Report on Project 2

Dynamic and Static Task Assignment.

CS415

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Embarrassingly Parallel Speed Up and Efficiency

Overview:

The goal of these test is to determine the speedup and efficiency of dynamic and static task assignment. These benchmarks are measured through the calculation of the Mandelbrot set. Three separates programs are written to measure sequential time, static assignment time and dynamic time.

Test Methodology:

Five trials are performed to get accurate data. The lowest and highest of each test is ignored. Each trial consists of 4 different core sizes (2, 4, 8, 16) and 7 different square sizes (500, 1000, 2000, 4000, 8000, 16000, 32000). In total, 28 unique tests are performed for each trial. The time for the sequential is used as a basis for all other calculations. For further control variables and other information on each program please see below.

-Sequential

Timing starts when the first pixel is calculated and ends when the last pixel is finished.

-Static Assignment

Timing starts when the first pixels is calculated and ends when the last row is received. Important note on timing, the calculations for which rows to calculate is not included in the timing. The master does equal row calculation as the slaves

-Dynamic Assignment

Timing starts when the first row is sent and the last row is received. The master node does not perform any pixel calculations. The master node only handles the which rows need to be sent to slaves.

Data Analysis:

Data Irregularities

Two noticeable irregularities exist in the data found, usual static speedup and over 100% efficiency. First, the usual speedup found in Graph 3.1 and 3.3 where static experiences abnormal peak at 2 cores and 8000x8000 pixels. This peak is likely caused by algorithm speed up by static task assignment. Second, over 100% efficiency is seen in graph 3.2. This is likely caused by sequential timing having slowdown as the size of the image increases.

Sequential

The sequential timing increased linearly as shown in Graph 1.1. These results were expected as the variable changed linearly. Static timing is shown in Graph 2.1 and Dynamic timing is shown in Graph 2.2. Both methods show that the time decreases as the number of cores increase. The speedup of both methods around 2 cores was approximately 1.5. As the number of cores increased, the speedup increased. The speedup can be seen in Graph 3.3 and 3.4. At this point, the difference between static and dynamic is very noticeable and the analysis will be discussed more in depth in the Static vs Dynamic sections. The efficient of both methods had various effects as the cores increased as seen in graph 3.1 and 3.2

Static vs Dynamic

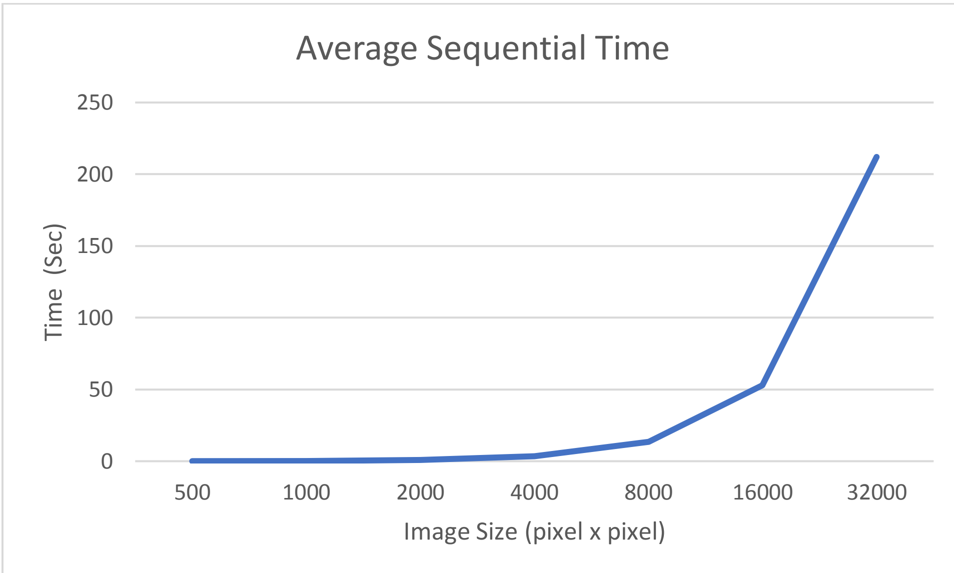
The most noticeable difference between the two is that dynamic decreases faster as the size of the image increase. The higher change in time is likely caused by the algorithm difference between the two. Dynamic uses load balancing to increase efficiency of all slaves while static must wait for all slaves to finish. This effect is seen in graph 2.1 and 2.2. This difference is also noticeable in the speedup analysis and efficiency analysis. The efficiency of the dynamic increases as the number of nodes increase. The exception is when dynamic has 16 cores and process an image size of 500x500 pixels. The efficiency was the same as static at this point. The efficiency of static decreases as the number of nodes increase. Graph 4.1 and 4.2 illustrate this effect. The speed up of static reached at most 5 in the tests performed. The speed up for dynamic reached 15 and above in the tests.

