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Project #2

Project Questions:

1. Tell us what machine you ran this on?
   I ran my program on my Windows machine utilizing Visual Studio Code. To run my program in the terminal, I inputted the following lines of code:
   ```
   chmod u+x proj02.sh
   proj02.sh >& proj02.csv
   ```

2. What do you think the actual volume is?
   Analyzing the run containing 10,000 nodes, the average volume for all threads (1, 2, 4, 8, 12, 16, 20, 24, 32), was calculated by the following work.
   ```
   (2 + 4 + 7.63 + 7.79 + 7.73 + 7.76 + 7.73 + 7.73 + 7.72) / 9 = 6.67667
   ```
   Our estimated actual volume has been calculated to be 6.67667.

3. Show the performances you achieved in tables and two graphs showing:

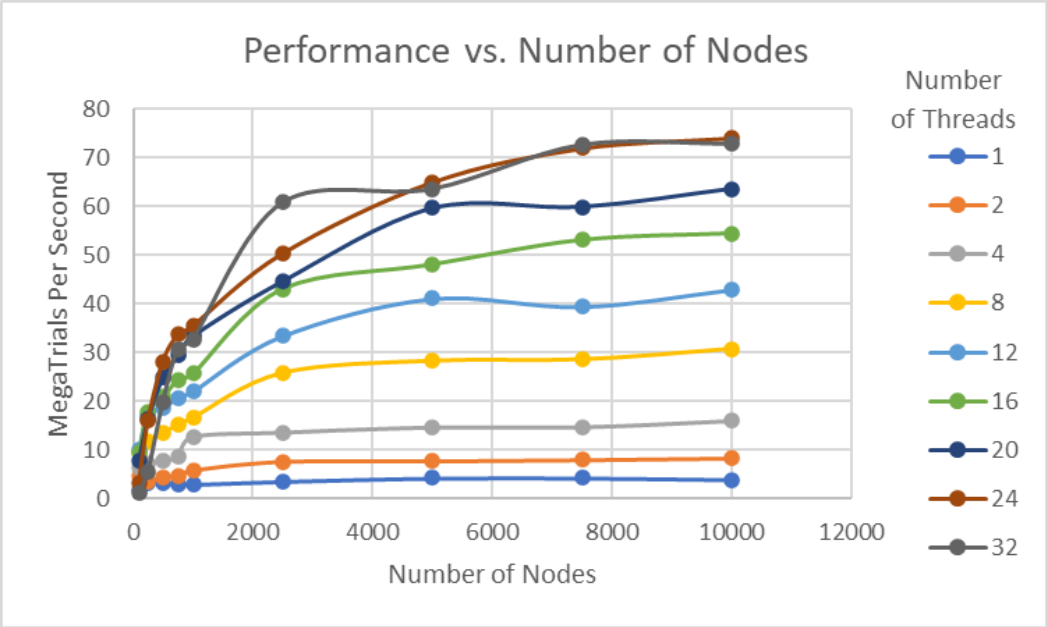
   Pivot Table Displaying Max Performance:

		Number of Nodes (NUMN)								
		100	250	500	750	1000	2500	5000	7500	10000
Number of Threads (NUMT)	1	1.7	3.38	3.22	2.99	2.91	3.54	4.25	4.28	3.94
	2	4.57	3.66	4.43	4.8	5.83	7.64	7.75	7.99	8.32
	4	6.26	7.25	7.87	8.6	12.74	13.63	14.68	14.73	16.01
	8	9.53	11.81	13.38	15.11	16.54	25.76	28.25	28.53	30.69
	12	9.97	17.26	18.62	20.72	21.98	33.4	41.07	39.42	42.91
	16	9.46	17.81	20.82	24.42	25.67	43.04	48.07	53.1	54.44
	20	7.76	16.33	24.84	29.43	33.38	44.62	59.63	59.91	63.62
	24	3.37	15.97	28.17	33.68	35.54	50.38	64.96	71.93	74.02
	32	1.33	5.49	19.8	30.77	32.78	60.77	63.55	72.61	72.84

