

Brian Laccone
CS 475
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laccone@oregonstate.edu

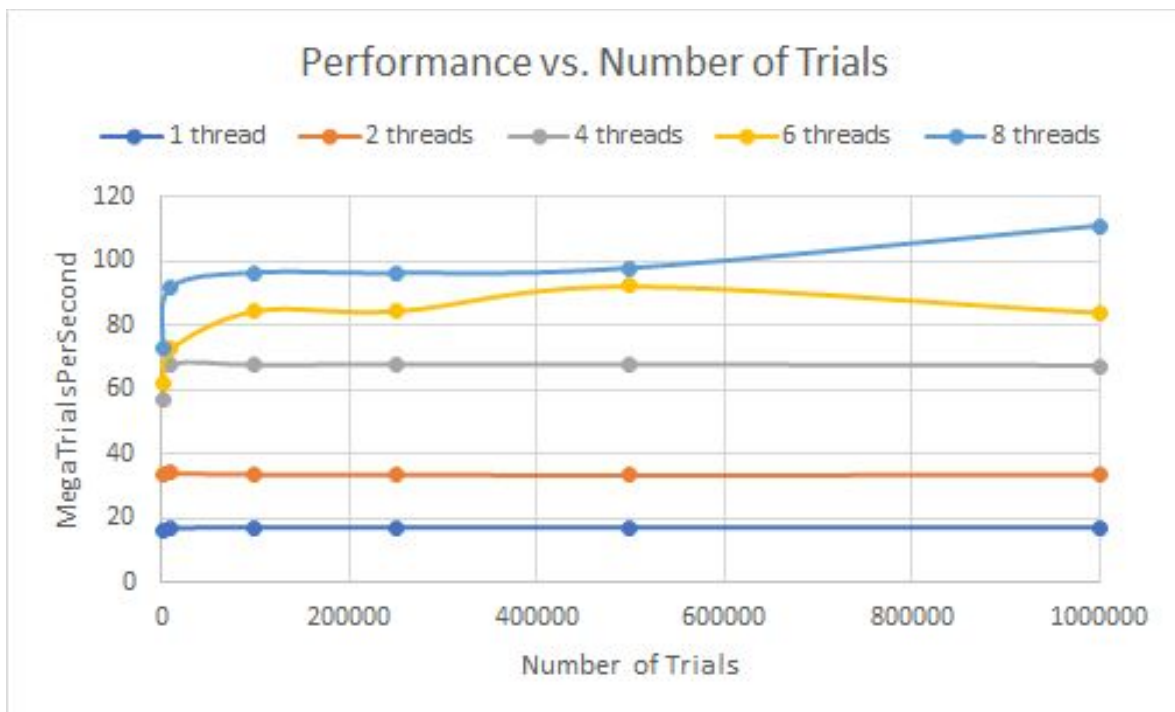
Project 1

*All project 1 executions were run on Flip 3.

