

# HW #3

CS410/510: Introduction to Performance Measurement, Modeling and Analysis

Due February 6, 2019

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## Part A: Hands-on Experience with pthreads(Class Partner : AJ Wood)

- (1) Compare the performance of the sequential version to the performance of the pthreads version. What can you conclude about whether or not one is faster? [hint: use confidence intervals]

The data from the dotproduct programs is included below:

Type	Confidence	Conf. Coef	# Samples	Mean	StdDev	c1	c2	c2-c1
Serial	90%	1.645	30	1130.70	68.47	1110.14	1151.26	41.13
Pthread	90%	1.645	30	1420.07	254.33	1343.68	1496.45	52.77
Serial	95%	1.96	30	1130.70	68.47	1106.20	1155.20	49.00
Pthread	95%	1.96	30	1420.07	254.33	1329.06	1511.08	182.02

From this data, it seems evident that the serial program is faster as well as being more "consistent". However, when I looked at the data closer and ran more samples, both the pthread and serial programs have some significant outliers. This is shown in the attached graphs. By running more samples(>1000), I saw that there is a regularity to the outliers. My conclusion is that there is an OS timer interrupting the execution and that the pthread version is more susceptible to these interruptions and that improvements in the code may produce different results where the pthread version could have better performance.

- (2) How many runs do you need to measure to be able to specify a reasonable confidence interval at 90% confidence? At 95% confidence?  
 To find the number of runs, I use the pthread program data as this has the larger standard deviation - which is consistent with the larger impact the OS interrupts have on the run times. I also use 5% as a reasonable level of confidence.

At 90%:

$$n = (z_{1-\alpha/2} \times s/e \times \bar{x})^2 = (1.65 \times 254.33) / (0.05 \times 1420.07)^2 = 35 \text{ samples}$$

At 95%:

$$n = (z_{1-\alpha/2} \times s/e \times \bar{x})^2 = (1.96 \times 254.33) / (0.05 \times 1420.07)^2 = 50 \text{ samples}$$

**Part B: Using python for statistics** *Write python code to solve the following problems.*

- (1) Comparing 3 servers

Program	S1 exec time (sec)	S2 exec time (sec)	S3 exec time (sec)	# Instructions
1	33.4	28.8	28.3	$1.45 \times 10^{10}$
2	19.9	22.1	25.3	$7.97 \times 10^9$
3	6.5	5.3	4.7	$3.11 \times 10^9$
4	84.3	75.8	80.1	$3.77 \times 10^{10}$
5	101.1	99.4	7.2	$4.56 \times 10^{10}$

- a Calculate the mean for the 3 different Systems S1, S2, S3

Mean for the 3 different systems S1, S2, S3

S1 Mean = 49.040000

S2 Mean = 46.280000

S3 Mean = 29.120000

- b Calculate the average across the 3 systems of the MIPS rate for each of Programs 1-5

Average across the 3 systems of the MIPS rate for each of Program

```

Program 1 | RunTime Mean: 30.166667(sec) MIPS Mean: 480.662983(MIPS)
Program 2 | RunTime Mean: 22.433333(sec) MIPS Mean: 355.274889(MIPS)
Program 3 | RunTime Mean: 5.500000(sec) MIPS Mean: 565.454545(MIPS)
Program 4 | RunTime Mean: 80.066667(sec) MIPS Mean: 470.857619(MIPS)
Program 5 | RunTime Mean: 69.233333(sec) MIPS Mean: 658.642273(MIPS)

```

- c Using S3 as the basis system, calculate the average speedup for S1 and S2

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Average speedup for S1 and S2 with S3 as baseline
S1 Average Speed up = -68.406593%
S2 Average Speed up = -58.928571%

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- d Determine the coefficient of variation of the execution times for each of the 3 systems

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Coefficient of variation of the execution times
S1 Coef. of Variation = 0.844275
S2 Coef. of Variation = 0.854986
S3 Coef. of Variation = 1.043166

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## (2) Reporting Meaningful Results

We want to determine, on average, how long it takes to write a file of a particular size to a disk drive.

We take 8 measurements: 8.0 7.0 5.0 9.0 9.5 11.3 5.2 8.5

- a Calculate a 90% confidence interval for the mean time.

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8 sample t-score = 1.895 (from df = 7 and A = 0.05)
90% confidence interval for mean time(c1, c2) = (6.500573, 9.374427)

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- b How many measurements would be required to be 90% confident that the mean value is within 7% of the actual value?

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Measurements for 90% confidence with 7% error
n = 15

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PThread DotProduct Program Data



Serial DotProduct Program RunTime Data

