CSC 840

Project 1

Matthew Wishoff

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Abstract

The art of making fast and excellent software is a dying art. As computers get faster and faster programmers can become lazier and sloppier with how they write code. They may not look for the fastest solution, and settle for just a solution that works. This is the first papers of many that will be looking into software metrics. Gaining knowledge and skills in the area of evaluating if a piece of software has been written well, or if it has just been written.

1.0 Introduction (make it an introduction to just ping measurments)

The purpose of this project is to develop our skills with basic measuring, modeling, and predicting run times of programs. We will be taking 600 round trip pings to multiple servers across the world, and comparing them to find correlations. The servers I chose are along the same latitude so that I may be able to do some analysis on a countries network structure. For example to see which country has the best (fastest) network connections, and which countries have the slowest. We will also be testing short processor times, such as the clock and time functions. We will also be testing the speed of matrix multiplication, and matrix inversion. However, we will be starting with the analysis and graphs of the ping measurements.

1.1 Method and software used (Problem 1)

I took five samples of data over the course of an evening. Each sample consists of pinging 7 servers simultaneously, allowing me to gather data from all the servers at the exact same time. How I achieved this is with a Batch script (See appendix).What the Batch script does is it initializes the ping commands for all the servers and executes them at the same moment with a time stamp. This made data collection very easy to gather multiple samples of data in a decent amount of time. Other software I used includes MatLab which allowed me to easily and efficiently make beautiful graphs that represents the data, so that I can analyze it well. As well as compute the mean, mode, median, and standard deviation of the round trip ping data.

1.2 Experimental results data and analysis

1.2.0 Raw Data

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Warwick University Data set 1

198,188,187,185,180,180,186,185,180,188,186,188,184,185,188,185,186,187,180,189,200,188,190,189,186,192,199,180,194,185,193,189,189,191,200,185,188,186,181,178,184,177,181,195,188,187,185,181,186,184,183,183,184,185,189,181,175,181,184,184,182,193,178,182,186,181,183,184,191,182,175,188,194,185,179,182,200,184,182,180,191,186,188,182,182,185,188,179,179,180,181,185,187,189,181,190,177,185,182,195,189,191,187,186,254,313,372,180,220,278,336,186,181,188,194,178,182,186,186,181,189,186,185,189,186,197,189,190,183,196,190,198,188,192,197,196,191,184,182,188,185,189,190,185,197,183,200,178,183,188,187,190,196,180,180,183,187,187,179,183,185,184,184,187,189,184,184,185,184,179,181,185,182,175,177,184,185,184,196,189,187,188,183,185,176,184,193,179,179,182,188,197,184,205,185,183,187,189,179,177,186,187,181,195,178,188,189,183,186,184,183,183,183,178,183,190,190,184,187,187,183,184,177,180,179,187,180,178,184,177,175,182,188,187,188,176,179,185,190,177,179,188,181,186,184,197,186,186,187,186,185,182,187,183,194,179,183,194,180,189,183,183,183,186,184,178,181,187,187,182,187,187,199,187,176,183,182,181,186,182,193,181,196,192,186,184,188,179,179,182,187,187,187,180,179,185,182,183,201,180,190,184,188,181,184,181,189,182,188,189,188,182,178,178,183,182,183,195,191,184,188,182,187,179,183,182,182,174,184,194,183,184,185,184,187,181,183,186,184,182,180,184,185,187,189,182,193,187,172,180,186,182,184,181,182,188,185,186,180,188,182,181,184,190,185,180,183,180,184,176,187,186,189,185,184,184,181,183,183,184,189,184,188,180,186,183,184,188,189,178,183,187,188,187,185,185,188,178,187,175,184,186,196,192,190,194,186,192,185,176,180,186,182,183,192,183,185,188,194,180,184,185,188,188,180,187,184,189,179,184,186,182,190,183,187,186,185,190,185,193,188,186,186,186,185,183,187,185,185,183,182,184,187,187,181,185,182,184,188,188,187,181,183,187,191,180,187,183,198,176,182,176,193,178,189,188,180,185,181,186,190,190,181,188,183,196,179,188,188,185,185,185,185,183,186,185,184,183,187,187,187,196,184,184,187,186,186,188,178,183,187,188,181,187,190,183,188,186,187,189,182,185,188,175,184,184,182,192,182,187,190,197,188,191,178,183,188,173,177,183,184,178,185,185,180,181,186,176,191,183,192,185,186,184,188,174,184,193,189,181,195,188,186,186,188,184,188,190,182,188,190,183,196,178,200,188,185,190,184,182,175,189,188,184,192,184,188,186,181,181

Other data sets can be provided upon request, but in the interest of saving space, and not bloating this report I will not be putting all the raw data into this report.