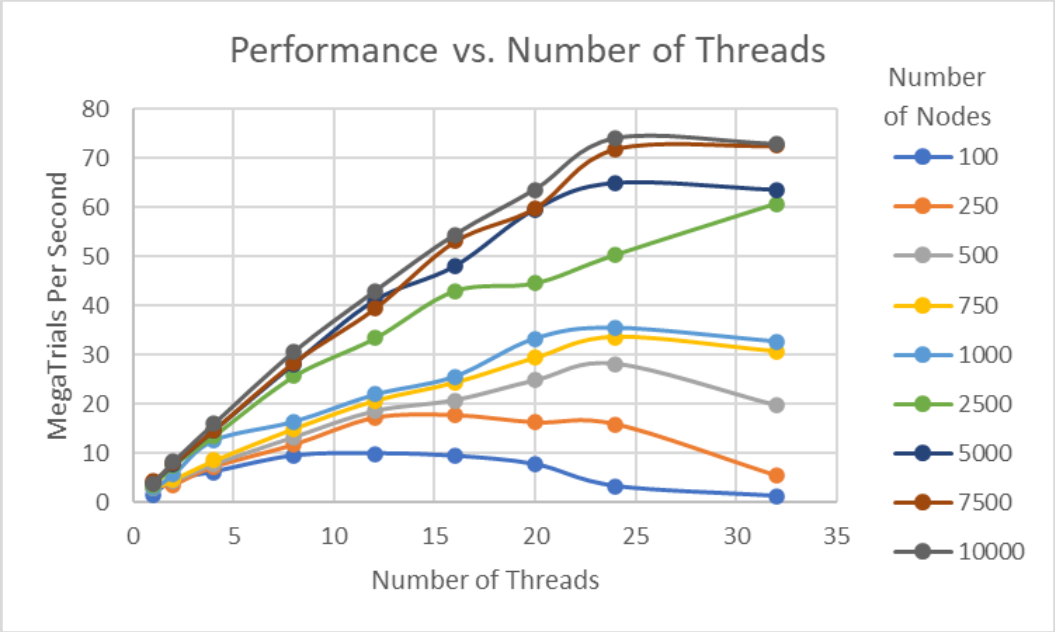
   Pivot Table Displaying Volume:

		Number of Nodes (NUMN)								
		100	250	500	750	1000	2500	5000	7500	10000
Number of Threads (NUMT)	1	7.76	7.76	7.76	7.76	7.76	7.7	8	4	2
	2	7.76	7.76	7.76	7.76	7.76	7.72	7.63	8	4
	4	7.76	7.76	7.76	7.76	7.76	7.76	7.73	7.11	7.63
	8	7.76	7.76	7.76	7.76	7.76	7.76	7.72	7.75	7.79
	12	7.76	7.76	7.76	7.76	7.76	7.76	7.74	7.84	7.73
	16	7.76	7.76	7.76	7.76	7.76	7.76	7.76	7.78	7.76
	20	7.76	7.76	7.76	7.76	7.76	7.76	7.76	7.76	7.73
	24	7.76	7.76	7.76	7.76	7.76	7.76	7.76	7.76	7.73
	32	7.76	7.76	7.76	7.76	7.76	7.76	7.76	7.75	7.72

a. Performance as a function of NUMN with colored lines showing different NUMT values?



b. Performance as a function of NUMT with colored lines showing different NUMN values?



4. What patterns are you seeing in the speeds?
   In the first chart displaying the performance as a function of number of nodes, as the number of nodes increases the megatrials per second in its performance increases as well. Similarly, in the second chart displaying the performance as a function of number

of threads, as the number of threads increases the megatrials per second in its performance also increases. Although as the number of nodes increases the performance also increases, some of the lines as the number of threads increases do not also increase in performance.

5. Why do you think it is behaving this way?
   There can be many factors that contribute to the data in the charts behaving this way. The first factor that I recognize is that the decreases in performances generally occur in the data representing a higher number of threads. These abnormal decreases can be caused by the higher parallel fractions. The behavior in the charts can also be caused by the lack of memory and space available due to the fact that the program requires a significant amount in order to perform. This lack of available memory and space results in a compounding domino effect decreasing the performances as the threads increase.

6. What is the Parallel Fraction for this application, using the Inverse Amdahl equation?
   1-Thread & 10,000 Trials = 3.94
   32-Thread & 10,000 Trials = 72.84
   Speed-Up = (32-Thread / 1-Thread) = 72.84 / 3.94 = 18.4873 MegaHeights Per Second
   Parallel Fraction = (n / (n-1)) * (1 - (1 / Speed-Up)) = (32/31) * (1 - (1 / 18.4873))
   = 0.976422

7. Given that Parallel Fraction, what is the maximum speed-up you could ever get?
   Max Speed-Up = (1 / (1 - 0.976422)) = 42.4124 MegaHeights Per Second

8. Conclusion?
   In order to complete the .cpp program file, I took the syntax within the assignment and followed along with the instructions. After implementing my program, I then proceeded forward to completing my bash script. I was able to essentially copy and paste my bash script from the previous project and modify the values to be more suitable to the current assignment. Overall, completing the program and generating my .csv file went incredibly smoothly. The small obstacles occurred when it came time to generate charts displaying the max performance in comparison to the number of nodes and the number of threads. After creating my two scatter plots, I realized that my reported performances were incredibly abnormal. To combat this issue, I re-ran my program and generated a new .csv file containing newer updated data. After doing this, my charts seemed much more normal and the data appeared to be what I had originally expected. The rest of the project involving answering the commentary write-up went very smoothly with no issues, following along with the assignment instructions was very helpful throughout.