Conclusion:

Dynamic assignment appears to be the best method for parallel computing if the data is large and easily made parallel. Dynamic has the benefit of higher speed up as due to load balancing. Static assignment appears to suffer for efficiency loss as it must wait for all slaves to finish. Given enough cores, the efficiency for static and dynamic would be effectively the same as the communication between the two are roughly equal. Dynamic gives better computing power than static.

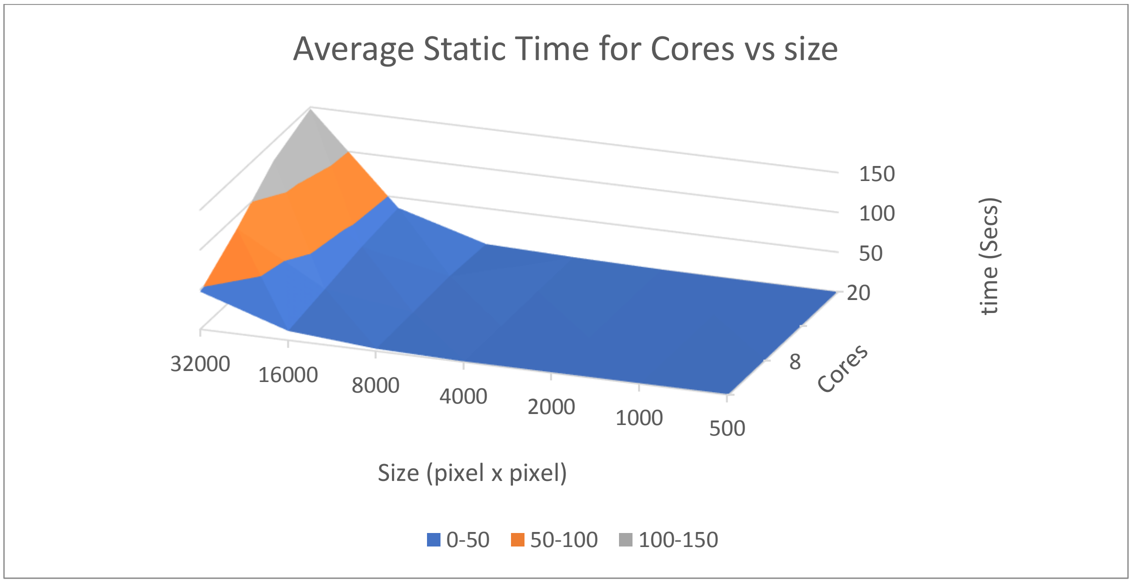
Graphs and Tables

Graph 1.1



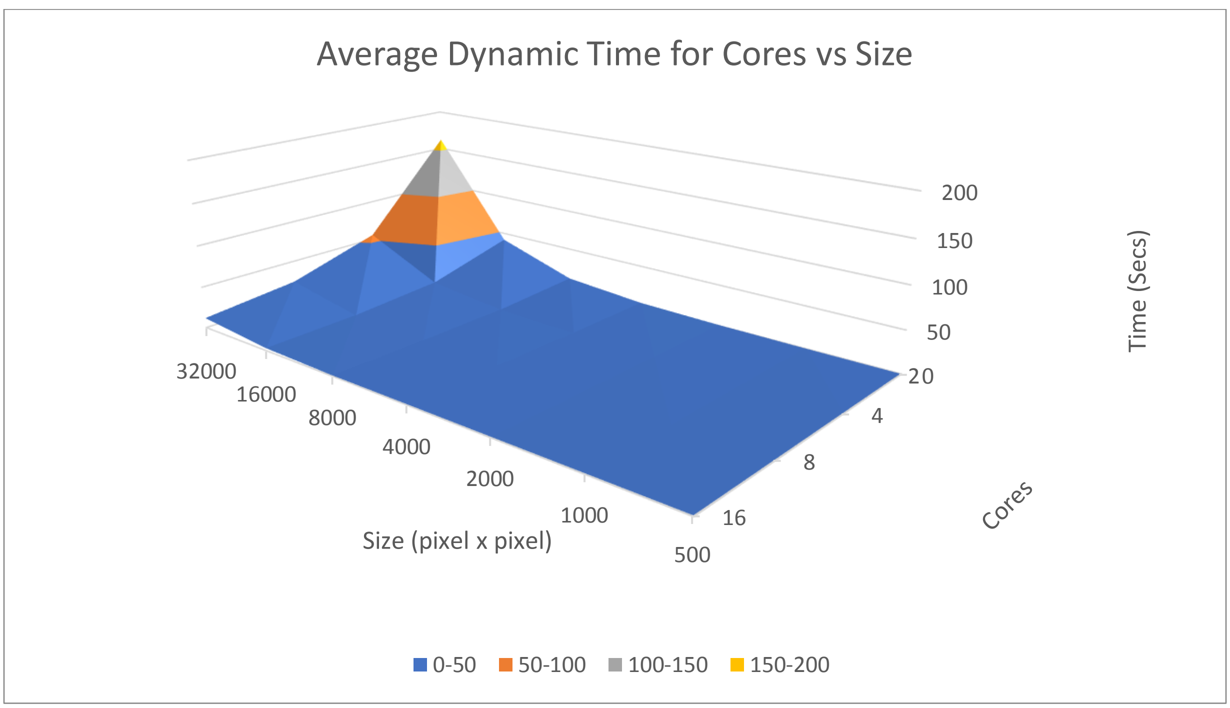
The sequential time linearly as the size of the image increases.

Graph 2.1



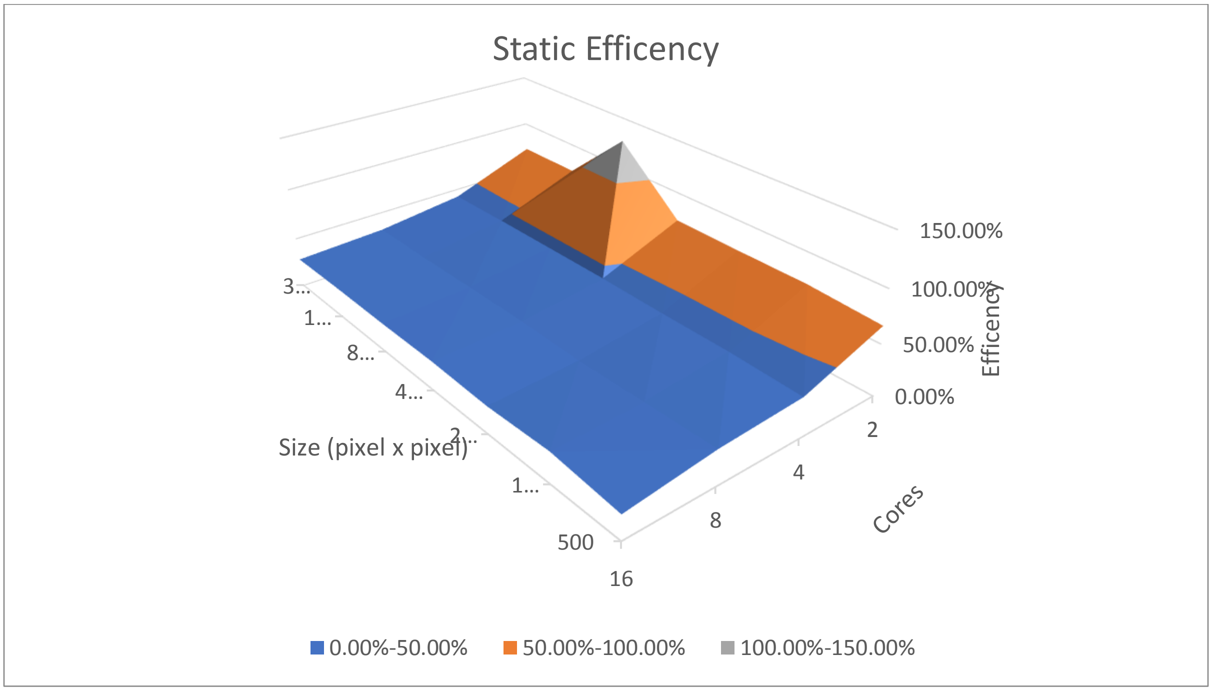
The time of static assignment decreases linearly with number of processes and increases linearly as size increases.