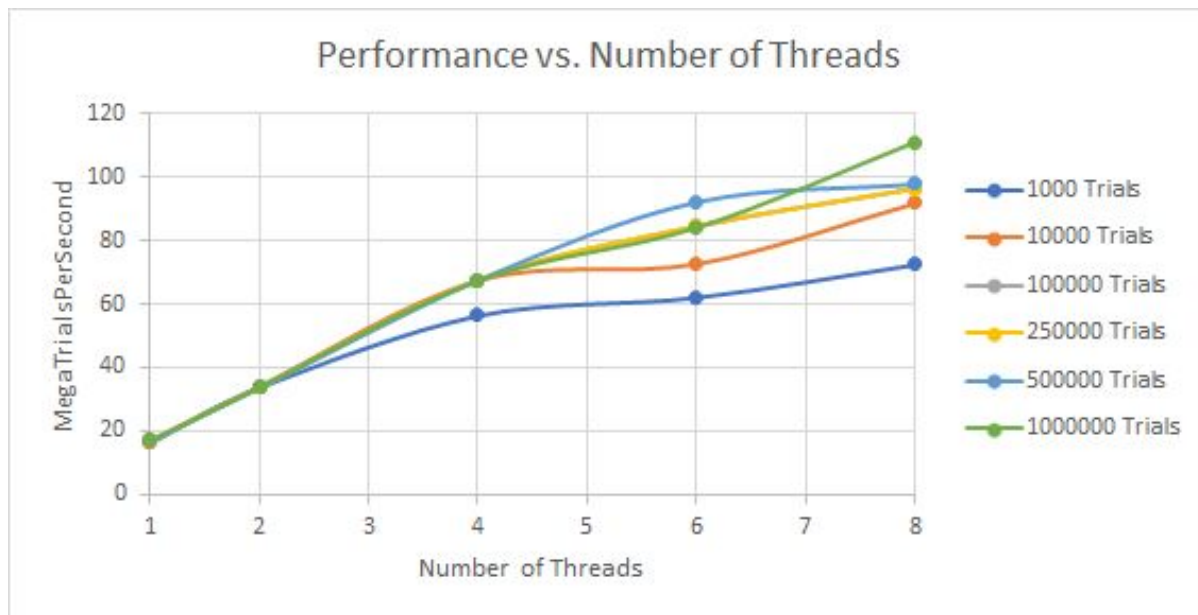
Table

	A	B	C	D	E	F	G
1		1000	10000	100000	250000	500000	1000000
2	1	16.22359	16.71584	16.9645	16.9324	16.96166	16.87211
3	2	33.69553	33.96541	33.84296	33.83694	33.74016	33.83614
4	4	56.48894	67.49154	67.49154	67.63537	67.64516	67.33331
5	6	62.2459	72.73688	84.6107	84.52184	92.24013	84.02203
6	8	72.6483	91.92208	96.49756	96.34119	97.87263	110.9536

Graph A: Performance vs. Number of Trials



Graph B: Performance vs. Number of Threads



Probability

Based on the results of all the threads running 1000000 trials, my guess is that the probability is around 19 percent. All the threads were almost identical at 0.19, so I will guess around 19%, give or take a few percentages. Going into this project, I would have thought the probability would have been close to 25% since there are 4 possibilities that could happen but the rng positioning could have thrown this percentage off slightly. It is also very possible that there is a reason, that I'm not thinking of, as to why the percentages aren't equal for the 4 possibilities.

Parallel Fraction

*Speedups will be based on the 1 million trial run for each thread

2 threads

$$S = 33.836136 / 16.872110 = 2.005$$

$$Fp = (2 / (2 - 1)) * (1 - 1 / 2.005) = 1.00249$$

4 threads

$$S = 67.333305/16.872110 = 3.9908$$

$$Fp = (4/(4-1)) * (1-1/3.9908) = 0.9992$$

6 threads

$$S = 84.022026/16.872110 = 4.9799$$

$$Fp = (6/(6-1)) * (1-1/4.9799) = 0.95903$$

8 threads

$$S = 110.95636/16.872110 = 6.5763$$

$$Fp = (8/(8-1)) * (1-1/6.5763) = 0.96907$$

Results Discussion

Most of Project 1 worked exactly like I would have expected it to. The more threads that I used the faster the program ran. The graphs show a nice speed progression when using more threads. There was one result that I thought was a little weird. When running 500,000 trials with 6 threads, it ran quite a bit faster than the rest of the trials for 6 threads. My guess is that this was a fluke and somehow caught a moment when there was no traffic on Flip 3. Most of the other results were pretty expected because the more you are able to use multiple threads the faster the program should run. The Speedup and Parallel Fraction results were for the most part expected. Running 2 threads was the only weird result because I got a speed up of 2 and an Fp of 1 which is very good but also makes me wonder how it was so good. It may have been another fluke result or perfect timing because I would expect some overhead to exist and have the Fp range be more like .95-.99. Assuming that I wrote the program correctly, the probability was almost exactly the same for most of the high trial runs for each thread that I ran. I am very curious to know what the exact probability is and if I wrote the program correctly.

Program Output Screenshots

1 thread

```
flip3 ~/CS475/project_1 164% ls
proj1 project1_laccone.c
flip3 ~/CS475/project_1 165% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 166% ./proj1
Number of threads = 1
Number of trials = 1000
Probability of hitting the plate = 0.199000
Performance = 16.223587
flip3 ~/CS475/project_1 167% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 168% ./proj1
Number of threads = 1
Number of trials = 10000
Probability of hitting the plate = 0.185200
Performance = 16.715837
flip3 ~/CS475/project_1 169% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 170% ./proj1
Number of threads = 1
Number of trials = 100000
Probability of hitting the plate = 0.190050
Performance = 16.964499
flip3 ~/CS475/project_1 171% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 172% ./proj1
Number of threads = 1
Number of trials = 250000
Probability of hitting the plate = 0.190692
Performance = 16.932400
flip3 ~/CS475/project_1 173% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 174% ./proj1
Number of threads = 1
Number of trials = 500000
Probability of hitting the plate = 0.190204
Performance = 16.961655
flip3 ~/CS475/project_1 175% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 176% ./proj1
Number of threads = 1
Number of trials = 1000000
Probability of hitting the plate = 0.190622
Performance = 16.872110
flip3 ~/CS475/project_1 177% █
```

