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CS575: Introduction to Parallel Programming
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# Project #02

1. Tell what machine you ran this on

I ran my code on my laptop – Lenovo – L390 Yoga using Visual Studio
Operating System - Windows 10
CPU – Intel core i5 processor
Memory – 8 GB RAM

2. What do you think the actual volume is?

   The actual Volume is 6.48 unit^3 for N=4.

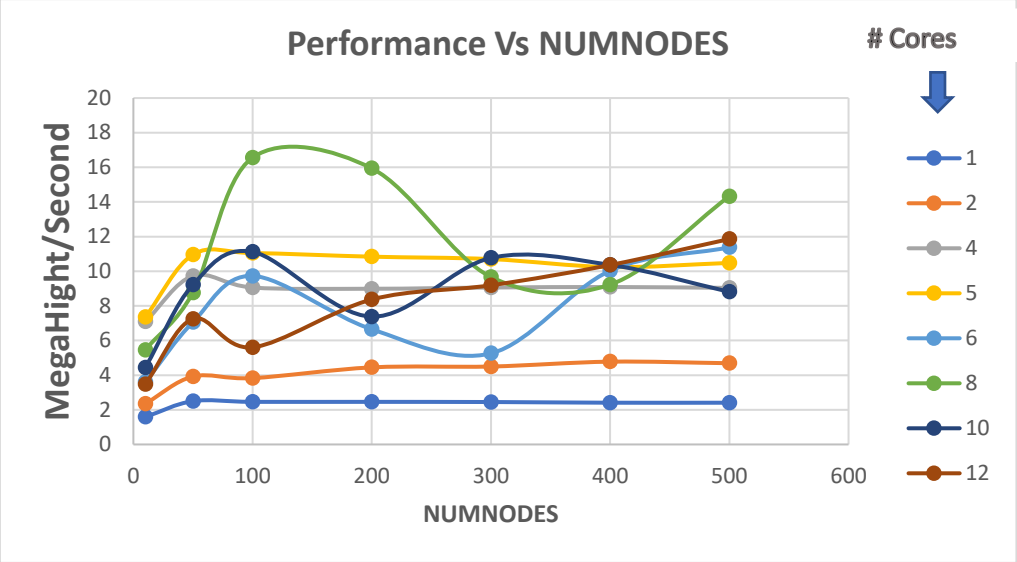
3. Show the performances you achieved in tables and graphs as a function of NUMNODES and NUMT

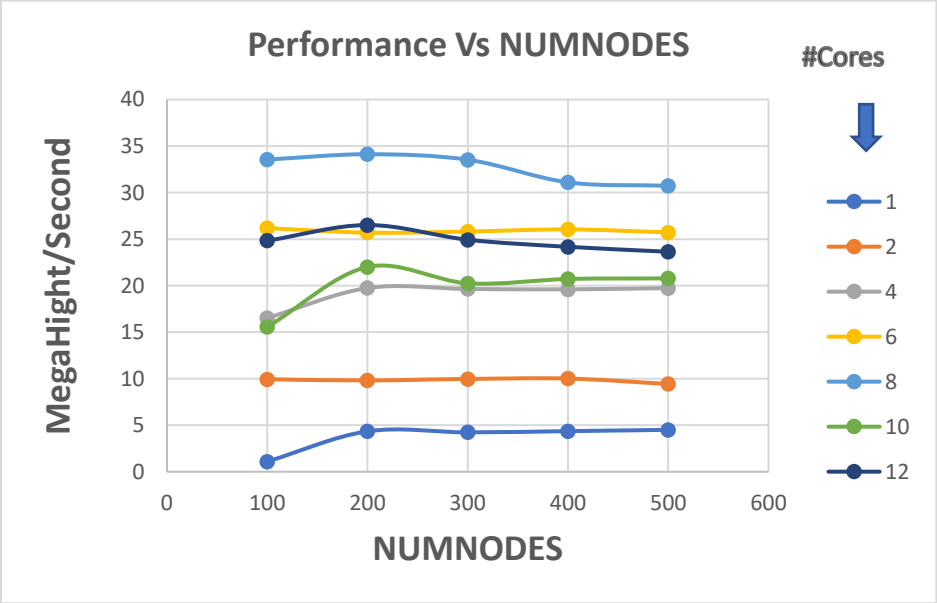
Data values in table :

