OpenMP:MonteCarlo Simulation

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Machine Configuration

```
rabbit ~ 1003$ lscpu
Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Little Endian
CPU(s):                32
On-line CPU(s) list:   0-31
Thread(s) per core:    2
Core(s) per socket:    8
Socket(s):             2
NUMA node(s):          2
Vendor ID:             GenuineIntel
CPU family:            6
Model:                 63
Model name:            Intel(R) Xeon(R) CPU E5-2630 v3 @ 2.40GHz
Stepping:              2
CPU MHz:               1200.000
CPU max MHz:           3200.0000
CPU min MHz:           1200.0000
BogoMIPS:              4800.00
Virtualization:        VT-x
L1d cache:             32K
L1i cache:             32K
L2 cache:              256K
L3 cache:              20480K
NUMA node0 CPU(s):     0,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30
NUMA node1 CPU(s):     1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31
Flags:                 fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush d
ts acpi mmx fxsr sse sse2 ss ht tm pbe syscall nx pdpe1gb rdtscp lm constant_tsc arch_perfmon pebs bts r
ep_good nopl xtopology nonstop_tsc aperfmperf eagerfpu pni pclmulqdq dtes64 monitor ds_cpl vmx smx est t
m2 ssse3 sdbg fma cx16 xtpr pdcm pcid dca sse4_1 sse4_2 x2apic movbe popcnt tsc_deadline_timer aes xsave
 avx f16c rdrand lahf_lm abm epb invpcid_single ssbd ibrs ibpb stibp tpr_shadow vnmi flexpriority ept vp
id fsgsbase tsc_adjust bmi1 avx2 smep bmi2 erms invpcid cqm xsaveopt cqm_llc cqm_occup_llc dtherm ida ar
at pln pts md_clear spec_ctrl intel_stibp flush_l1d
```

Software

```
rabbit ~ 1004$ g++ --version
g++ (GCC) 4.8.5 20150623 (Red Hat 4.8.5-44)
Copyright (C) 2015 Free Software Foundation, Inc.
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
```

Result

```
rabbit ~/CS575ParallelProgramming/week2 1011$ cat proj1.csv
 1 threads :        1 trials ; probability = 100.00% ; megatrials/sec =   0.63
 1 threads :       10 trials ; probability =  40.00% ; megatrials/sec =   4.20
 1 threads :      100 trials ; probability =  18.00% ; megatrials/sec =  11.95
 1 threads :     1000 trials ; probability =  28.00% ; megatrials/sec =  16.41
 1 threads :    10000 trials ; probability =  29.65% ; megatrials/sec =  13.90
 1 threads :   100000 trials ; probability =  29.09% ; megatrials/sec =  13.80
 1 threads :   500000 trials ; probability =  29.29% ; megatrials/sec =  13.79
 1 threads :  1000000 trials ; probability =  29.14% ; megatrials/sec =  13.80
 2 threads :        1 trials ; probability = 100.00% ; megatrials/sec =   0.42
 2 threads :       10 trials ; probability =  20.00% ; megatrials/sec =   3.06
 2 threads :      100 trials ; probability =  31.00% ; megatrials/sec =  17.24
 2 threads :     1000 trials ; probability =  28.10% ; megatrials/sec =  34.41
 2 threads :    10000 trials ; probability =  29.92% ; megatrials/sec =  27.94
 2 threads :   100000 trials ; probability =  28.94% ; megatrials/sec =  27.61
 2 threads :   500000 trials ; probability =  29.05% ; megatrials/sec =  27.60
 2 threads :  1000000 trials ; probability =  29.14% ; megatrials/sec =  27.52
 4 threads :        1 trials ; probability =   0.00% ; megatrials/sec =   0.34
 4 threads :       10 trials ; probability =  40.00% ; megatrials/sec =   3.07
 4 threads :      100 trials ; probability =  30.00% ; megatrials/sec =  20.55
 4 threads :     1000 trials ; probability =  30.90% ; megatrials/sec =  64.12
 4 threads :    10000 trials ; probability =  29.43% ; megatrials/sec =  57.32
 4 threads :   100000 trials ; probability =  29.27% ; megatrials/sec =  54.06
 4 threads :   500000 trials ; probability =  29.19% ; megatrials/sec =  53.79
 4 threads :  1000000 trials ; probability =  29.10% ; megatrials/sec =  54.68
 8 threads :        1 trials ; probability =   0.00% ; megatrials/sec =   0.28
 8 threads :       10 trials ; probability =  10.00% ; megatrials/sec =   2.83
 8 threads :      100 trials ; probability =  31.00% ; megatrials/sec =  19.00
 8 threads :     1000 trials ; probability =  29.30% ; megatrials/sec =  90.67
 8 threads :    10000 trials ; probability =  29.86% ; megatrials/sec = 104.87
 8 threads :   100000 trials ; probability =  28.95% ; megatrials/sec =  99.75
 8 threads :   500000 trials ; probability =  29.19% ; megatrials/sec =  97.43
 8 threads :  1000000 trials ; probability =  29.11% ; megatrials/sec =  98.01
12 threads :        1 trials ; probability =   0.00% ; megatrials/sec =   0.19
12 threads :       10 trials ; probability =  30.00% ; megatrials/sec =   2.49
12 threads :      100 trials ; probability =  29.00% ; megatrials/sec =  18.08
12 threads :     1000 trials ; probability =  28.00% ; megatrials/sec =  92.04
12 threads :    10000 trials ; probability =  28.61% ; megatrials/sec = 154.50
12 threads :   100000 trials ; probability =  29.15% ; megatrials/sec = 139.47
12 threads :   500000 trials ; probability =  29.03% ; megatrials/sec = 137.93
12 threads :  1000000 trials ; probability =  29.09% ; megatrials/sec = 139.39
16 threads :        1 trials ; probability =   0.00% ; megatrials/sec =   0.16
16 threads :       10 trials ; probability =  10.00% ; megatrials/sec =   1.79
16 threads :      100 trials ; probability =  33.00% ; megatrials/sec =  14.65
16 threads :     1000 trials ; probability =  30.20% ; megatrials/sec =  85.69
16 threads :    10000 trials ; probability =  29.11% ; megatrials/sec = 196.75
16 threads :   100000 trials ; probability =  29.05% ; megatrials/sec = 179.36
16 threads :   500000 trials ; probability =  29.03% ; megatrials/sec = 178.02
```