2 threads

```
flip3.engr.oregonstate.edu - PuTTY
proj1 project1_laccone.c
flip3 ~/CS475/project_1 177% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 178% ./proj1
Number of threads = 2
Number of trials = 1000
Probability of hitting the plate = 0.164000
Performance = 33.695534
flip3 ~/CS475/project_1 179% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 180% ./proj1
Number of threads = 2
Number of trials = 10000
Probability of hitting the plate = 0.189600
Performance = 33.965412
flip3 ~/CS475/project_1 181% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 182% ./proj1
Number of threads = 2
Number of trials = 100000
Probability of hitting the plate = 0.189860
Performance = 33.842964
flip3 ~/CS475/project_1 183% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 184% ./proj1
Number of threads = 2
Number of trials = 250000
Probability of hitting the plate = 0.190688
Performance = 33.836937
flip3 ~/CS475/project_1 185% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 186% ./proj1
Number of threads = 2
Number of trials = 500000
Probability of hitting the plate = 0.189406
Performance = 33.740158
flip3 ~/CS475/project_1 187% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 188% ./proj1
Number of threads = 2
Number of trials = 1000000
Probability of hitting the plate = 0.190595
Performance = 33.836136
flip3 ~/CS475/project_1 189% █
```


4 threads

```
flip3.engr.oregonstate.edu - PuTTY
flip3 ~/CS475/project_1 194% ls
proj1 project1_laccone.c
flip3 ~/CS475/project_1 195% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 196% ./proj1
Number of threads = 4
Number of trials = 1000
Probability of hitting the plate = 0.175000
Performance = 56.488941
flip3 ~/CS475/project_1 197% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 198% ./proj1
Number of threads = 4
Number of trials = 10000
Probability of hitting the plate = 0.188200
Performance = 66.586166
flip3 ~/CS475/project_1 199% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 200% ./proj1
Number of threads = 4
Number of trials = 100000
Probability of hitting the plate = 0.192030
Performance = 67.491539
flip3 ~/CS475/project_1 201% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 202% ./proj1
Number of threads = 4
Number of trials = 250000
Probability of hitting the plate = 0.191460
Performance = 67.635368
flip3 ~/CS475/project_1 203% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 204% ./proj1
Number of threads = 4
Number of trials = 500000
Probability of hitting the plate = 0.190992
Performance = 67.645157
flip3 ~/CS475/project_1 205% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 206% ./proj1
Number of threads = 4
Number of trials = 1000000
Probability of hitting the plate = 0.189973
Performance = 67.333305
flip3 ~/CS475/project_1 207% █
```

6 threads

```
flip3.engr.oregonstate.edu - PuTTY
flip3 ~/CS475/project_1 213% ls
proj1 project1_laccone.c
flip3 ~/CS475/project_1 214% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 215% ./proj1
Number of threads = 6
Number of trials = 1000
Probability of hitting the plate = 0.179000
Performance = 62.245903
flip3 ~/CS475/project_1 216% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 217% ./proj1
Number of threads = 6
Number of trials = 10000
Probability of hitting the plate = 0.193800
Performance = 72.736877
flip3 ~/CS475/project_1 218% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 219% ./proj1
Number of threads = 6
Number of trials = 100000
Probability of hitting the plate = 0.190930
Performance = 84.610695
flip3 ~/CS475/project_1 220% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 221% ./proj1
Number of threads = 6
Number of trials = 250000
Probability of hitting the plate = 0.191124
Performance = 84.521843
flip3 ~/CS475/project_1 222% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 223% ./proj1
Number of threads = 6
Number of trials = 500000
Probability of hitting the plate = 0.190862
Performance = 92.240128
flip3 ~/CS475/project_1 224% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 225% ./proj1
Number of threads = 6
Number of trials = 1000000
Probability of hitting the plate = 0.190139
Performance = 84.022026
flip3 ~/CS475/project_1 226% █
```

8 threads

```
flip3 ~/CS475/project_1 242% ls
proj1 project1_laccone.c
flip3 ~/CS475/project_1 243% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 244% ./proj1
Number of threads = 8
Number of trials = 1000
Probability of hitting the plate = 0.155000
Performance = 72.648300
flip3 ~/CS475/project_1 245% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 246% ./proj1
Number of threads = 8
Number of trials = 10000
Probability of hitting the plate = 0.195100
Performance = 91.922081
flip3 ~/CS475/project_1 247% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 248% ./proj1
Number of threads = 8
Number of trials = 100000
Probability of hitting the plate = 0.190070
Performance = 96.497559
flip3 ~/CS475/project_1 249% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 250% ./proj1
Number of threads = 8
Number of trials = 250000
Probability of hitting the plate = 0.190660
Performance = 96.341187
flip3 ~/CS475/project_1 251% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 252% ./proj1
Number of threads = 8
Number of trials = 500000
Probability of hitting the plate = 0.190554
Performance = 97.872627
flip3 ~/CS475/project_1 253% g++ -o proj1 project1_laccone.c -lm -fopenmp
flip3 ~/CS475/project_1 254% ./proj1
Number of threads = 8
Number of trials = 1000000
Probability of hitting the plate = 0.190498
Performance = 110.953636
flip3 ~/CS475/project_1 255%
```