1.2.1 Data set tables

Data set 1 – Time taken (5:03 PM)

Server	Mean ping (ms)	Standard Dev.	Packets Lost	Distance from SF
stanford.edu	18	6.29	0	35 mi
turing.mit.edu	95	5.34	0	3,096 mi
bton.ac.uk	164	5.54	0	5,065 mi
warwick.ac.uk	171	6.98	3	5,269 mi
paris1web.univ-paris1.fr	158	5.89	0	5,560 mi
univ-alger.dz	230	6.76	0	6,200 mi
web.uca.ma	203	5.89	1	6,075 mi

Data set 2 – Time taken (7:28 PM)

Server	Mean ping (ms)	Standard Dev.	Packet Loss	Distance from SF
stanford.edu	15	4.78	0	35 mi
turing.mit.edu	93	6.96	0	3,096 mi
bton.ac.uk	162	13.48	0	5,065 mi
warwick.ac.uk	186	13.16	10	5,269 mi
paris1web.univ-paris1.fr	156	11.31	0	5,560 mi
univ-alger.dz	222	8.87	0	6,200 mi
web.uca.ma	210	7.47	6	6,075 mi

Data set 3 – Time taken (12:30 AM)

Server	Mean ping (ms)	Standard Dev.	Packet Loss	Distance from SF
stanford.edu	16	7.95	0	35 mi
turing.mit.edu	93	10.6	0	3,096 mi
bton.ac.uk	163	14.26	0	5,065 mi
warwick.ac.uk	162	9.08	0	5,269 mi
paris1web.univ-paris1.fr	157	9.32	0	5,560 mi
univ-alger.dz	211	12.22	0	6,200 mi
web.uca.ma	203	14.69	0	6,075 mi

Data set 4 – Time taken (10:09 AM)

Server	Mean ping (ms)	Standard Dev.	Packet Loss	Distance from SF
stanford.edu	15	3.03	0	35 mi
turing.mit.edu	93	3.95	0	3,096 mi
bton.ac.uk	172	7.81	0	5,065 mi
warwick.ac.uk	162	4.23	0	5,269 mi
paris1web.univ-paris1.fr	155	3.37	0	5,560 mi
univ-alger.dz	207	3.15	0	6,200 mi
web.uca.ma	207	9.32	7	6,075 mi

Data set 5 – Time taken (3:48 PM)

Server	Mean ping (ms)	Standard Dev.	Packet Loss	Distance from SF
stanford.edu	13	16.8	6	35 mi
turing.mit.edu	101	21.89	7	3,096 mi
bton.ac.uk	156	21.69	3	5,065 mi
warwick.ac.uk	172	24.21	4	5,269 mi
paris1web.univ-paris1.fr	173	22.46	1	5,560 mi
univ-alger.dz	215	25.96	6	6,200 mi
web.uca.ma	209	28.75	61	6,075 mi

Data set 6 – Time taken (4:52 PM)

Server	Mean ping (ms)	Standard Dev.	Packet Loss	Distance from SF
stanford.edu	16	5.16	0	35 mi
turing.mit.edu	93	7.93	0	3,096 mi
bton.ac.uk	179	8.88	1	5,065 mi
warwick.ac.uk	164	13.63	0	5,269 mi
paris1web.univ-paris1.fr	157	14.26	0	5,560 mi
univ-alger.dz	209	9.47	0	6,200 mi
web.uca.ma	205	15.62	1	6,075 mi

After looking at the data you can clearly see that data set 5 has some strange numbers compared to the other data sets. I think this is due to AT&T maintenance in the area. Around the time I was taking the data for that sample a couple people from AT&T knocked on my door and told me they were doing maintenance. So I think you can clearly see that it effected the sample by looking at the standard deviation since almost all of them are at least 20 plus and higher; as well as, looking at the packet loss for the 600 pings to each server, you can clearly see by looking at web.uca.ma that losing 61 packets is not normal for these data sets. Due to these factors I will not be including data set 5 in my analysis as it may lead to incorrect assumptions.

The standard deviations for the data sets look really good being almost all of them are below 10, with only a couple here and there that go above that. Meaning that are data reaches a nice high frequency point where a lot of my data is going to be centered at. As demonstrated by these histograms below.

