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CS 475
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Project 02

Hardware

This experiment was ran on Gentoo Linux with kernel 5.4.28 on a desktop pc with the following hardware configuration:

CPU: AMD Ryzen 7 3800X 8- (16) @ 3.900GHz
GPU: NVIDIA GeForce GTX 1080
Memory: 32078MiB DDR4

Performance Results

The test was to run multiple parallel reductions to compute the volume of a superquadrafic using the equation $x^N + y^N + z^N = 1$ where X = 4. This was done in a C++ program compiled with gcc. The trial was run with 10, 100, 1000, and 10000 subdivisions(NUMNODES). This was done on a single thread, 2, threads, and incremented by 2 up to the 16 threads available to the AMD Ryzen 7 CPU. Performance was measured in Mega Heights per Second (MH/s). The experiment was run partially within the C++ program and with a python3 script which redirects the output of the C++ program to a CSV file which was uploaded to google drive for analysis in Google sheets.

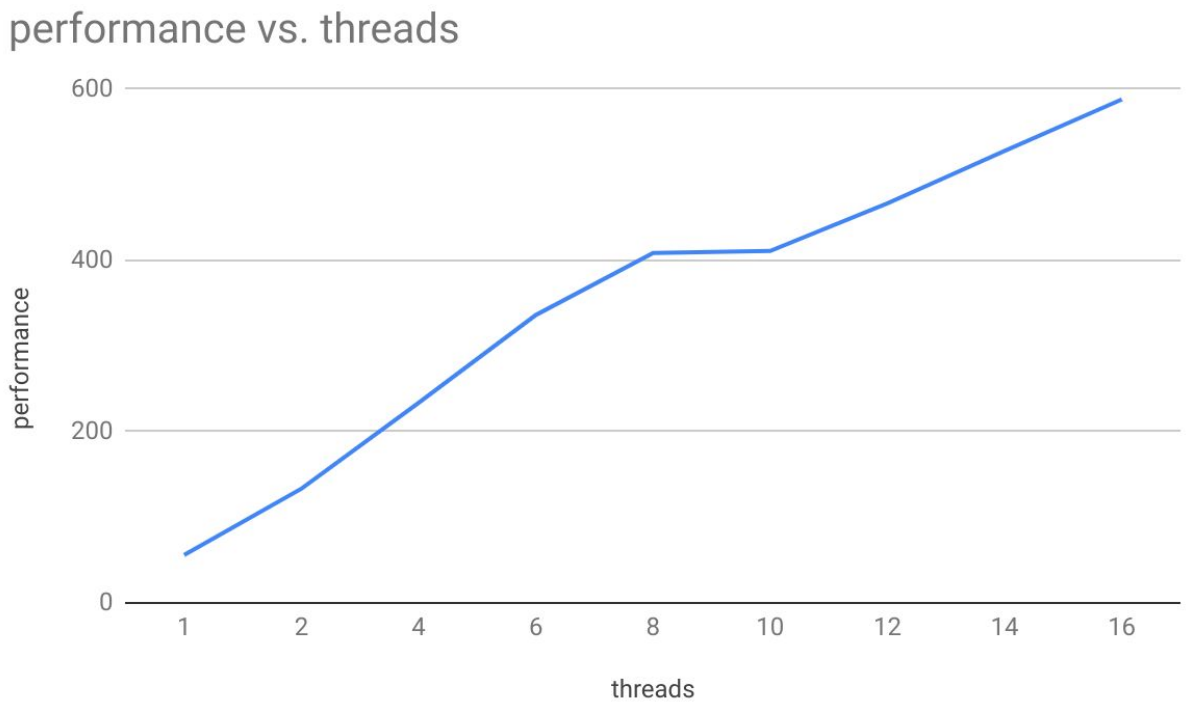
The python3 program can be called with ./run.py
The script compiles and executes the C++ program for each number of trial and thread combinations. The C++ program prints the threads, number of subdivisions(NUMNODES), the average height calculated, and the performance in a comma separated format to be redirected to a CSV file when executed. The script handles the redirects and multiple runs.