Graph 2.2



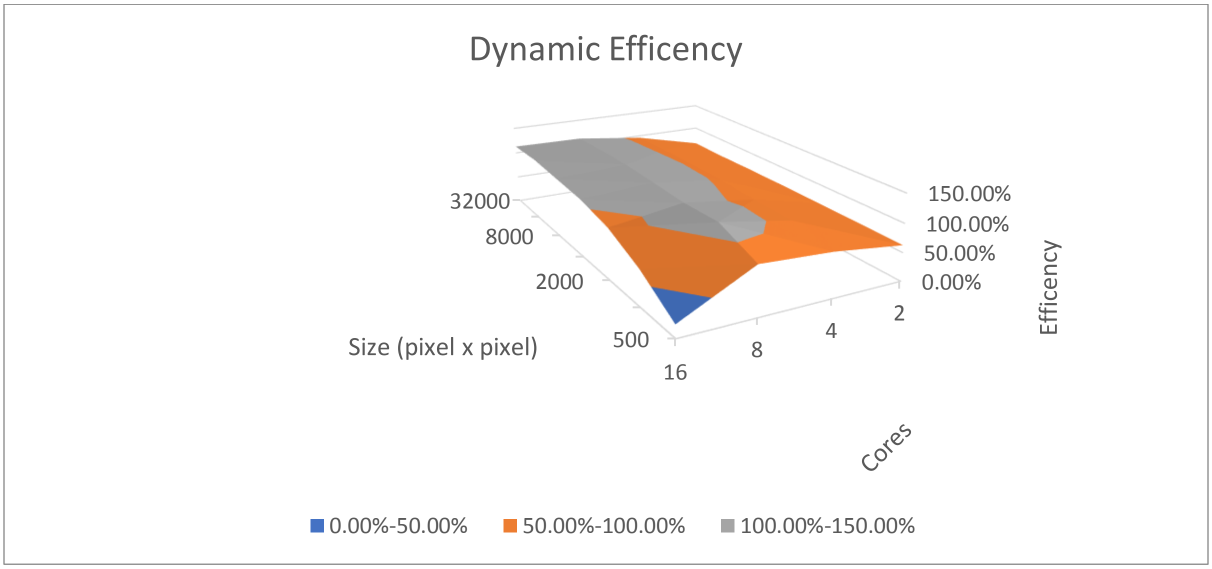
The time of dynamic assignment decreases linearly with number of processes and increases linearly as size increases.

