Project #1

OpenMP: Monte Carlo Simulation

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1. Tables and Graphs

Table

Table 1: DATA COLLECTION

NUMT	NUMTRIAL	PROBABILITY	MAXPERFORMANCE
1	1	0.00%	1.31
1	10	10.00%	7.59
1	100	29.00%	13.89
1	1000	31.70%	15.34
1	10000	29.24%	15.43
1	100000	29.37%	15.34
1	500000	29.13%	15.34
1	1000000	29.14%	15.1
2	1	0.00%	0.52
2	10	10.00%	6.23
2	100	21.00%	19.36
2	1000	27.90%	29.58
2	10000	29.26%	30.41
2	100000	28.96%	30.47
2	500000	29.15%	30.27
2	1000000	29.10%	30.34
4	1	0.00%	0.47
4	10	30.00%	4.42
4	100	35.00%	28.91
4	1000	28.70%	53.15
4	10000	28.87%	41.01
4	100000	29.06%	60.83
4	500000	29.02%	60.85
4	1000000	29.10%	60.7
8	1	0.00%	0.38

NUMT	NUMTRIAL	PROBABILITY	MAXPERFORMANCE
8	10	30.00%	3.83
8	100	25.00%	27.36
8	1000	29.30%	69.09
8	10000	29.10%	80.3
8	100000	28.89%	89.46
8	500000	28.94%	121.2
8	1000000	29.02%	120.74

Then make a Pivot table for visualization, the row label is NUMTRIALS and the column label is NUMTS.

Table 2: PIVOT TABLE

	1	10	100	1000	10000	100000	500000	1000000
1	1.31	7.59	13.89	15.34	15.43	15.34	15.34	15.1
2	0.52	6.23	19.36	29.58	30.41	30.47	30.27	30.34
4	0.47	4.42	28.91	53.15	41.01	60.83	60.85	60.7
8	0.38	3.83	27.36	69.09	80.3	89.46	121.2	120.74

Graphs

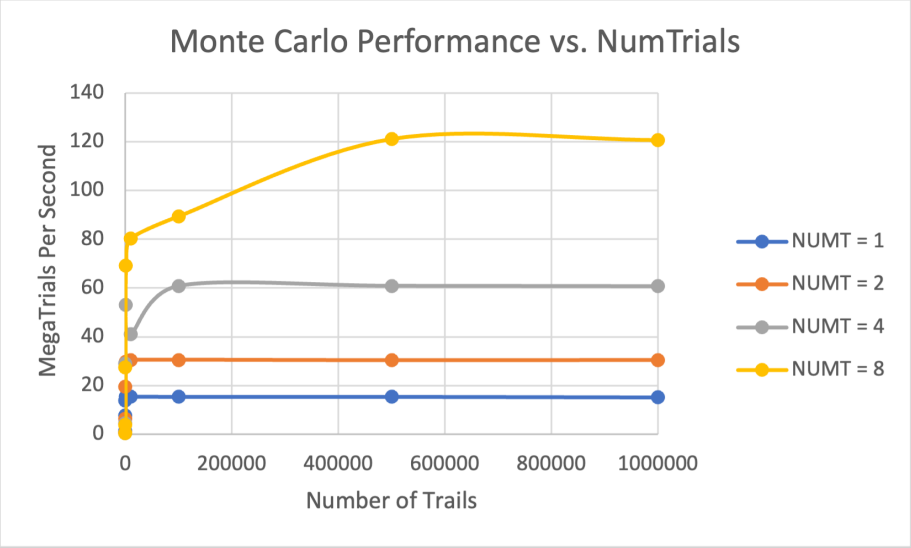

Figure 1: Performance versus the number of Monte Carlo trials

I ran this Monte Carlo simulation on flip3.

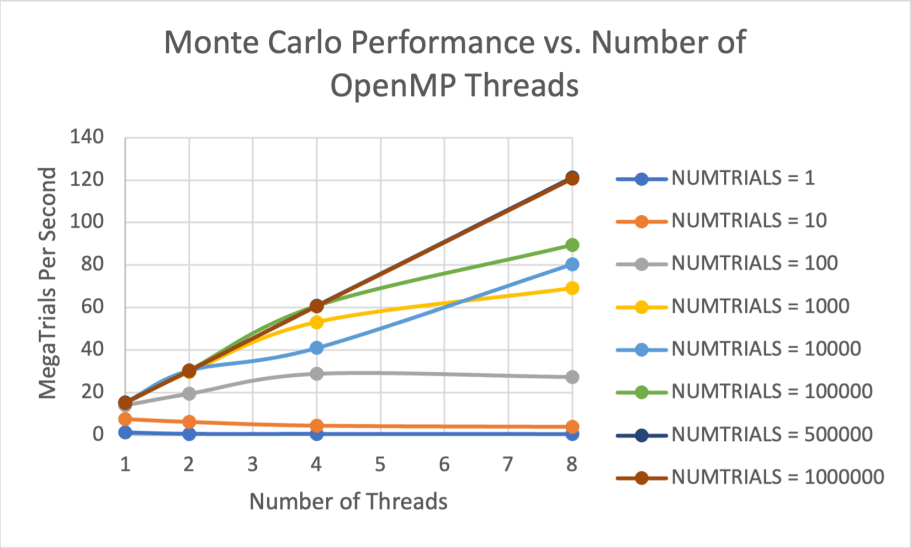

Figure 2: Performance versus the number of OpenMP threads

2. Actual Probability

I choose the one with maximum number of trials to get the actual probability. As it can be seen in Table 1, the actual probability is about 29.1. Since in Monte Carlo simulation, with the number of trails increasing, the probability will be more reliable and close to the true probability.

3. Parallel Fraction Computation

According to Amdahl's Law:

$$S = \frac{P_n}{P_1} = \frac{1}{\frac{F_p}{n} + (1 - F_p)}$$

Solving for F:

$$F = \frac{n}{(n-1)}(1 - \frac{1}{S}) = \frac{n}{(n-1)}\frac{P_n - P_1}{P_n}$$

Where P_1 and P_n stand for Performance.

Using number of trails equaling to 100000 to calculate the parallel fraction as a example.

$$F_{p,2} = \frac{n}{(n-1)} \frac{P_n - P_1}{P_n} = \frac{2}{(2-1)} \frac{30.47 - 15.34}{30.34} = 0.99736$$

$$F_{p,4} = \frac{n}{(n-1)} \frac{P_n - P_1}{P_n} = \frac{4}{(4-1)} \frac{60.83 - 15.34}{60.83} = 0.99710$$

$$F_{p,8} = \frac{n}{(n-1)} \frac{P_n - P_1}{P_n} = \frac{8}{(8-1)} \frac{89.46 - 15.34}{89.46} = 0.94689$$

$$\bar{F_p} = \frac{\sum_{i=2}^{N} F_{p,i}}{N-1} = \frac{0.99736 + 0.99710 + 0.94689}{3} = 0.98045$$

And do calculations for all number of trials in Excel.

Table 3: Parallel Fraction Computation

NumTrails	Parallel Fraction
100	0.606821278
1000	0.933477553
10000	0.9133738
100000	0.979030461
500000	0.993956624
1000000	1.002063609
Average	0.904787221

So, the average parallel fraction is 0.9048.