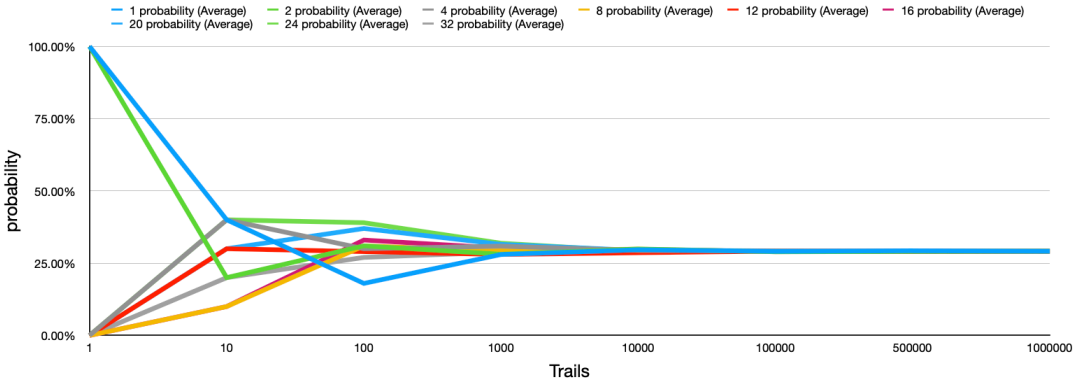
Data Analysis

1:The Probability Around 29%~30%

2:Good graph of performance vs. number of trials

the number of Monte Carlo trials, with the colored lines being the number of OpenMP threads.

