**Short Answers**

**RTT**:

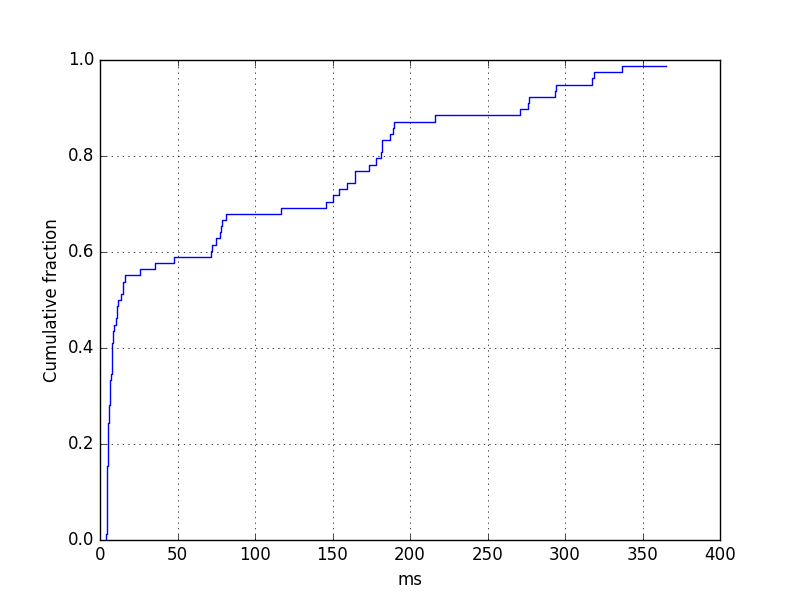
1. Questions on experiment a:

* What percentage of the websites do not respond to pings at all? What percentage have at least one failed ping?

Percent of websites that do not respond: 0.22. Percent with at least one failed ping: 0.31.

* Using the plot functions and rtt a agg.json, please plot a CDF of the median RTT of the websites that respond to ping.

Median RTT Graph:



1. Questions on experiment b:

* What are the median RTT and maximum RTT for each website? What loss rate do you observe?

todayhumor.co.kr

median\_rtt: 92.409

drop\_rate: 0.2

max\_rtt: 197.281

google.com

median\_rtt: 4.909

drop\_rate: 0.2

max\_rtt: 239.982

taobao.com

median\_rtt: 257.448

drop\_rate: 11.4

max\_rtt': 785.063

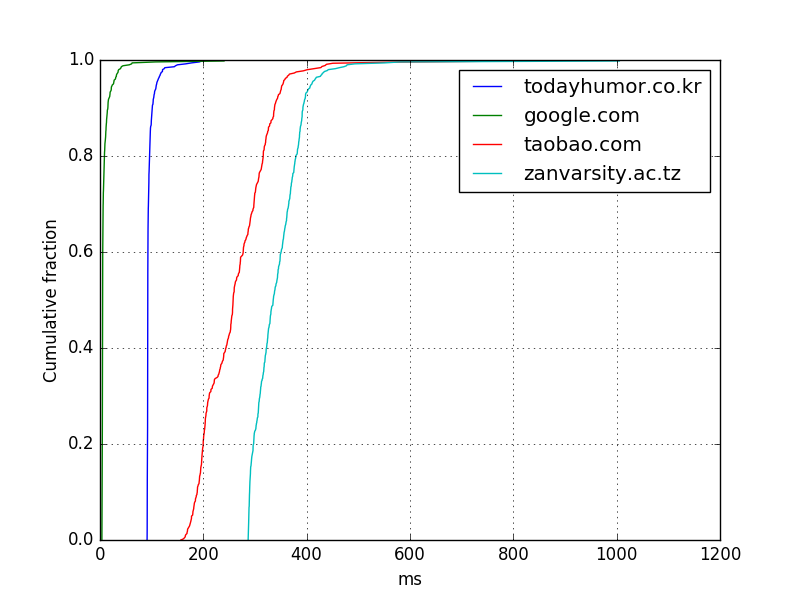
zanvarsity.ac.tz

median\_rtt: 335.078

drop\_rate: 0.2

max\_rtt: 1005.17

* Using the plot functions to and rtt b raw.json, please plot a CDF of the RTT for each website. You can plot the four CDFs on the same graph. Be sure to include a legend so we know which CDF corresponds to which of the four websites.



1. In this question, you will analyze the ping times to two websites and compare the results to the expected speed-of-light times. The websites are google.com (located in Mountain View, CA, USA) and zanvarsity.ac.tz (located in Zanzibar, Tanzania). You can use your ping data from experiment b. The distance from Berkeley to Mountain view is 35.23 miles, and the distance from Berkeley to Zanzibar is 9,953.50 miles.

* Compare the median ping time to the speed of light time. What’s the multiplier for each server (calculate as [ping time / speed of light time])?

google.com multiplier is 25.956807777. zanvarsity.ac.tz multiplier is 6.2710604307.

* Using one sentence each, list two reasons why the ping time is not equal to the speed of light time. Plausible but unlikely answers (e.g., “a bear chewed through the wire, causing a long delay) will not receive full credit.

