CSC 249 Project 4
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Link to GitHub repo: https://github.com/SerenaG19/csc-249-p4-diy-ping-traceroute
Note: Google Maps was used to locate all institutions in this analysis.

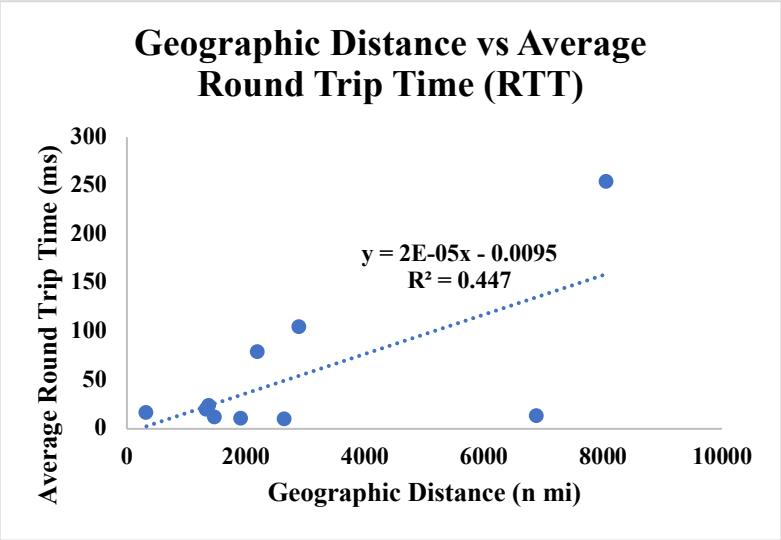

Figure 1. Plot of geographic distance of location from Smith College versus average round trip time.

1. Are RTT and geographic distance correlated positively, negatively, or not at all, given a geospatially distributed population of IP addresses? If applicable, also comment on the strength of correlation (weak vs. strong).

Round trip time and geographic distance appear to be positively correlated according to the linear regression model above. The correlation coefficient of R=0.447 is relatively weak. To test this and form a conclusion with more confidence, one could collect more data and perform a hypothesis test for a linear regression model with a single predictor.

2. Why do you think you observe this trend (or lack thereof)?

This trend seems to make sense considering that the farther away a server is, the more time it would take a data frame (in this case an ICMP packet) to reach it. For example, the data frame is traveling via radio wave, ethernet, optic fiber, or through some other method – all of which require time, in addition to routing and routing time. It would be counterintuitive if the data instead demonstrated that RTT is smaller for locations farther away from Smith College. However, this is possible given the complexity of the modern internet.

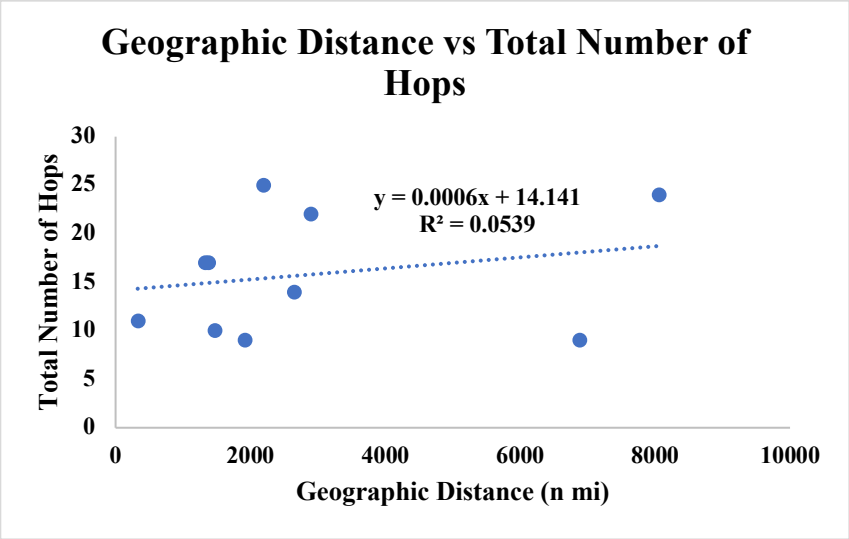

Figure 2. Plot of geographic distance of location from Smith College versus total number of hops.

