59 time=8.56 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=49 ttl=59 time=21.5 ms
64 bytes from 164.194.250.142.in-addr.arpa (142.250.194.164): icmp_seq=50 ttl=59 time=8.76 ms

--- google.in ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49087ms
rtt min/avg/max/mdev = 8.178/9.613/21.538/1.955 ms
```

c)

- The total ping latency of all intermediate hosts is: 1.315+2.739+6.993+7.271+17.850+8.878+9.738+9.260+9.057+10.297=83.398
- The average latency of all intermediate hosts in a) part : 83.398 ms / 10 = 8.3398 ms.
- The average latency obtained in b) part: 9.078 ms
- The latencies obtained in both the parts are close to each other which suggests that the latency of the intermediate hosts is a significant contributor to the overall latency of the connection.
- This makes sense, as the latency of each hop can affect the overall latency of the connection.

d)

- The maximum average latency amongst the intermediate hosts is 17.850 ms, which is close to average latency of 21.538 ms obtained in part (b).
- Traceroute measures the round-trip time (RTT) to each intermediate hop along the path to the destination, while ping measures the RTT directly to the final destination, encompassing the entire network path.
- The ping latency includes all potential delays across every hop, resulting in a higher overall value. Additionally, network conditions like congestion can vary between the two measurements, further contributing to the difference.

e)

Multiple entries in traceroute command in a single hop represents multiple packets(mostly three) sent by the traceroute to each hop for a more accurate estimate of the response time(latency).

f)

Average latency: 254.254 ms

```
gargdhawal05@Dhawal:~$ 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=246 time=251 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=2 ttl=246 time=247 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=3 ttl=246 time=248 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=4 ttl=246 time=248 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=5 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=6 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=7 ttl=246 time=251 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=8 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=9 ttl=246 time=248 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=10 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=11 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=12 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=13 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=14 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=15 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=16 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=17 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=18 ttl=246 time=248 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=19 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=20 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=21 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=22 ttl=246 time=248 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=23 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=24 ttl=246 time=248 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=25 ttl=246 time=251 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=26 ttl=246 time=248 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=27 ttl=246 time=247 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=28 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=29 ttl=246 time=252 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=30 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=31 ttl=246 time=248 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=32 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=33 ttl=246 time=248 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=34 ttl=246 time=247 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=35 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=36 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=37 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=38 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=39 ttl=246 time=298 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=40 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=41 ttl=246 time=305 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=42 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=43 ttl=246 time=250 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=44 ttl=246 time=291 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=45 ttl=246 time=269 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=46 ttl=246 time=295 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=47 ttl=246 time=275 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=48 ttl=246 time=272 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=49 ttl=246 time=249 ms
64 bytes from 200.215.67.171.in-addr.arpa (171.67.215.200): icmp_seq=50 ttl=246 time=248 ms

--- stanford.edu ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49067ms
rtt min/avg/max/mdev = 247.149/254.254/305.389/13.953 ms
```

g)

```
gargdhawal05@Dhawal:~$ traceroute stanford.edu
traceroute to stanford.edu (171.67.215.200), 30 hops max, 60 byte packets
 1  172.24.224.1 (172.24.224.1)  0.540 ms  1.398 ms  0.585 ms
 2  192.168.1.1 (192.168.1.1)  2.310 ms  2.323 ms  2.147 ms
 3  223.182.79.255 (223.182.79.255)  7.088 ms  7.078 ms  7.866 ms
 4  9.30.187.122.in-addr.arpa (122.187.30.9)  7.225 ms  7.219 ms  7.210 ms
 5  116.119.44.134 (116.119.44.134)  240.266 ms 116.119.44.132 (116.119.44.132)  248.220 ms 116.119.44.134 (116.119.44.134)  249.574 ms
 6  * * *
 7  * * port-channel8.core2.lax1.he.net (184.104.197.109)  264.140 ms
 8  * port-channel12.core3.sjc2.he.net (184.104.195.50)  263.831 ms *
 9  * * *
10  stanford-university.e0-62.core2.pao1.he.net (184.105.177.238)  249.805 ms  265.227 ms  288.595 ms
11  campus-east-rtr-vl1018.SUNet (171.64.255.228)  244.924 ms campus-east-rtr-vl1118.SUNet (171.66.255.228)  255.224 ms  244.859 ms
12  * * *
13  200.215.67.171.in-addr.arpa (171.67.215.200)  255.348 ms  251.877 ms  241.662 ms
```

The number of hops for stanford.edu is 13 which is greater than the number of hops for google.edu (10).

h) The difference between the latency of ‘google.in’ and ‘stanford.edu’ is due to geographical distance and network infrastructure. Servers for Google located in India are geographically closer to my location as compared to Stanford’s server associated with the US causing high latency due to the longer distance data must travel.

Q6)
Step 1: Shutdown the loopback interface (lo interface) using the : sudo ifconfig lo down
Step 2: Use the ping command to send 100 packets to 127.0.0.1
Since the interface which is used to communicate (loopback) is turned down no packets would be transferred resulting in 100% packet loss.

```
gargdhawal05@Dhawal:~$ sudo ifconfig lo down
[sudo] password for gargdhawal05:
Sorry, try again.
[sudo] password for gargdhawal05:
gargdhawal05@Dhawal:~$ ping -c 100 127.0.0.1
PING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.

--- 127.0.0.1 ping statistics ---
100 packets transmitted, 0 received, 100% packet loss, time 102933ms
```