Graph 3.1



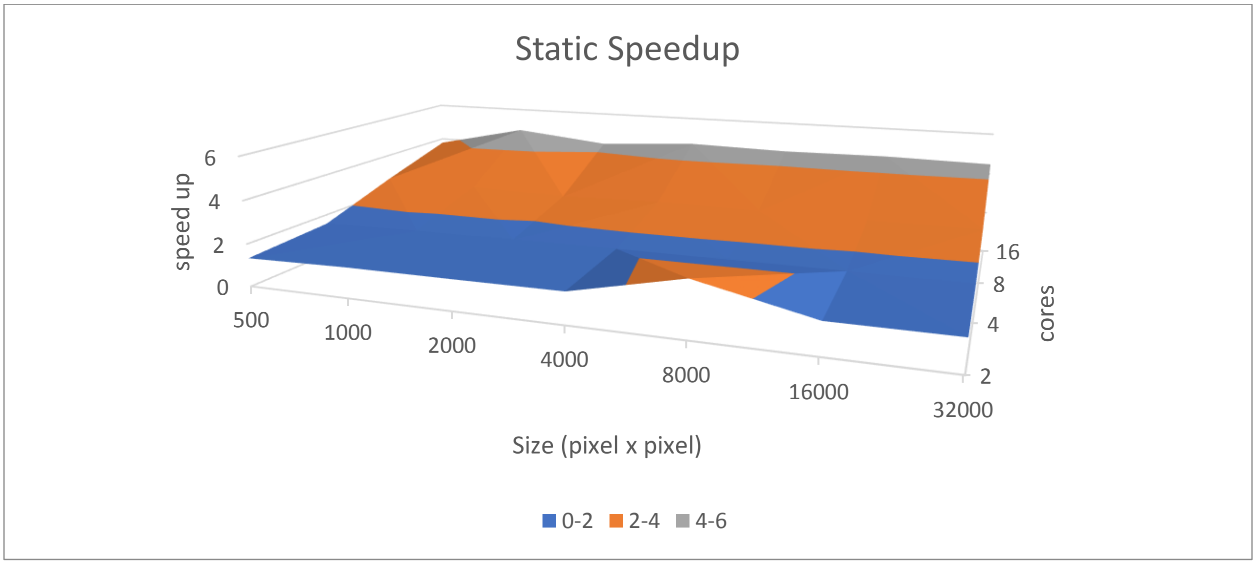
The efficiency decreases as the number of cores increase. The peak at size 8000, 2 cores is a potential outlier. The abnormal peak is likely caused by algorithm speed up due to task assignment.

Graph 3.2



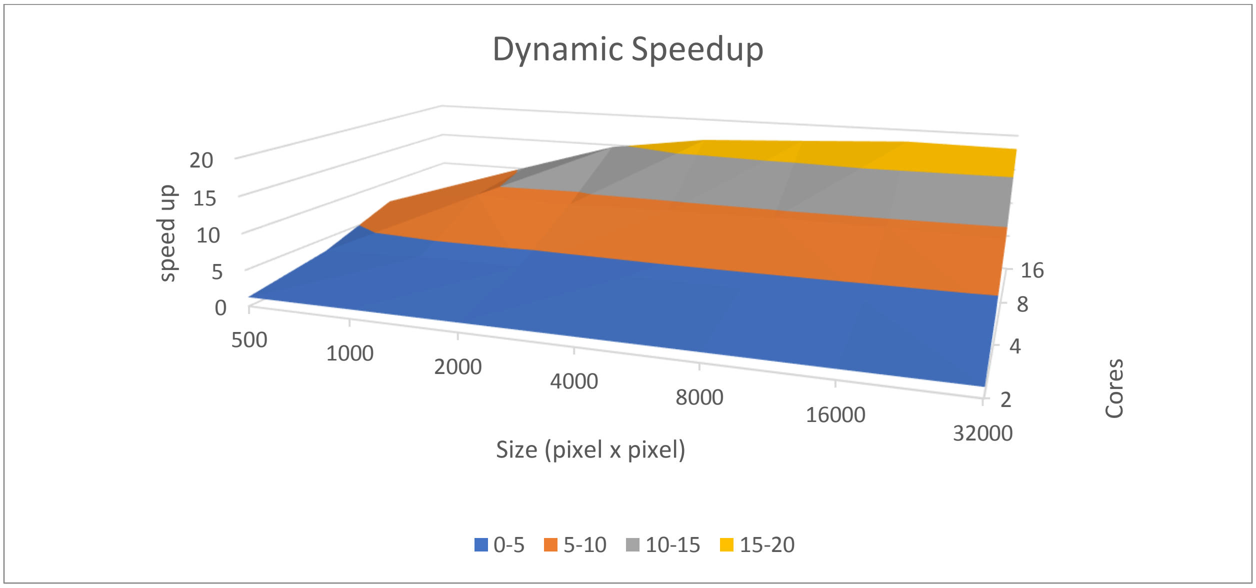
The efficiency increases as the number of cores increases. The efficiency increase is not seen at size 500, 16 cores. The likely cause is that communication time dominated over calculations. The efficiency goes above 100% likely due to algorithm slowdown from sequential code at higher image sizes.