1. Are # hops and geographic distance correlated positively, negatively, or not at all, given a geospatially distributed population of IP addresses? If applicable, also comment on the strength of correlation (weak vs. strong).

The number of hops and geographic distance are slightly positively correlated according to the linear regression model above. The correlation coefficient of R=0.0539 is very weak. To test this and form a conclusion with more confidence, one could collect more data and perform a hypothesis test for a linear regression model with a single predictor.

2. Why do you think you observe this trend (or lack thereof)?

This trend seems intuitive since the longer the distance an ICMP packet needs to travel, the more intermediate nodes (routers) it will pass through along the way. In other words, it makes sense that a longer distance traveled corresponds to a greater number of hops to reach the destination. However, as mentioned above, this trend is very weak, with a slope of 0.006 hops per nautical mile. Thus, it is possible that if more data were collected, one would find a negative relationship, or no relationship between these variables. This is possible, as perhaps data frame which are addressed to locations very far away make larger hops. As mentioned earlier, it is difficult to draw a definite conclusion from this relatively small dataset, and the modern internet is very complex.

Note: I hard-coded the ICMPpinger.py and ICMPtraceroute.py scripts to analyze the list of the following IP addresses in the order of this list, as reflected in the ping and traceroute traces on the next few pages:

```
addressList = ["130.111.46.127","169.236.10.214",
               "54.83.192.228", "54.163.225.50",
               "151.101.118.133", "128.232.132.8",
               "104.17.118.46", "103.6.198.52",
               "104.17.192.191", "18.239.168.110"]
```

Ping Trace

Last login: Tue Dec 12 15:21:48 on ttys011
(base) owner@owners-MacBook-Pro ~ % cd Documents/CSC249/P4/csc-249-p4-diy-ping-traceroute
(base) owner@owners-MacBook-Pro csc-249-p4-diy-ping-traceroute % sudo python ICMPpinger.py
Password:
Pinging 130.111.46.127 [130.111.46.127] 3 times using Python:
Ping 1 RTT 0.017114 sec
Ping 2 RTT 0.016176 sec
Ping 3 RTT 0.018589 sec
Pinging 169.236.10.214 [169.236.10.214] 3 times using Python:
Ping 1 RTT 0.078732 sec
Ping 2 RTT 0.076987 sec
Ping 3 RTT 0.0829 sec
Pinging 54.83.192.228 [54.83.192.228] 3 times using Python:
Ping 1 RTT 0.018794 sec
Ping 2 RTT 0.022542 sec
Ping 3 RTT 0.019776 sec
Pinging 54.163.225.50 [54.163.225.50] 3 times using Python:
Ping 1 RTT 0.020349 sec
Ping 2 RTT 0.017545 sec
Ping 3 RTT 0.034674 sec
Pinging 151.101.118.133 [151.101.118.133] 3 times using Python:
Ping 1 RTT 0.016629 sec
Ping 2 RTT 0.009224 sec
Ping 3 RTT 0.011061 sec
Pinging 128.232.132.8 [128.232.132.8] 3 times using Python:
Ping 1 RTT 0.106777 sec
Ping 2 RTT 0.104856 sec
Ping 3 RTT 0.104052 sec
Pinging 104.17.118.46 [104.17.118.46] 3 times using Python:
Ping 1 RTT 0.009018 sec
Ping 2 RTT 0.008048 sec
Ping 3 RTT 0.016348 sec
Pinging 103.6.198.52 [103.6.198.52] 3 times using Python:
Ping 1 RTT 0.249101 sec
Ping 2 RTT 0.249868 sec
Ping 3 RTT 0.265671 sec
Pinging 104.17.192.191 [104.17.192.191] 3 times using Python:
Ping 1 RTT 0.009962 sec
Ping 2 RTT Request timed out. sec
Ping 3 RTT 0.018155 sec
Pinging 18.239.168.110 [18.239.168.110] 3 times using Python:
Ping 1 RTT 0.007144 sec

```
Ping 2 RTT 0.016772 sec
Ping 3 RTT 0.007497 sec
(base) owner@owners-MacBook-Pro csc-249-p4-diy-ping-traceroute %
```

