

## Part A

For Sequence numbers, I passed in `rtt_cnt + 1` for ID in `sendOnePing()`. `rtt_cnt` increments in `doOnePing()` whenever a ping is successfully sent (the else condition). The checksum is precomputed with `checksum()`. The time is calculated by taking the difference in time between sending the packet and receiving the packet. The packet is composed of the ICMP header and the data (the time it was sent). After unpacking the time data, take the difference by the later `time.time()` yielded the time needed for the packet to be sent and received. Multiplying the result by 3 gives the time in milliseconds.

```
tahmidul@tahmidul-MS-7C56:~/Desktop/CSE 310$ sudo python3 pinger.py 127.0.0.1
Pinging 127.0.0.1 using Python:
Pinging 127.0.0.1: Checksum: 2130, ID: 15471, Seq: 1, Time: 0.0343 ms
Pinging 127.0.0.1: Checksum: 1163, ID: 15471, Seq: 2, Time: 0.0477 ms
Pinging 127.0.0.1: Checksum: 60531, ID: 15471, Seq: 3, Time: 0.0622 ms
Pinging 127.0.0.1: Checksum: 55295, ID: 15471, Seq: 4, Time: 0.0582 ms
Pinging 127.0.0.1: Checksum: 49001, ID: 15471, Seq: 5, Time: 0.0689 ms
Pinging 127.0.0.1: Checksum: 41708, ID: 15471, Seq: 6, Time: 0.0651 ms
Pinging 127.0.0.1: Checksum: 36031, ID: 15471, Seq: 7, Time: 0.0625 ms
Pinging 127.0.0.1: Checksum: 30738, ID: 15471, Seq: 8, Time: 0.0622 ms
Pinging 127.0.0.1: Checksum: 24444, ID: 15471, Seq: 9, Time: 0.0625 ms
Pinging 127.0.0.1: Checksum: 17906, ID: 15471, Seq: 10, Time: 0.0637 ms
^C
--- 127.0.0.1 ping statistics ---
10 packets transmitted, 10 packets received, 0.0% packet loss
round-trip min/avg/max 0.034/0.059/0.069 ms
```

```
tahmidul@tahmidul-MS-7C56:~/Desktop/CSE 310$ sudo python3 pinger.py stonybrook.edu
Pinging 129.49.2.176 using Python:
Pinging 129.49.2.176: Checksum: 33670, ID: 13646, Seq: 1, Time: 1.6100 ms
Pinging 129.49.2.176: Checksum: 21668, ID: 13646, Seq: 2, Time: 1.4622 ms
Pinging 129.49.2.176: Checksum: 10192, ID: 13646, Seq: 3, Time: 1.7209 ms
Pinging 129.49.2.176: Checksum: 62563, ID: 13646, Seq: 4, Time: 1.9431 ms
Pinging 129.49.2.176: Checksum: 48552, ID: 13646, Seq: 5, Time: 1.8342 ms
Pinging 129.49.2.176: Checksum: 35837, ID: 13646, Seq: 6, Time: 1.5788 ms
Pinging 129.49.2.176: Checksum: 28366, ID: 13646, Seq: 7, Time: 1.6649 ms
Pinging 129.49.2.176: Checksum: 16092, ID: 13646, Seq: 8, Time: 1.7405 ms
Pinging 129.49.2.176: Checksum: 3409, ID: 13646, Seq: 9, Time: 1.4822 ms
^C
--- stonybrook.edu ping statistics ---
9 packets transmitted, 9 packets received, 0.0% packet loss
round-trip min/avg/max 1.462/1.671/1.943 ms
```

```
tahmidul@tahmidul-MS-7C56:~/Desktop/CSE 310$ sudo python3 pinger.py cs.stonybrook.edu
Pinging 130.245.27.3 using Python:
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Request timed out.
^C
--- cs.stonybrook.edu ping statistics ---
6 packets transmitted, 0 packets received, 100.0% packet loss
```