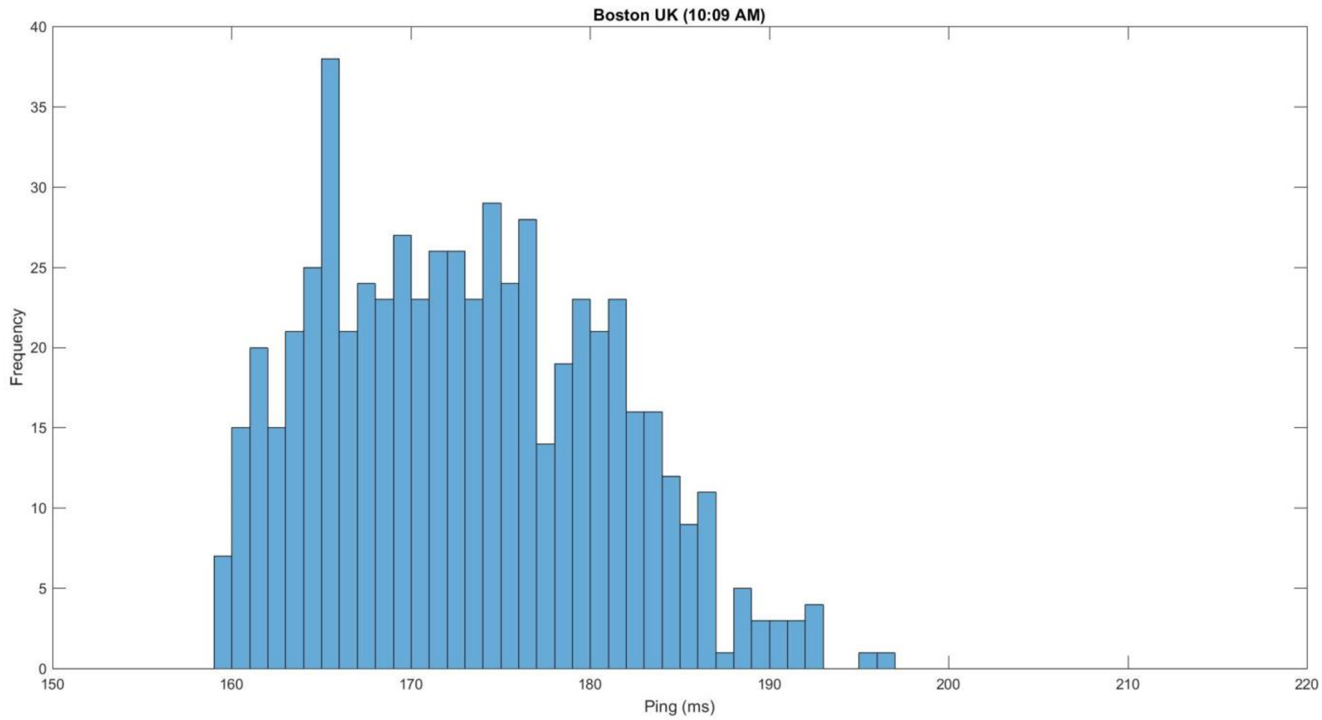

Figure 1

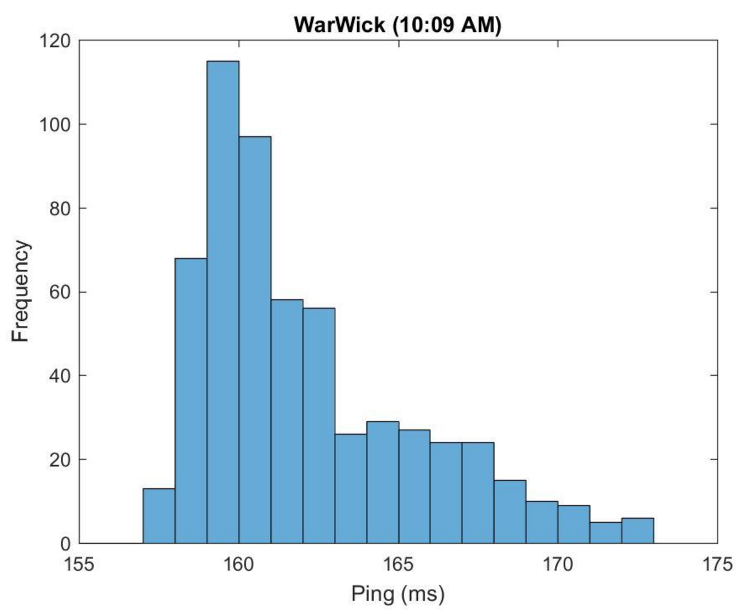

Figure 2

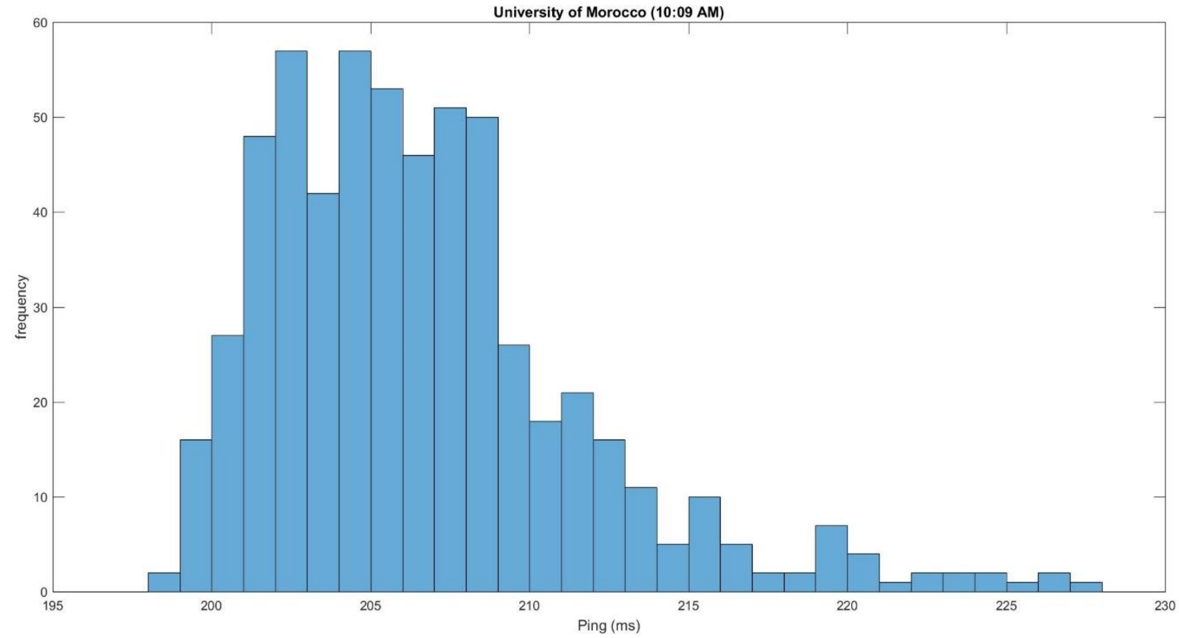

Figure 3

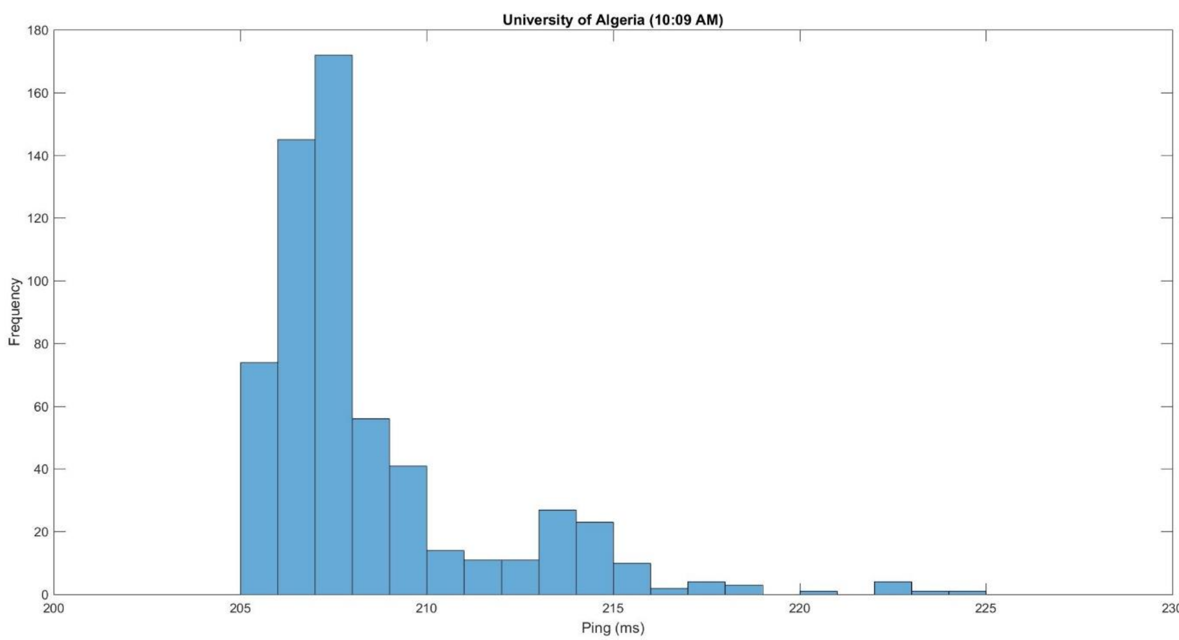

Figure 4

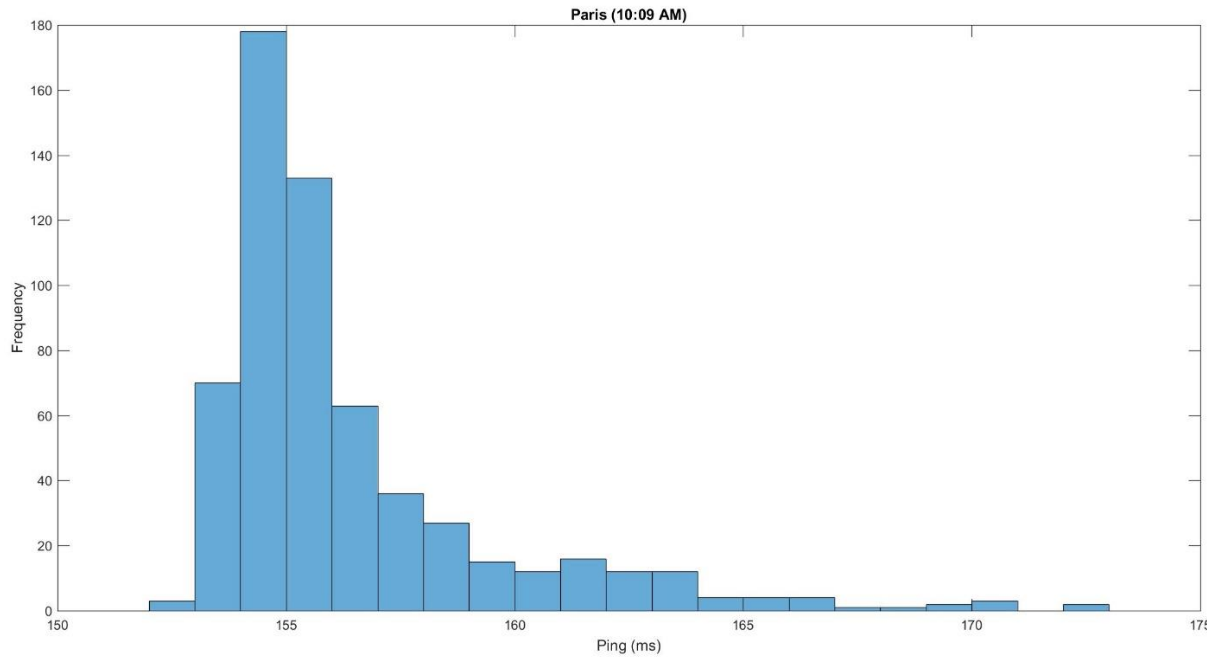

Figure 5

As you can see from figures 2through 5 they each have a very identifiable mean, unlike figure 1 where the data is more spread out. Due to a heavy portion of the data being spread out between 160ms and 190ms I feel like the server located in United Kingdom, Boston might be very unreliable. When comparing it to a server from say Paris where the mean is more centered around one value, I think it is a fair assumption to say that it is a very reliable server since the ping time is more constant. I would like to say a reliable connection and a good connection are not the same thing, and that when I say reliable I mean a constant connection.

The next thing I'd like to compare is multiple data sets to each other, and to see if we can compare the network infastructure. The way I'm going to do this is since I picked servers along the same latitude, it should for the most part make any differences in distance negligable. To visualize this is as s graph I layered an entire data set onto one histogram, and did this multiple times. This way you can see an entire data set and see the difference in their mean ping times;as well as, you get to see the distribution of all of them to see how far apart they are.