Traceroute Trace

Last login: Tue Dec 12 15:47:15 on ttys006
(base) owner@owners-MacBook-Pro ~ % cd Documents/CSC249/P4/csc-249-p4-diy-ping-traceroute
(base) owner@owners-MacBook-Pro csc-249-p4-diy-ping-traceroute % sudo python ICMPtraceroute.py
Password:
1 rtt=42 ms 131.229.149.254
2 rtt=37 ms 131.229.11.142
3 rtt=60 ms 131.229.10.104
4 rtt=22 ms 134.241.249.33
5 rtt=27 ms 69.16.1.33
6 rtt=48 ms 18.2.8.89
7 rtt=11 ms 192.5.89.57
8 rtt=22 ms 18.2.0.78
9 rtt=30 ms 130.111.0.126
10 rtt=47 ms 130.111.0.25
11 rtt=32 ms 130.111.46.127
1 rtt=16 ms 131.229.149.254
2 rtt=23 ms 131.229.11.142
3 rtt=37 ms 131.229.10.104
4 rtt=17 ms 134.241.249.33
5 rtt=18 ms 69.16.1.33
6 rtt=17 ms 18.2.8.89
7 rtt=44 ms 192.5.89.254
8 rtt=74 ms 163.253.1.21
9 rtt=85 ms 163.253.2.146
10 rtt=101 ms 163.253.1.211
11 rtt=89 ms 163.253.1.206
12 rtt=89 ms 163.253.2.29
13 rtt=83 ms 163.253.1.250
14 rtt=76 ms 163.253.1.169
15 rtt=85 ms 163.253.1.114
16 rtt=80 ms 137.164.26.200
17 rtt=87 ms 137.164.25.74
18 rtt=89 ms 137.164.25.34
19 rtt=94 ms 137.164.11.95
20 rtt=96 ms 137.164.11.89
21 rtt=84 ms 137.164.11.101
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.

* * * Request timed out.
25 rtt=79 ms 169.236.10.214
1 rtt=7 ms 131.229.149.254
2 rtt=6 ms 131.229.11.142
3 rtt=24 ms 131.229.10.104
4 rtt=7 ms 134.241.249.33
5 rtt=6 ms 69.16.1.33
6 rtt=5 ms 18.2.8.89
7 rtt=10 ms 192.5.89.57
8 rtt=18 ms 192.5.89.222
9 rtt=20 ms 163.253.1.44
10 rtt=20 ms 163.253.1.116
11 rtt=19 ms 163.253.1.131
12 rtt=23 ms 99.82.179.34
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
17 rtt=23 ms 54.83.192.228
1 rtt=11 ms 131.229.149.254
2 rtt=81 ms 131.229.11.142
3 rtt=35 ms 131.229.10.104
4 rtt=10 ms 134.241.249.33
5 rtt=8 ms 69.16.1.33
6 rtt=13 ms 18.2.8.89
7 rtt=11 ms 192.5.89.57
8 rtt=20 ms 192.5.89.222
9 rtt=21 ms 163.253.1.42
10 rtt=21 ms 163.253.1.116
11 rtt=25 ms 163.253.1.131
12 rtt=28 ms 99.82.179.34
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
17 rtt=28 ms 54.163.225.50
1 rtt=16 ms 131.229.149.254
2 rtt=48 ms 131.229.11.142