Queueing delays contribute to the extra delay in ping times as compared to speed of light. Speed of light is not constant in all mediums, i.e. we assumed speed of light in a vacuum, whereas it may travel through different mediums such as glass, metal, etc.

**Routing:**

1. Answer the following questions using the results obtained from experiment a.
   * Which ASes are Berkeley directly connected to?

Just AS2152.

* + Which traceroute traverses the most number of ASes? How about the least number of ASes?

The traces to zanvarsity.ac.tz and vutbr.cz trace the most ASes with 6 each. The traceroute to Berkeley.edu has the least number of ASes, with just 2. (These are counting 0 as a separate AS.)

* + Which websites' routes are load-balanced?

You can tell which websites’ routes are load-balanced by seeing if any of there intermediate hops have multiple ip addresses through all the runs.

The load-balanced website routes are:

Google.com, facebook.com, allspice.lcs.mit.edu, todayhumor.co.kr, [www.city.kobe.lg.jp](http://www.city.kobe.lg.jp), zanvarsity.ac.tz.

The only non-loadbalanced sites appear to be [www.vutbr.cz](http://www.vutbr.cz) and [www.berkeley.edu](http://www.berkeley.edu).

* + Are the observed routes stable over multiple runs? For each website, how many unique routes did you observe?

Observed routes are stable for some sites but not others. The number of unique runs per site:

- [www.vutbr.cz](http://www.vutbr.cz): 1

- todayhumor.co.kr: 5

- google.com: 1

- www.city.kobe.lg.jp: 5

- www.berkeley.edu: 1

- facebook.com: 5

- zanvarsity.ac.tz: 5

- allspice.lcs.mit.edu: 3

* + Using one sentence, please explain one advantage of having stable routes.

Having stable routes causes more consistent routing performance.

1. Answer the following questions using the results obtained from experiment b.
   * How many hops do you observe in each route when you run traceroute *from* your computer? How many hops do you observe in the reverse direction?

From my computer:

tpr-route-server.saix.net: 13 hops

route-server.ip-plus.net: 14 hops

route-views.oregon-ix.net: 8 hops

route-views.on.bb.telus.com: 10 hops

In reverse direction (to my first hop router):

tpr-route-server.saix.net: 12 hops

route-server.ip-plus.net: 11 hops

route-views.oregon-ix.net: 8 hops

route-views.on.bb.telus.com: 15 hops

* + Are these routes symmetric? How many are symmetric and how many are not?

None of the routes ended up symmetric.

tpr-route-server.saix.net: Not symmetric

route-server.ip-plus.net: Not symmetric

route-views.oregon-ix.net: Not symmetric

route-views.on.bb.telus.com: Not symmetric

* + What might cause asymmetric routes? List one or two reasons.

- Routing policies of ASes (due to economics) may permit them to route one way but not another.

- Traffic may be split up for load balancing.

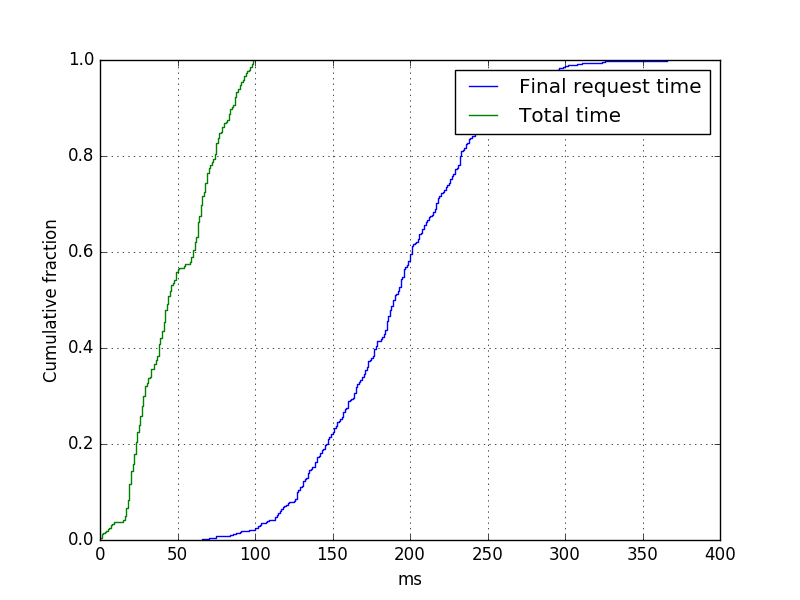
**DNS:**

1. Average Root TTL 489955.44799999992

Average TLD TTL 172800.0

Average Other TTL 111838.71415629037

Average Terminating TTL 7955.1000000000004



1. Difference in DNS response with one-hour difference (55, 56). 55 change within the first trial, 59 change in total.
2. Difference in DNS response with server from Makati (55, 78)
3. The reason for different DNS server being returned is to allow for load balancing, distributing the loads to different providers
4. It would have been much faster because wouldn’t have to resolve all requests iteratively, instead going directly to the server. This is evident from seeing as the average get times for +trace argument in place is 382.18 ms, whereas from the Makati server it is 206.99 ms