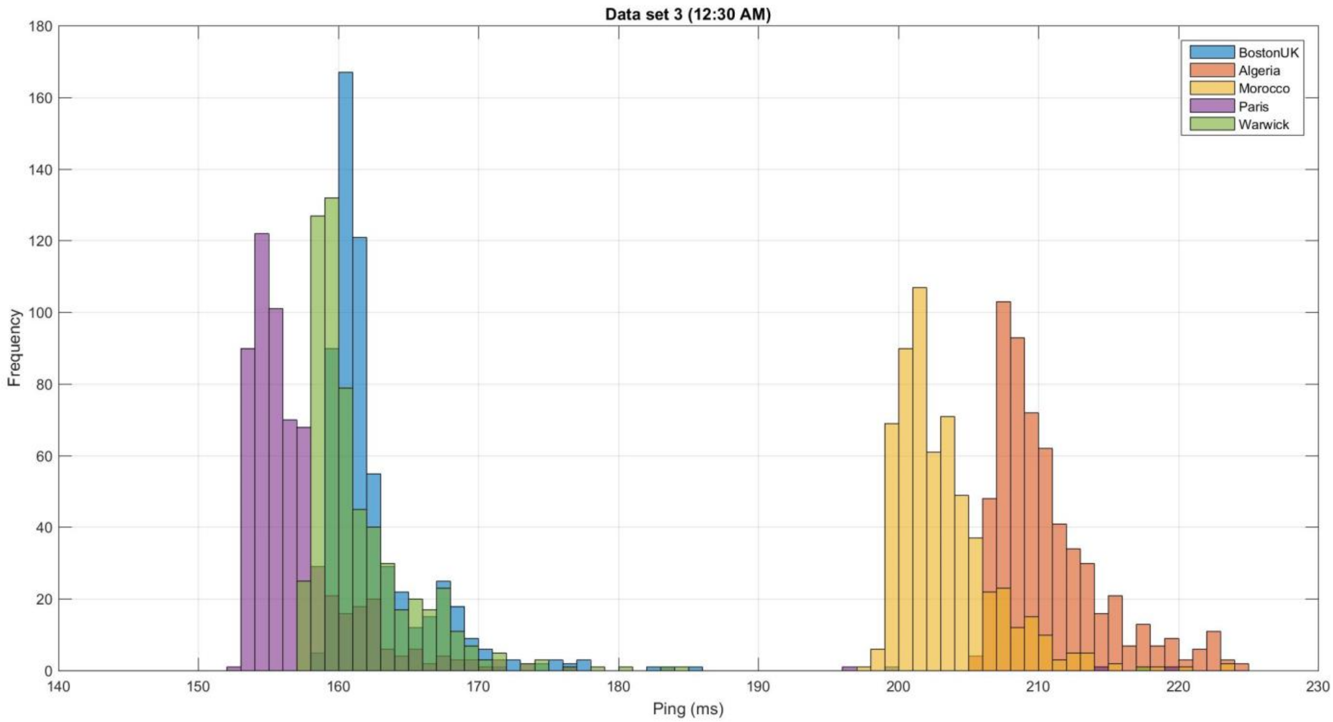

Figure 6

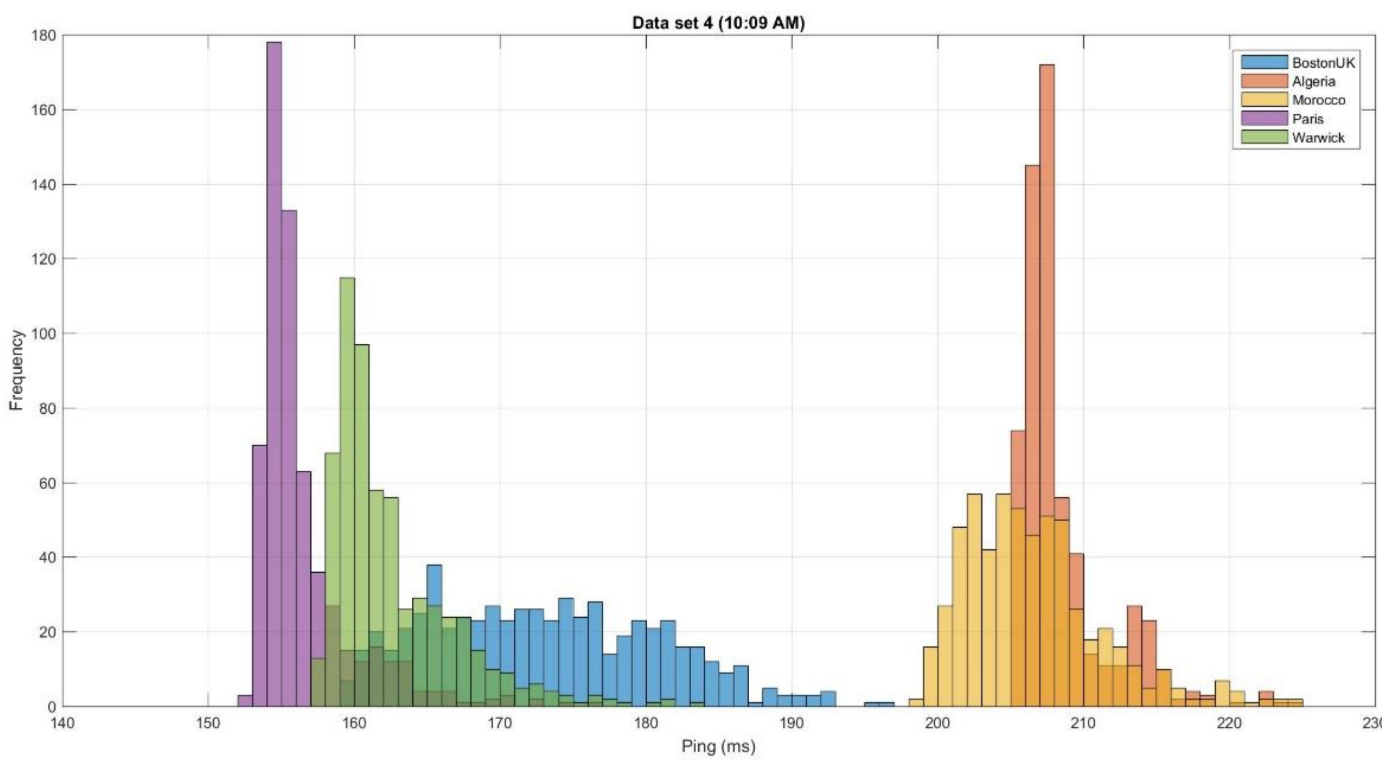

Figure 7

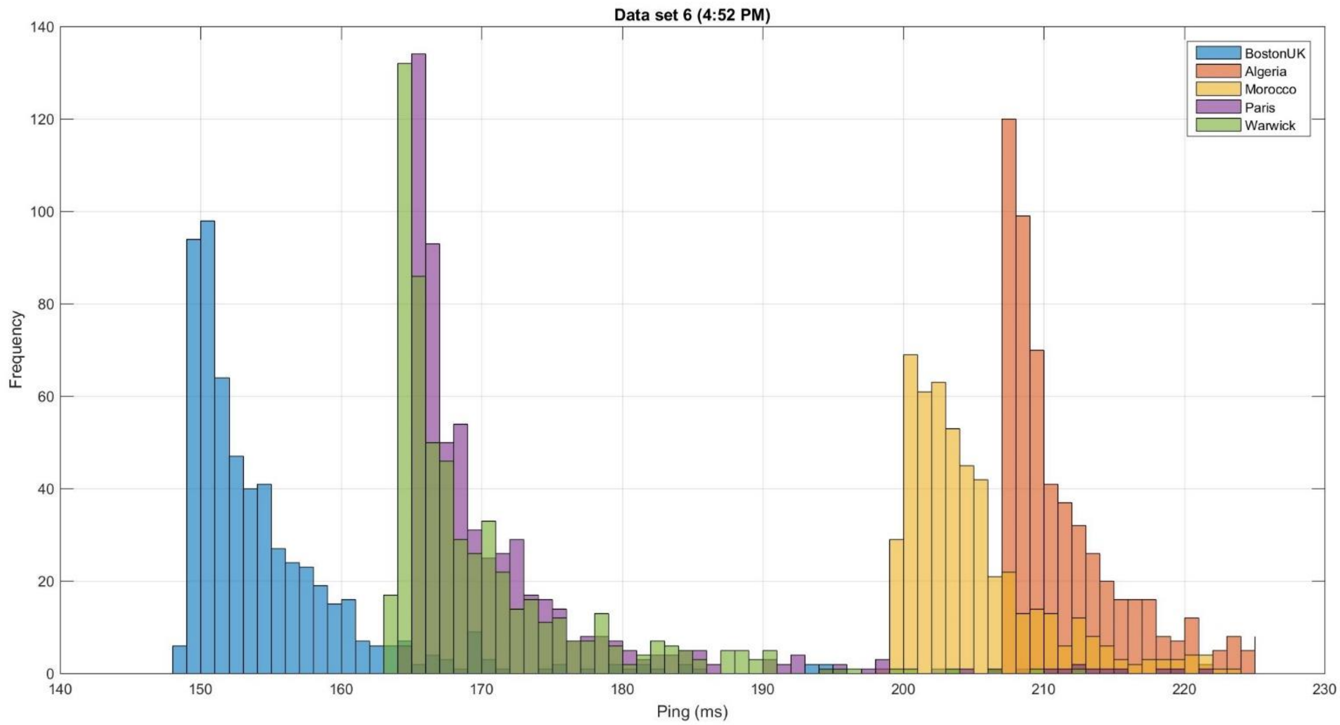

Figure 8

Looking at figures six, seven, and eight you can clearly see a heavy divide in the distribution of the data. The servers based in Boston United Kingdom, Warwick, and Paris performed roughly 50ms to 70ms better than Morocco and Algeria. Now granted that Morocco and Algeria are about 400 to 700 miles further away than Boston United Kingdom, Warwick, and Paris I don't think that the gap in pings should be that far apart. If we just look at Paris and Morocco in figure 7 there is around a 65ms ping difference, and these two are only 400 miles apart. Could this be due to heavy traffic at a certain time? I don't think so either, because if we look at figures 6 and 8 we see that the data for Morocco remains very reliable staying around 200ms to 210ms.

1.3 Conclusion

Therefore what makes sense to me is that the network infrastructure in Morocco is not very good. It may be that they have out dated cables such as copper to make their connections work. While Paris might have Fiber-Optic or Fiber Light for their infrastructure which is much faster. In the future it would be interesting to do more testing; such as, taking 24 samples one every hour for a week to get a better idea of the traffic loads these networks face. Comparing them to see which countries are most active at certain times. Also I could possibly select servers that are the exact same distance from San Francisco, and redoing this test to confirm that my intuition about the Morocco and Algeria servers having outdated cables.

2.0 Introduction Problem Two

In this second part we will be investigating the method of measuring short processor times using the clock () or time () function. The clock () function depends heavily on your processor. So if you have a very fast processor your clock will increment faster and will therefore be more accurate. It's here where we get into how to measure such a small and fast running program like the clock () function. To do this we need to be able to run it a large number of times and divide the time by the number of times it has been ran. This will give us a good idea of how are clock function is performing.

2.1 Method and Software used Problem Two

Software used includes Dev-C++ which is a free open source compiler for running C++ programs. To solve for the amount of times (N) we need to iterate through the program to get an error that is less than 1%, we use the formula ((2*r)/(T*eMax)) < N. And then with this N when you run it you will get an error of less than eMax.