Results

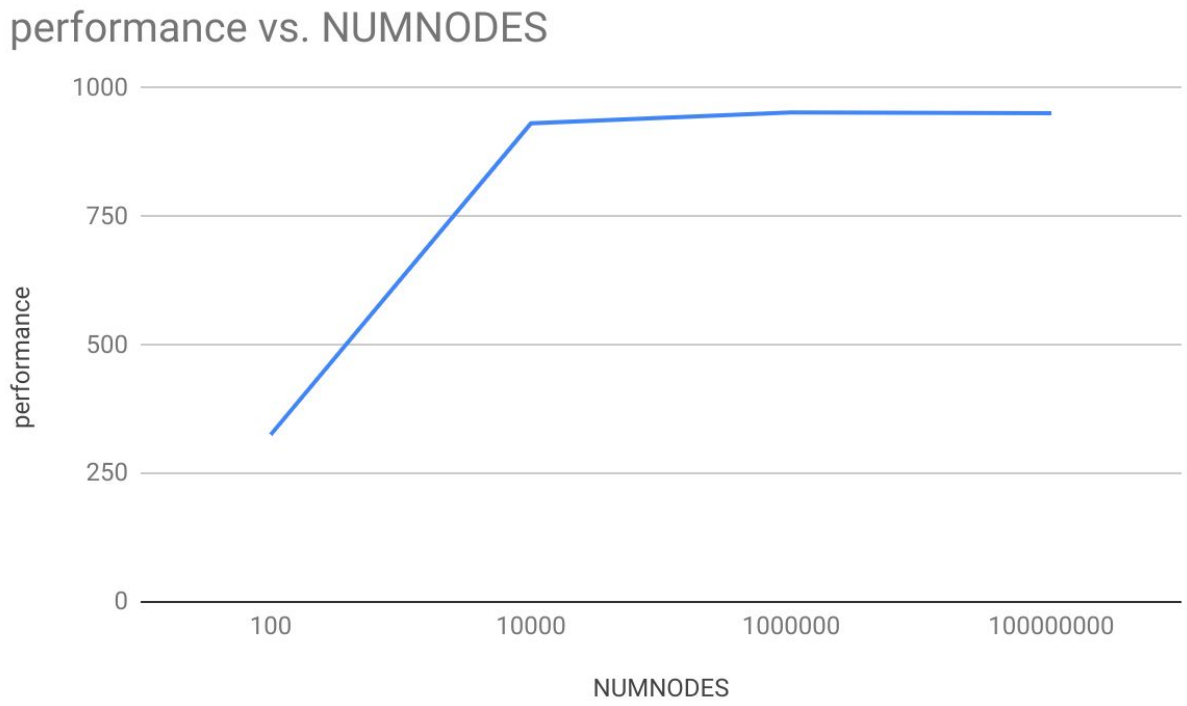
threads	NUMNODES	average_area	performance
1	100	6.588395	5.98444
1	10000	7.272442	16.755218
1	1000000	7.291631	16.57748
1	100000000	7.292215	16.528204
2	100	6.588395	33.898298
2	10000	7.272442	33.453767
2	1000000	7.291631	32.906185
2	100000000	7.292215	33.032646
4	100	6.588395	40.322593
4	10000	7.272442	64.804614
4	1000000	7.291631	64.08421
4	100000000	7.292215	64.385727
6	100	6.588395	46.511589
6	10000	7.272442	96.655713
6	1000000	7.291631	96.859693
6	100000000	7.292215	96.091213
8	100	6.588395	45.4545
8	10000	7.272442	106.428268
8	1000000	7.291631	129.09834
8	100000000	7.292215	127.684184
10	100	6.588395	43.859693
10	10000	7.272442	121.93635
10	1000000	7.291631	120.251668
10	100000000	7.292215	124.878055
12	100	6.588395	38.75969
12	10000	7.272442	142.918387
12	1000000	7.291631	141.159319
12	100000000	7.292215	143.763039
14	100	6.588395	37.037054
14	10000	7.272442	163.291966
14	1000000	7.291631	164.158462

14	100000000	7.292215	163.335763
16	100	6.588395	33.670008
16	10000	7.272442	185.45995
16	1000000	7.291631	187.592096
16	100000000	7.292215	181.264954
		7.11117075	
		S	10.96700851
			0.09118256803
			0.908817432
			1.066666667
		FP	0.9694052608

Performance (Mega Heights per Second) vs Threads (at 1000k Trials)



Performance (Mega Trials per Second) vs Nodes



Parallel Fraction

The single thread speed for 1000 trials was **16.528204 MH/s**
The multi thread speed (at 16 threads) for 1000 trials was **181.264954 MH/S**
S = Multi Thread Speed / Single Thread Speed = **181.264954 /16.528204**
Therefore we can calculate the Speedup at 16 threads vs single threaded
to be **S = 10.96700851**

The parallel fraction can be calculated with (N/ N-1)*(1 - (1/S))
Which is (16/15)*(1 - (1/10.96700851))
Which is (16/15) * (0.908817432) = 0.9694052608
And that gives us **FP = 0.969**

Area

The average area calculated across all subdivisions for the superquadratic where N=4 was 7.11117075. I believe this is likely the area.

Speed Pattern

Performance increases with both threads and nodes. We see at 16 threads there was close to an 11x speed up from single threaded to 16 threads. Interestingly, for threads, (in the aggregate) there was a plateau in the graph between 8 and 10 threads. The Ryzen R7 3800x has 8 real cores and 16 with hyper threading. It is possible that this was a contributing factor to this plateau. The number of nodes was an important factor in Mega Heights per Second. The maximum megageights per second recorded was 148.749756 MH/s and this was at 10k nodes with 16 threads.