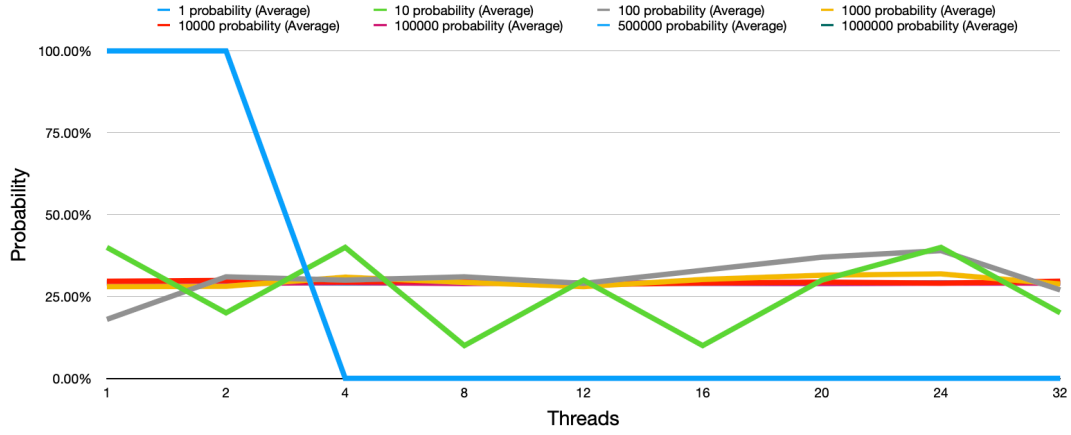
Thread	1	2	4	8	12	16	20	24	32	Grand Total
trail	probability (Average)									
1	100.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**22.22%**
10	40.00%	20.00%	40.00%	10.00%	30.00%	10.00%	30.00%	40.00%	20.00%	**26.67%**
100	18.00%	31.00%	30.00%	31.00%	29.00%	33.00%	37.00%	39.00%	27.00%	**30.56%**
1000	28.00%	28.10%	30.90%	29.30%	28.00%	30.20%	31.50%	31.90%	28.80%	**29.63%**
10000	29.65%	29.92%	29.43%	29.86%	28.61%	29.11%	29.40%	29.07%	29.67%	**29.41%**
100000	29.09%	28.94%	29.27%	28.95%	29.15%	29.05%	28.97%	29.05%	29.10%	**29.06%**
500000	29.29%	29.05%	29.19%	29.19%	29.03%	29.03%	29.01%	29.14%	29.20%	**29.13%**
1000000	29.14%	29.14%	29.10%	29.11%	29.09%	29.10%	29.08%	29.20%	29.07%	**29.11%**
Grand Total	**37.90%**	**37.02%**	**27.24%**	**23.43%**	**25.36%**	**23.69%**	**26.87%**	**28.42%**	**24.10%**	**28.22%**



3: Good graph of performance vs. number of Threads

the number OpenMP threads, with the colored lines being the number of Monte Carlo trials

trail	1	10	100	1000	10000	100000	500000	1000000	Grand Total
Thread	probability (Average)								
1	100.00%	40.00%	18.00%	28.00%	29.65%	29.09%	29.29%	29.14%	**37.90%**
2	100.00%	20.00%	31.00%	28.10%	29.92%	28.94%	29.05%	29.14%	**37.02%**
4	0.00%	40.00%	30.00%	30.90%	29.43%	29.27%	29.19%	29.10%	**27.24%**
8	0.00%	10.00%	31.00%	29.30%	29.86%	28.95%	29.19%	29.11%	**23.43%**
12	0.00%	30.00%	29.00%	28.00%	28.61%	29.15%	29.03%	29.09%	**25.36%**
16	0.00%	10.00%	33.00%	30.20%	29.11%	29.05%	29.03%	29.10%	**23.69%**
20	0.00%	30.00%	37.00%	31.50%	29.40%	28.97%	29.01%	29.08%	**26.87%**
24	0.00%	40.00%	39.00%	31.90%	29.07%	29.05%	29.14%	29.20%	**28.42%**
32	0.00%	20.00%	27.00%	28.80%	29.67%	29.10%	29.20%	29.07%	**24.10%**
Grand Total	**22.22%**	**26.67%**	**30.56%**	**29.63%**	**29.41%**	**29.06%**	**29.13%**	**29.11%**	**28.22%**



4: Comput Fp. The Parallel Fraction

The Parallel Fraction

threads	probability	megatrials	F1	speedup	Fparallel
1	29.14%	13.80	13.80	1.00	0.00
2	29.14%	27.52	13.80	1.99	0.51
4	29.10%	54.68	13.80	3.96	0.77
8	29.11%	98.01	13.80	7.10	0.89
12	29.09%	39.39	13.80	2.85	0.67
20	29.08%	64.23	13.80	4.65	0.81
24	29.20%	93.30	13.80	6.76	0.88
32	29.07%	57.30	13.80	4.15	0.78