2.2 Experiment Data and Analysis

r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1
r = 0.001 sec Clock increment = 1

Razer Blade stealth Clock time (2.6 GHz) = 2002 iterations
CLOCKS_PER_SEC = 1000
Clock increment min,ave,max = 1 , 1.0005 , 2
r = 0.0010005 sec, 1/r = 999.501 increments per sec

How I found what value of N to run was by using the equation, (2r)/(T * Emax) < N. Evaluating this equation we get:

$$(2 * r) / (T * Emax) < N$$

$$= (2 * 0.0010005) / (0.0001 * .01) < N$$

$$= (0.002001) / (0.0001 * 0.01) < N$$

$$= 2001 < N$$

Therefore, to get an error that is less than 1% we must have at least more than 2001 iterations. Now when we compare this to a machine 10 to 15 years ago we see some amazing things.

Looking at the data in the reader (pg.46, 47), we see that a 1.7GHz Pentium Windows XP machine has an r value of 0.015625, and increments 64 times per second. Comparing this machine to my machine we can see that my system increments the clock 935.501 times per second, with an r value that is 15 times faster than the 1.7GHz Pentium Windows XP machine.

2.4 Conclusion

This experiment concludes that over the years from 1998 to 2016 computers have become faster. This experiment specifically tested the clock function which directly relates to the processor. As you can see the processors from 16 to 18 years ago are at least 10 times slower, as their clocks only update 64 times per second. While my computers clock updates 999 times per second, which is a huge leap in processor speeds.

Appendix

Program used in part 2 to determine the clock speed

```
//By Matthew Wishoff
// 2/20/16

#include <iostream>
#include <time.h>
#define N 2002


double sec(clock_t& c)
{
	return double(c=clock())/CLOCKS_PER_SEC;
}

using namespace std;

int main()
{
	double T1, T2, r = 0.0, c, cave = 0.0, cmin = 999999.0, cmax = 0.0;
	clock_t c1, c2;

	for(int i = 1; i <= N; i++)
	{
		T1 = T2 = sec(c2);
		c1 = c2;
		while(T2 == T1)
		{
			T2 = sec(c2);
		}

		r += (T2 - T1);
		cave += (c = c2 - c1);

		if( c > cmax )
		{
			cmax = c;
		}
		else if(c < cmin )
```

```
		{
			cmin = c;
		}

		if( N - i < 11)
		{
			std::cout << "\nr = " << T2-T1 << " sec Clock increment = "<< c;
		}
	}
	r /= N; cave /= N;

	cout << "\n\nRazer Blade stealth Clock time (2.6 GHz) = " << N
			<< " iterations\nCLOCKS_PER_SEC = " << CLOCKS_PER_SEC
			<< "\nClock increment min,ave,max = "
			<< cmin << " , " << cave << " , " << cmax
			<< "\nr = " << r << " sec, 1/r = "
			<< 1./r << " increments per sec		\n";
}
```

Batch script used to collect data in part 1

```
@ECHO off
ECHO Program started
echo %DATE:/=-%@%TIME::=-%
start "UnivMorocco" cmd.exe /k "(echo %DATE:/=-%@%TIME::=-% & ping -n 600 www.uca.ma & echo %DATE:/=-%@%TIME::=-%) >> log/UnivMorocco.txt & exit"
start "UnivAlger" cmd.exe /k "(echo %DATE:/=-%@%TIME::=-% & ping -n 600 univ-alger.dz & echo %DATE:/=-%@%TIME::=-%) >> log/UnivAlgeria.txt & exit"
start "UnivParis" cmd.exe /k "(echo %DATE:/=-%@%TIME::=-% & ping -n 600 www.univ-paris1.fr & echo %DATE:/=-%@%TIME::=-%) >> log/UnivParis.txt & exit"
start "WarWick" cmd.exe /k "(echo %DATE:/=-%@%TIME::=-% & ping -n 600 warwick.ac.uk & echo %DATE:/=-%@%TIME::=-%) >> log/Warwick.txt & exit"
start "BostonUK" cmd.exe /k "(echo %DATE:/=-%@%TIME::=-% & ping -n 600 bton.ac.uk & echo %DATE:/=-%@%TIME::=-%) >> log/BostonUK.txt & exit"
start "MIT" cmd.exe /k "(echo %DATE:/=-%@%TIME::=-% & ping -n 600 turing.mit.edu & echo %DATE:/=-%@%TIME::=-%) >> log/mit.txt & exit"
start "stanford" cmd.exe /k "(echo %DATE:/=-%@%TIME::=-% & ping -n 600 stanford.edu & echo %DATE:/=-%@%TIME::=-%) >> log/standford.txt & exit"
ECHO Program terminated successfully
echo %DATE:/=-%@%TIME::=-%
PAUSE
```