When NUMNODES were set between the range 10 to 500

| #Cores/NUMNODES | 10 | 50 | 100 | 200 | 300 | 400 | 500 |
|---|---|---|---|---|---|---|---|
| 1 | 1.59 | 2.5 | 2.46 | 2.46 | 2.45 | 2.41 | 2.41 |
| 2 | 2.35 | 3.92 | 3.83 | 4.45 | 4.5 | 4.78 | 4.69 |
| 4 | 7.09 | 9.73 | 9.06 | 8.99 | 9.06 | 9.09 | 9.04 |
| 5 | 7.35 | 10.96 | 11.05 | 10.84 | 10.7 | 10.24 | 10.48 |
| 6 | 3.6 | 7.06 | 9.73 | 6.65 | 5.26 | 10.03 | 11.38 |
| 8 | 5.46 | 8.77 | 16.56 | 15.94 | 9.67 | 9.23 | 14.33 |
| 10 | 4.44 | 9.22 | 11.12 | 7.38 | 10.77 | 10.37 | 8.81 |
| 12 | 3.48 | 7.25 | 5.61 | 8.37 | 9.19 | 10.36 | 11.86 |

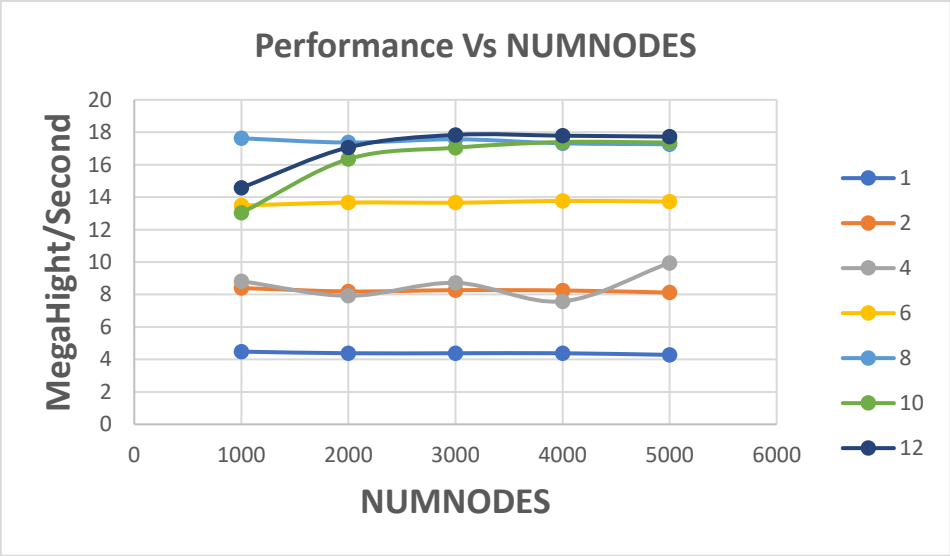
**Graph 1- Performance Vs NUMNODES**



When NUMNODES were set from 1000 to 5000

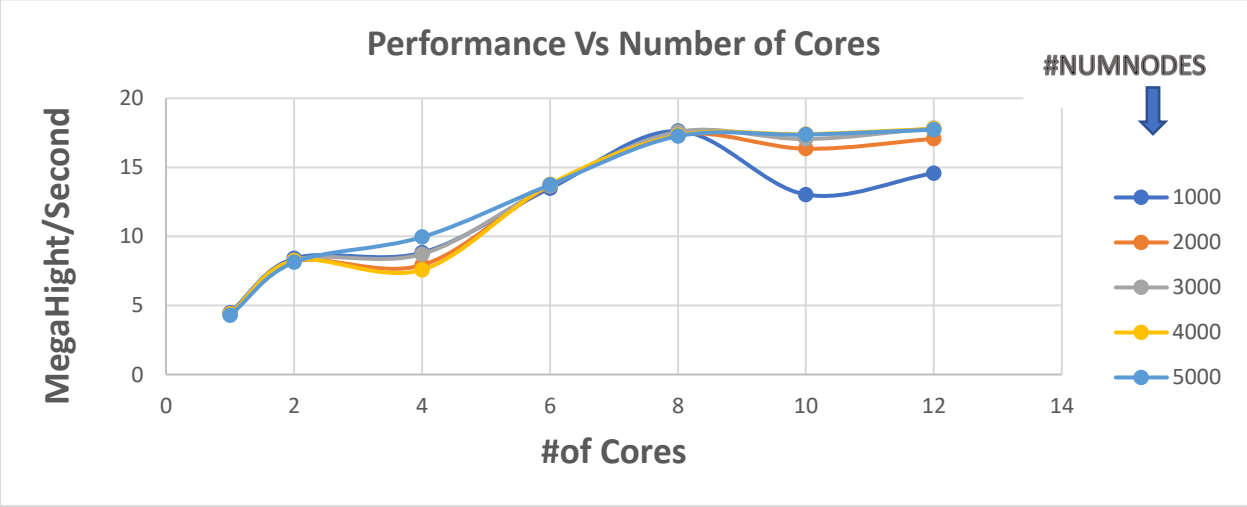
| #Cores/NUMNODES | 1000 | 2000 | 3000 | 4000 | 5000 |
|---|---|---|---|---|---|
| 1 | 4.48 | 4.38 | 4.38 | 4.38 | 4.28 |
| 2 | 8.4 | 8.19 | 8.27 | 8.25 | 8.12 |
| 4 | 8.82 | 7.92 | 8.72 | 7.58 | 9.95 |
| 6 | 13.49 | 13.67 | 13.66 | 13.77 | 13.73 |
| 8 | 17.63 | 17.37 | 17.57 | 17.32 | 17.26 |
| 10 | 13.03 | 16.35 | 17.05 | 17.4 | 17.37 |
| 12 | 14.58 | 17.07 | 17.84 | 17.79 | 17.73 |

