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Problem 1

a) The given log file contains BGP routing information snapshot. Each row of the log contains an IP Prefix, Next Hop, Metric, Local Preference, Weight and the AS Path. For each IP Prefix, the next hop refers to the next router to which the packet is to be sent, and the path represents the sequence of ASes to be taken. Local Preference and Weight is used to give preference to a particular route to be used. The AS Path can be prepended inorder to use the preferred router/path.

b) AS number of Emory University is 3512

c) IP Address prefixes belonging to Emory University.

64.214.127.128/27
163.246.0.0/16
170.140.0.0/16
206.57.72.0/21

Emory University does not have other IP addresses which are not part of this data.

d) ASes connected to Emory:

10490 - SOUTHERN-CROSSROADS-SOX - Georgia Institute of Technology
11686 - ENA - Education Networks of America
3549 - GBLX Global Crossing Ltd.
3595 - GNAXNET-AS - Global Net Access, LLC
6939 - HURRICANE - Hurricane Electric, Inc.

The common AS with Georgia Tech AS (2637) is 10490 - SOUTHERN-CROSSROADS-SOX - Georgia Institute of Technology.

e) Below is list all instances of AS prepending in the data with IP originating from Georgia Tech. It can be observed that IP prepending is done only when the next AS is 209 and 174, and this is done to ensure preference is given to a particular router/path.

128.61.0.0/19	12.0.1.63		0	0	0	7018	209	2637	2637	2637
128.61.0.0/19	206.24.210.102	0	0	0	3561	209	2637	2637	2637	i
128.61.0.0/19	144.228.241.130	0	0	0	1239	209	2637	2637	2637	i
128.61.0.0/19	129.250.0.11	5	0	0	2914	209	2637	2637	2637	i
128.61.0.0/19	157.130.10.233	0	0	0	701	209	2637	2637	2637	i
128.61.0.0/19	89.149.178.10	10	0	0	3257	209	2637	2637	2637	i
128.61.128.0/17	12.0.1.63	0	0	0	7018	209	2637	2637	2637	i
128.61.128.0/17	206.24.210.102	0	0	0	3561	209	2637	2637	2637	i
128.61.128.0/17	144.228.241.130	0	0	0	1239	209	2637	2637	2637	i
128.61.128.0/17	129.250.0.11	5	0	0	2914	209	2637	0	2637	i
128.61.128.0/17	157.130.10.233	0	0	0	701	209	2637	2637	2637	i
128.61.128.0/17	89.149.178.10	10	0	0	3257	209	2637	2637	2637	i