## Part C

Dhaka University (Asia, Bangladesh)	<pre>tahmidul@tahmidul-MS-7C56:~/Desktop/CSE 310\$ sudo python3 pinger.py du.ac.bd Pinging 103.221.255.104 using Python: Pinging 103.221.255.104: Checksum: 36708, ID: 13818, Seq: 1, Time: 309.2821 ms Pinging 103.221.255.104: Checksum: 45181, ID: 13818, Seq: 2, Time: 309.1938 ms Pinging 103.221.255.104: Checksum: 53007, ID: 13818, Seq: 3, Time: 309.5477 ms Pinging 103.221.255.104: Checksum: 60271, ID: 13818, Seq: 4, Time: 309.2444 ms Pinging 103.221.255.104: Checksum: 2195, ID: 13818, Seq: 5, Time: 309.2456 ms Pinging 103.221.255.104: Checksum: 10691, ID: 13818, Seq: 6, Time: 309.6328 ms ^C --- du.ac.bd ping statistics --- 6 packets transmitted, 6 packets received, 0.0% packet loss round-trip min/avg/max 309.194/309.358/309.633 ms</pre>
ETH Zürich (Europe, Switzerland)	<pre>tahmidul@tahmidul-MS-7C56:~/Desktop/CSE 310\$ sudo python3 pinger.py ethz.ch Pinging 129.132.19.216 using Python: Pinging 129.132.19.216: Checksum: 15320, ID: 14119, Seq: 1, Time: 84.3079 ms Pinging 129.132.19.216: Checksum: 53667, ID: 14119, Seq: 2, Time: 84.4398 ms Pinging 129.132.19.216: Checksum: 21088, ID: 14119, Seq: 3, Time: 84.5490 ms Pinging 129.132.19.216: Checksum: 53419, ID: 14119, Seq: 4, Time: 84.3494 ms Pinging 129.132.19.216: Checksum: 21086, ID: 14119, Seq: 5, Time: 85.8374 ms Pinging 129.132.19.216: Checksum: 49070, ID: 14119, Seq: 6, Time: 84.5790 ms Pinging 129.132.19.216: Checksum: 16072, ID: 14119, Seq: 7, Time: 84.4209 ms ^C --- ethz.ch ping statistics --- 7 packets transmitted, 7 packets received, 0.0% packet loss round-trip min/avg/max 84.308/84.640/85.837 ms</pre>
University of Chile (South America, Chile)	<pre>tahmidul@tahmidul-MS-7C56:~/Desktop/CSE 310\$ sudo python3 pinger.py uchile.cl Pinging 200.89.76.36 using Python: Pinging 200.89.76.36: Checksum: 3618, ID: 14843, Seq: 1, Time: 149.1151 ms Pinging 200.89.76.36: Checksum: 27235, ID: 14843, Seq: 2, Time: 148.4892 ms Pinging 200.89.76.36: Checksum: 54639, ID: 14843, Seq: 3, Time: 148.3197 ms Pinging 200.89.76.36: Checksum: 17354, ID: 14843, Seq: 4, Time: 148.9604 ms Pinging 200.89.76.36: Checksum: 42898, ID: 14843, Seq: 5, Time: 148.3431 ms Pinging 200.89.76.36: Checksum: 5582, ID: 14843, Seq: 6, Time: 149.5380 ms Pinging 200.89.76.36: Checksum: 28703, ID: 14843, Seq: 7, Time: 148.5758 ms Pinging 200.89.76.36: Checksum: 56000, ID: 14843, Seq: 8, Time: 148.5033 ms Pinging 200.89.76.36: Checksum: 17815, ID: 14843, Seq: 9, Time: 168.8597 ms ^C --- uchile.cl ping statistics --- 9 packets transmitted, 9 packets received, 0.0% packet loss round-trip min/avg/max 148.320/150.967/168.860 ms</pre>
University of Melbourne (Australia, Australia)	<pre>tahmidul@tahmidul-MS-7C56:~/Desktop/CSE 310\$ sudo python3 pinger.py unimelb.edu.au Pinging 43.245.43.59 using Python: Pinging 43.245.43.59: Checksum: 28494, ID: 15071, Seq: 1, Time: 4.7128 ms Pinging 43.245.43.59: Checksum: 3765, ID: 15071, Seq: 2, Time: 71.5790 ms Pinging 43.245.43.59: Checksum: 26060, ID: 15071, Seq: 3, Time: 4.8747 ms Pinging 43.245.43.59: Checksum: 571, ID: 15071, Seq: 4, Time: 5.1289 ms Pinging 43.245.43.59: Checksum: 39938, ID: 15071, Seq: 5, Time: 70.2758 ms Pinging 43.245.43.59: Checksum: 2388, ID: 15071, Seq: 6, Time: 4.4911 ms Pinging 43.245.43.59: Checksum: 44201, ID: 15071, Seq: 7, Time: 71.5482 ms Pinging 43.245.43.59: Checksum: 427, ID: 15071, Seq: 8, Time: 71.7072 ms Pinging 43.245.43.59: Checksum: 22330, ID: 15071, Seq: 9, Time: 4.2925 ms Pinging 43.245.43.59: Checksum: 65037, ID: 15071, Seq: 10, Time: 4.8170 ms Pinging 43.245.43.59: Checksum: 39866, ID: 15071, Seq: 11, Time: 5.0862 ms Pinging 43.245.43.59: Checksum: 13052, ID: 15071, Seq: 12, Time: 71.5637 ms ^C --- unimelb.edu.au ping statistics --- 12 packets transmitted, 12 packets received, 0.0% packet loss round-trip min/avg/max 4.292/32.506/71.707 ms</pre>

## Part D

In part A, we are pinging our local server from our local machine, so the RTT is expected to be faster than pinging stonybrook.edu and pinging servers in different continents. The stonybrook.edu server is closer (dorm internet connection is closer to stonybrook.edu) and is closer to the client (the computer running the program) than the servers in different continents. Similarly, the RTT in different continents tends to be larger and vary due to the distance from the client (closer to the client, the smaller the RTT). Since the code is making a new socket every time a request is made, the time required to process the request (the CPU clock, other time factors in calling functions from other libraries, etc.) tends to vary. The “major” impact is the distance between the client and server that the ping is being sent to (echo request/reply pair). Some of the servers in different continents may have been cached so the RTT can be much smaller than expected.

## Parts E and F

The codes for printing out the Ping statistics are already given. The changes that were incorporated to yield accurate results are (seen in RTT Calculation in *receiveOnePing()* function):

- Incrementing *rtt\_cnt* by 1 (since the destination address matches with the response)
- Adding *rtt\_sum* by the difference in time (time received - time sent)
- Changing *rtt\_min* and *rtt\_max* whenever the RTT was the minimum or the maximum value