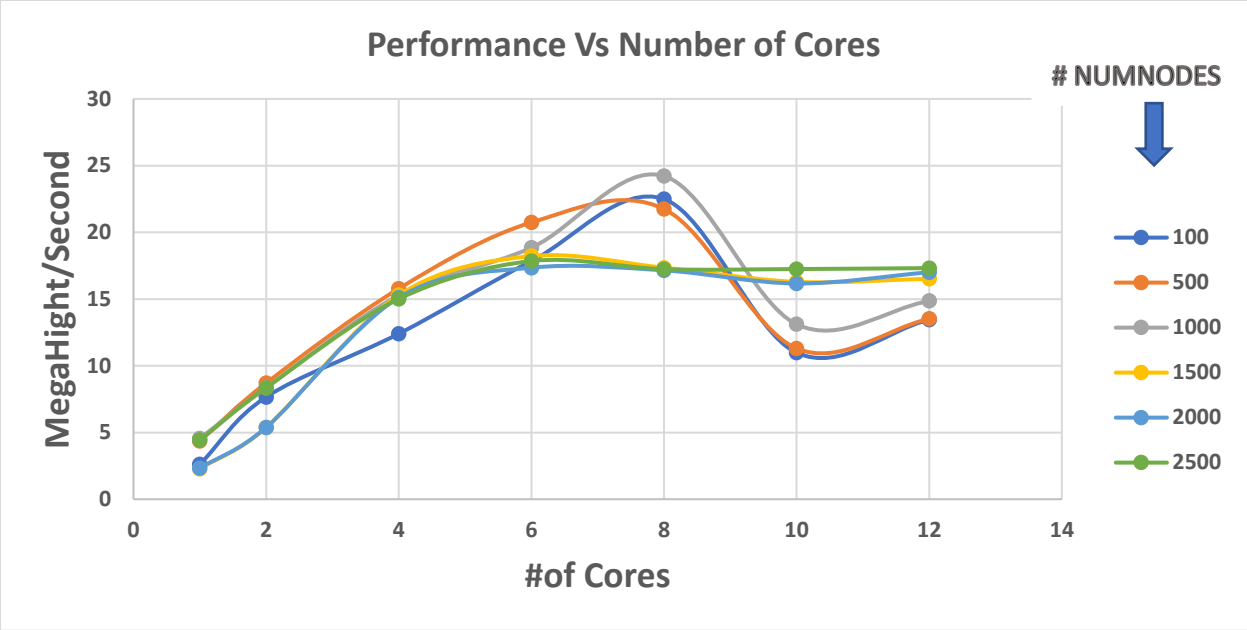



| Thread | Node | Performance | Volume |
|---|---|---|---|
| 2 | 100 | 9.93 | 6.46 |
| 2 | 200 | 9.81 | 6.48 |
| 2 | 300 | 9.97 | 6.48 |
| 2 | 400 | 10.01 | 6.48 |
| 2 | 500 | 9.43 | 6.48 |
| 4 | 100 | 16.52 | 6.46 |
| 4 | 200 | 19.74 | 6.48 |
| 4 | 300 | 19.64 | 6.48 |
| 4 | 400 | 19.6 | 6.48 |

| | | | |
|---|---|---|---|
| 4 | 500 | 19.73 | 6.48 |
| 6 | 100 | 26.18 | 6.46 |
| 6 | 200 | 25.69 | 6.48 |
| 6 | 300 | 25.81 | 6.48 |
| 6 | 400 | 26.04 | 6.48 |
| 6 | 500 | 25.72 | 6.48 |
| 8 | 100 | 33.55 | 6.46 |
| 8 | 200 | 34.12 | 6.48 |
| 8 | 300 | 33.53 | 6.48 |
| 8 | 400 | 31.1 | 6.48 |
| 8 | 500 | 30.73 | 6.48 |
| 10 | 100 | 15.55 | 6.46 |
| 10 | 200 | 22 | 6.48 |
| 10 | 300 | 20.25 | 6.48 |
| 10 | 400 | 20.71 | 6.48 |
| 10 | 500 | 20.78 | 6.48 |
| 12 | 100 | 24.83 | 6.46 |
| 12 | 200 | 26.51 | 6.48 |
| 12 | 300 | 24.93 | 6.48 |
| 12 | 400 | 24.17 | 6.48 |
| 12 | 500 | 23.64 | 6.48 |

**Graph 2 - Performance Vs Cores:**






4. What patterns are you seeing in the speeds?

The performance remains almost same even when the NUMNODES keep increasing. With increasing in the number of thread, we can see that in Graph 1 – Performance of Thread 8 is better than that of Thread 12. From Graph 2(Performance Vs #Cores) it can be observed that with increase in number of threads, the performance also increases.

5. Why do you think it is behaving this way?

One of the reason why it is behaving this way is because of the Compute to communicate ratio. When the number of nodes increases, due to the inter core communication the Compute to communicate ratio becomes high and this affects the performance.

Another reason why we are seeing the performance drop with the increase in number of nodes would be temporal coherence.

6. What is the Parallel Fraction for this application, using the Inverse Amdahl equation?

Calculating the SpeedUp when NUMNODES is 400 and Thread is 5

S = (Performance with 5 threads) / (Performance with 1 thread)

= 16.98/4.36

= 3.894

Therefore, SpeedUp is 3.894

Parallel Fraction ($F_p$)= (n/n-1)(1-(1/SeepdUp))

= (5/5-1) (1-(1/3.894))

= (5/4) (0.744)

= 0.93

7. Given that Parallel Fraction, what is the maximum speed-up you could *ever* get?

Max Speedup = $1/(1-F_p)$

= 1/1-0.93 = 1/0.07

= 14.285

Therefore, the maximum speedup that I could get is 14.285