130.207.0.0/16	12.0.1.63	0	0	0	7018	209	2637	2637	2637	i					
130.207.0.0/16	206.24.210.102	0	0	0	3561	209	2637	2637	2637	i					
130.207.0.0/16	144.228.241.130	0	0	0	1239	209	2637	2637	2637	i					
130.207.0.0/16	129.250.0.11	72	0	0	2914	2637	2637	2637	2637	2637	i				
130.207.0.0/16	157.130.10.233	0	0	0	701	209	2637	2637	2637	i					
130.207.0.0/16	89.149.178.10	10	0	0	3257	209	2637	2637	2637	i					
143.215.0.0/16	91.209.102.1	0	0	0	39756	3257	209	2637	2637	2637	i				
143.215.0.0/16	157.130.10.233	0	0	0	701	209	2637	2637	2637	i					
143.215.0.0/16	12.0.1.63	0	0	0	7018	209	2637	2637	2637	i					
143.215.0.0/16	206.24.210.102	0	0	0	3561	209	2637	2637	2637	i					
143.215.0.0/16	213.144.128.203	1	0	0	13030	11164	10490	2637	2637	i					
143.215.0.0/16	129.250.0.11	72	0	0	2914	2637	2637	2637	2637	2637	i				
143.215.0.0/16	144.228.241.130	0	0	0	1239	209	2637	2637	2637	i					
143.215.0.0/16	147.28.7.2	2	0	0	3130	2914	2637	2637	2637	2637	2637	i			
143.215.0.0/16	134.222.87.1	0	0	0	286	209	2637	2637	2637	i					
143.215.0.0/16	147.28.7.1	0	0	0	3130	2914	2637	2637	2637	2637	2637	i			
143.215.0.0/16	4.69.184.193	0	0	0	3356	209	2637	2637	2637	i					
143.215.0.0/16	168.209.255.23	0	0	0	3741	3356	209	2637	2637	2637	i				
143.215.0.0/16	203.62.252.186	0	0	0	1221	4637	209	2637	2637	2637	i				
143.215.0.0/16	85.114.0.217	0	0	0	8492	9002	11164	10490	2637	2637	i				
143.215.0.0/16	216.18.31.102	0	0	0	6539	11164	10490	2637	2637	i					
143.215.0.0/16	194.153.0.253	47	0	0	5413	1299	209	2637	2637	2637	i				
143.215.0.0/16	167.142.3.6	0	0	0	5056	3356	209	2637	2637	2637	i				
143.215.0.0/16	208.51.134.246	13227	0	0	3549	11164	10490	2637	2637	i					
143.215.0.0/16	154.11.11.113	0	0	0	852	209	2637	2637	2637	i					
143.215.0.0/16	154.11.98.225	0	0	0	852	209	2637	2637	2637	i					
143.215.0.0/16	66.185.128.1	2	0	0	1668	2914	2637	2637	2637	2637	2637	i			
143.215.0.0/16	89.149.178.10	10	0	0	3257	209	2637	2637	2637	i					
143.215.0.0/16	195.22.216.188	100	0	0	6762	209	2637	2637	2637	i					
143.215.0.0/16	80.91.255.62	0	0	0	1299	209	2637	2637	2637	i					
143.215.0.0/16	164.128.32.11	0	0	0	3303	209	2637	2637	2637	i					
143.215.0.0/16	67.17.82.114	2523	0	0	3549	209	2637	2637	2637	i					
143.215.0.0/16	202.232.0.3	0	0	0	2497	209	2637	2637	2637	i					
184.164.243.0/24	202.232.0.3	0	0	0	2497	209	2637	2637	2637	47065	14085	47065	i		
184.164.251.0/24	202.232.0.3	0	0	0	2497	209	2637	2637	2637	47065	i				
204.152.10.0/23	96.4.0.55	0	0	0	11686	19782	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	198.129.33.85	0	0	0	293	6939	1299	174	2637	2637	2637	2637	2637	i	
204.152.10.0/23	213.144.128.203	1	0	0	13030	3549	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	91.209.102.1	0	0	0	39756	174	2637	2637	2637	2637	2637	i			
204.152.10.0/23	206.24.210.102	0	0	0	3561	174	2637	2637	2637	2637	2637	i			
204.152.10.0/23	144.228.241.130	0	0	0	1239	174	2637	2637	2637	2637	2637	i			
204.152.10.0/23	129.250.0.11	6	0	0	2914	174	2637	2637	2637	2637	2637	i			
204.152.10.0/23	12.0.1.63	0	0	0	7018	174	2637	2637	2637	2637	2637	i			
204.152.10.0/23	147.28.7.2	2	0	0	3130	2914	174	2637	2637	2637	2637	2637	i		

204.152.10.0/23	134.222.87.1	0	0	0	286	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	147.28.7.1	0	0	0	3130	2914	174	2637	2637	2637	2637	2637	i	
204.152.10.0/23	4.69.184.193	0	0	0	3356	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	216.218.252.164	0	0	0	6939	1299	174	2637	2637	2637	2637	2637	i	
204.152.10.0/23	168.209.255.23	0	0	0	3741	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	203.62.252.186	0	0	0	1221	4637	174	2637	2637	2637	2637	2637	i	
204.152.10.0/23	85.114.0.217	0	0	0	8492	9002	174	2637	2637	2637	2637	2637	i	
204.152.10.0/23	216.18.31.102	0	0	0	6539	577	174	2637	2637	2637	2637	2637	i	
204.152.10.0/23	194.153.0.253	47	0	0	5413	1299	174	2637	2637	2637	2637	2637	i	
204.152.10.0/23	167.142.3.6	0	0	0	5056	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	157.130.10.233	0	0	0	701	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	208.51.134.246	13227	0	0	3549	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	154.11.11.113	0	0	0	852	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	154.11.98.225	0	0	0	852	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	66.185.128.1	64	0	0	1668	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	89.149.178.10	10	0	0	3257	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	195.22.216.188	100	0	0	6762	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	80.91.255.62	0	0	0	1299	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	67.17.82.114	2523	0	0	3549	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	164.128.32.11	0	0	0	3303	174	2637	2637	2637	2637	2637	i		
204.152.10.0/23	203.181.248.168	0	0	0	7660	2516	209	174	2637	2637	2637	2637	2637	i
204.152.10.0/23	202.232.0.3	0	0	0	2497	2914	174	2637	2637	2637	2637	2637	i	
204.152.10.0/23	137.164.16.84	0	0	0	2152	3356	174	2637	2637	2637	2637	2637	i	