3 rtt=24 ms 131.229.10.104
4 rtt=30 ms 134.241.249.33
5 rtt=8 ms 69.16.1.33
6 rtt=8 ms 69.16.0.9
7 rtt=8 ms 38.104.218.13
8 rtt=13 ms 154.54.41.129
9 rtt=9 ms 38.140.158.82
10 rtt=11 ms 151.101.118.133
1 rtt=11 ms 131.229.149.254
2 rtt=32 ms 131.229.11.142
3 rtt=21 ms 131.229.10.104
4 rtt=26 ms 134.241.249.33
5 rtt=14 ms 69.16.1.33
6 rtt=17 ms 18.2.8.89
7 rtt=11 ms 192.5.89.57
8 rtt=18 ms 192.5.89.222
9 rtt=20 ms 163.253.1.42
10 rtt=86 ms 198.71.45.237
11 rtt=99 ms 62.40.98.106
12 rtt=96 ms 62.40.98.64
13 rtt=156 ms 62.40.124.198
14 rtt=102 ms 146.97.33.18
15 rtt=100 ms 146.97.35.246
16 rtt=102 ms 146.97.41.38
17 rtt=103 ms 131.111.7.82
18 rtt=102 ms 193.60.88.6
19 rtt=102 ms 193.60.88.6
20 rtt=112 ms 128.232.128.6
21 rtt=104 ms 128.232.128.10
22 rtt=104 ms 128.232.132.8
1 rtt=16 ms 131.229.149.254
2 rtt=101 ms 131.229.11.142
3 rtt=24 ms 131.229.10.104
4 rtt=5 ms 134.241.249.33
5 rtt=7 ms 69.16.1.33
6 rtt=7 ms 18.2.136.89
7 rtt=9 ms 192.5.89.57
8 rtt=17 ms 206.53.143.9
9 rtt=9 ms 104.17.118.46
1 rtt=8 ms 131.229.149.254
2 rtt=18 ms 131.229.11.142
3 rtt=27 ms 131.229.10.104
4 rtt=6 ms 134.241.249.33
5 rtt=14 ms 69.16.1.33
6 rtt=7 ms 65.175.24.205
7 rtt=12 ms 173.241.131.14

8 rtt=27 ms 129.250.4.102
9 rtt=32 ms 129.250.2.26
10 rtt=81 ms 129.250.3.42
11 rtt=84 ms 129.250.3.82
12 rtt=170 ms 129.250.4.143
13 rtt=176 ms 129.250.5.54
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
15 rtt=268 ms 129.250.2.169
16 rtt=307 ms 129.250.6.25
17 rtt=317 ms 168.143.105.179
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
* * * Request timed out.
20 rtt=332 ms 223.28.26.154
* * * Request timed out.
* * * Request timed out.
21 rtt=301 ms 223.28.35.225
* * * Request timed out.
* * * Request timed out.
22 rtt=253 ms 210.19.226.122
* * * Request timed out.
* * * Request timed out.
23 rtt=261 ms 110.4.44.250
* * * Request timed out.
* * * Request timed out.
24 rtt=306 ms 103.6.198.52
1 rtt=7 ms 131.229.149.254
2 rtt=16 ms 131.229.11.142
3 rtt=27 ms 131.229.10.104
4 rtt=4 ms 134.241.249.33
5 rtt=5 ms 69.16.1.33
6 rtt=7 ms 18.2.136.89
7 rtt=8 ms 192.5.89.57
8 rtt=9 ms 206.53.143.9
9 rtt=7 ms 104.17.192.191
1 rtt=20 ms 131.229.149.254
2 rtt=20 ms 131.229.11.142
3 rtt=15 ms 131.229.10.104
4 rtt=5 ms 134.241.249.33
5 rtt=6 ms 69.16.1.33
6 rtt=7 ms 65.175.24.205
7 rtt=11 ms 89.149.130.30
* * * Request timed out.

```
 * * * Request timed out.
 * * * Request timed out.
 * * * Request timed out.
 * * * Request timed out.
 * * * Request timed out.
 * * * Request timed out.
 * * * Request timed out.
 * * * Request timed out.
 * * * Request timed out.
 * * * Request timed out.
 * * * Request timed out.
 14 rtt=65 ms 18.239.168.110
(base) owner@owners-MacBook-Pro csc-249-p4-diy-ping-traceroute %
```