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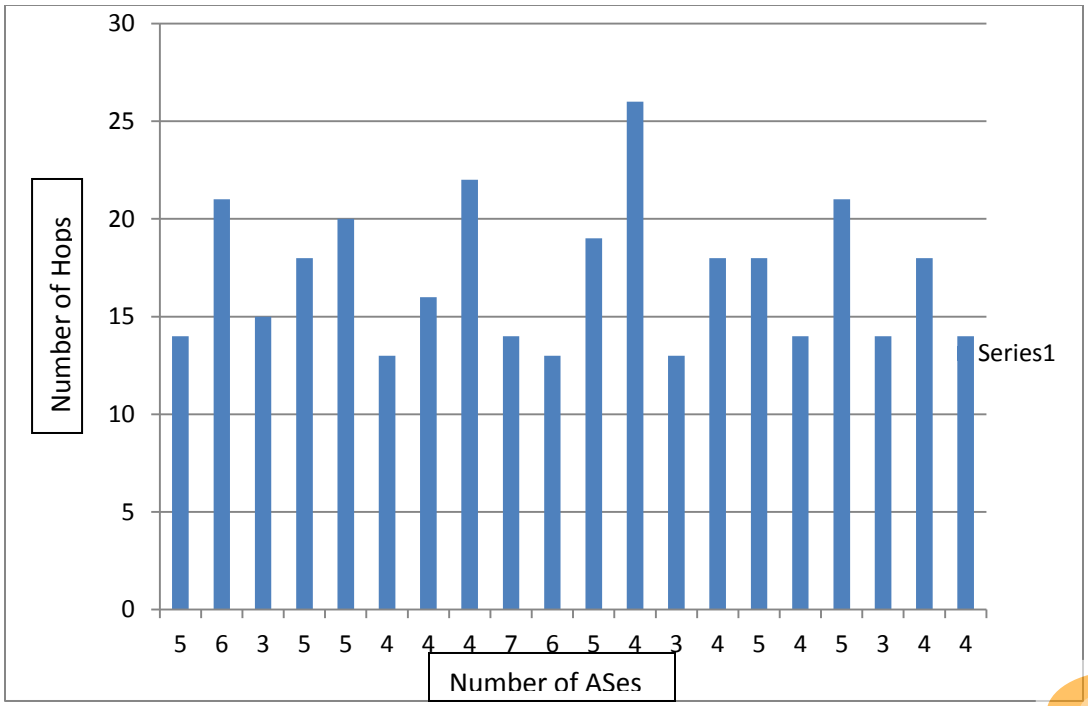
Problem 2

Below is the data collected for number of hops(routers) and the number of ASes for 20 traceroute servers with destination as “princeton.edu”. The graph below the table is the representation of the table.

	Number of ASes	Number of Routers
HostEurope	5	14
Wiberg	6	21
TeraByte	3	15
Institute of High Energy Physics – China	5	18
4Web.CA	5	20
ComXNetworks	4	13
IPExchange	4	16
Jaguar Networks	4	22
iNetBone	7	14
NTU Greece	6	13
Hutchison	5	19
Netplex	4	26
Savvis	3	13
Blue Moon	4	18
Colocation America	5	18
Steadfast	4	14
VGER	5	21
Cogent	3	14
MaxNoc	4	18
T1 Shopper	4	14



-2: This is not a proper graph, you need an X-axis representing the number of ASes, where values are not repeated. What you have is not an axis, it’s just a list of values. This chart does not represent the data well enough to make any conclusions about the relationship between #AS vs. #routers.

35/35 Problem 3 – Repeating Detour Results

a) The methodology followed in this experiment is similar to the Detour experiment with a slight variation. Instead of choosing the average of the three RTT (Round Trip Time) the highest of the 3 RTT is chosen. 5 servers were chosen and latency information along all possible paths were calculated. This was repeated for a sample set of three.

b) The raw data in the experiment is the 'highest latency' at the destination for each traceroute request. Following are the servers chosen for the experiment.

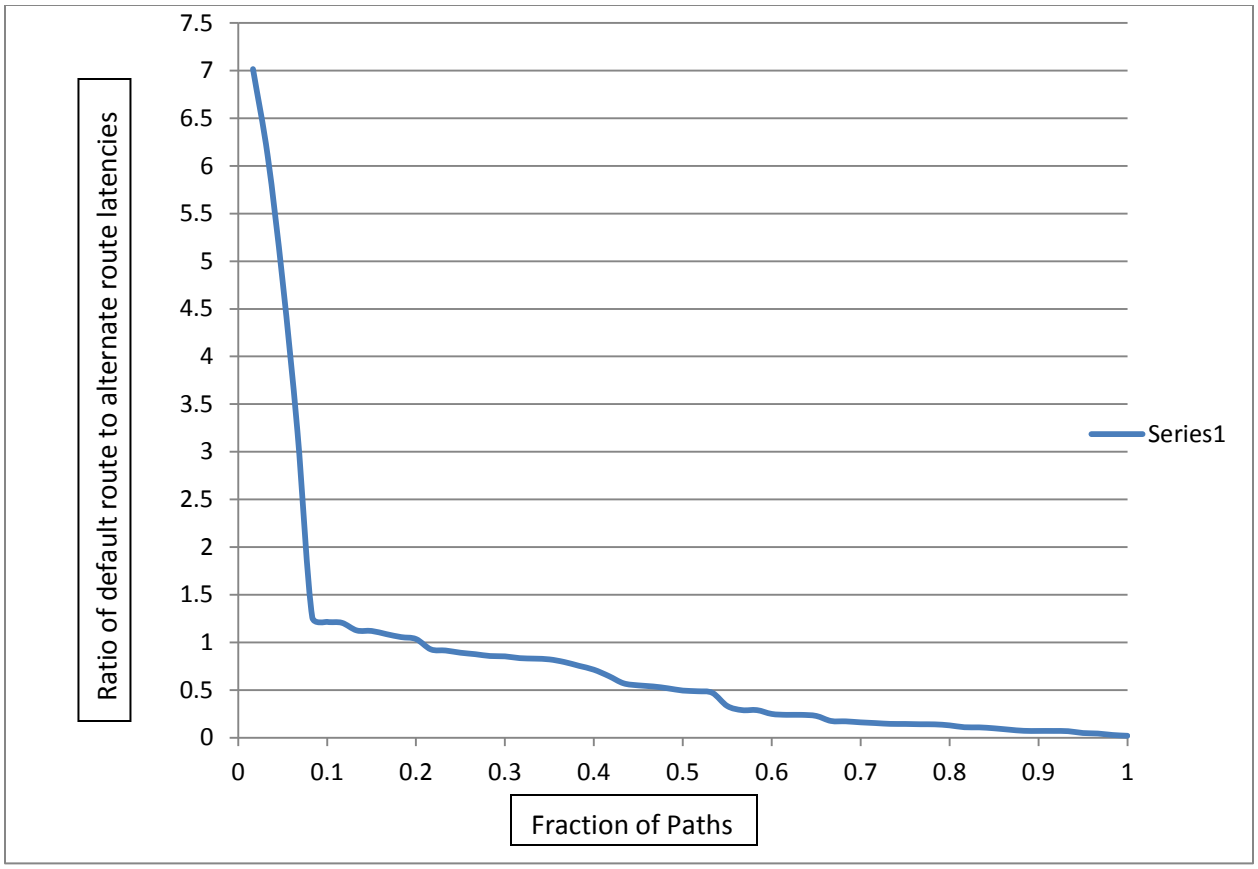
- Bluemoon (NY State) 64.200.84.2
- Steadfast (Chicago, IL) 208.100.4.50
- GetNet (Phoenix, AZ) 64.182.209.117
- UNESP (Brazil) 200.145.0.41
- USC (LosAngeles,CA) 128.125.137.243

Pair Wise Latency Matrix

	A	**B**	**C**	**D**	**E**
A	0	21.695	43.333	158.827	90.214
B	978.945	0	20.603	147.113	52.532
C	754.633	21.92	0	156.683	36.823
D	157.564	147.301	143.289	0	217.12
E	86.996	51.103	37.706	205.192	0

A	Bluemoon	64.200.84.2
B	Steadfast	208.100.4.50
C	GetNet	64.182.209.117
D	UNESP	200.145.0.41
E	USC	128.125.137.243

c) The graph below is the plot of the ratio of default latency and alternate latency against the fraction of the number of paths. The graph here is similar to the one in Detour in the way the slope decreases. However, the decrease in slope is high at the beginning, and later on becomes a gradual decrease. One main reason for this is the sample space taken uses the 'highest latency' and not the average. Also the Detour paper used a large data set, collected over a period of time and used the average case analysis. However in this experiment such a large dataset was not collected, and average case analysis was not performed to 'smoothen' the curve.


Ratio of default route to alternate route latencies
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Fraction of Paths
Series1