Graph 3.3



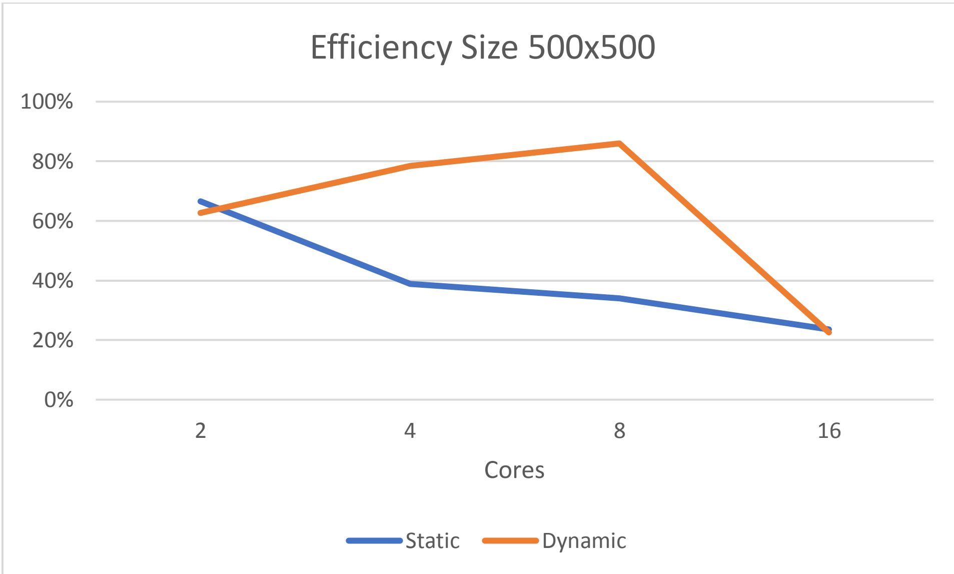
The speed up increases as the number of cores increase. The peak at size 8000, 2 cores is a potential outlier. The abnormal peak is likely caused by algorithm speed up due to task assignment.

Graph 3.4



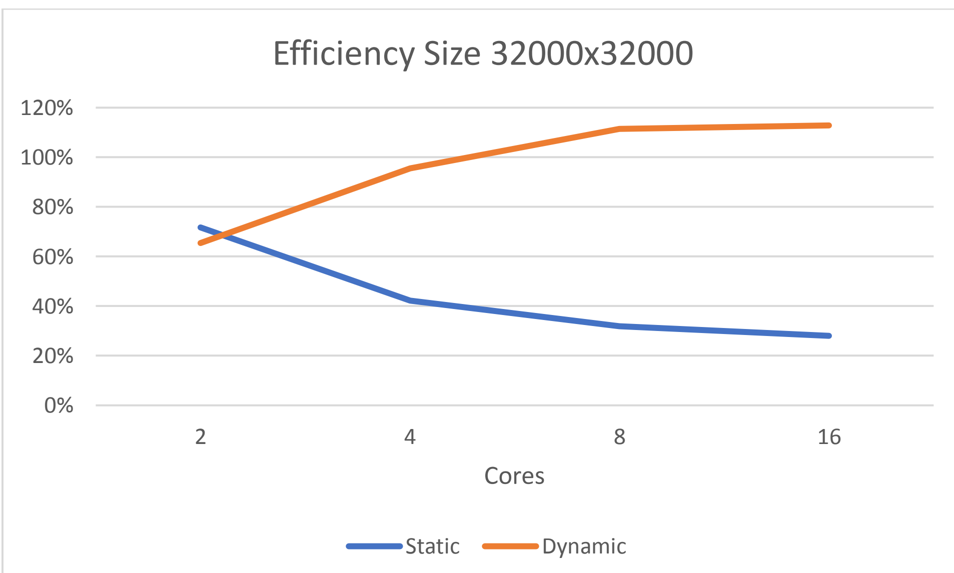
The speedup increase as the number of cores increases. The efficiency increase is not seen at size 500, 16 cores. The likely cause is that communication time dominated over calculations.

Graph 4.1



The efficiency at size 500x500 pixels is show above. Dynamic is more efficient until 16 cores. At 16 cores, Static and Dynamic are the same.

Graph 4.2



The efficiency at size 32000x32000 pixels is show above. Dynamic is more efficient as the number of cores increases. Dynamic appears to have higher than 100% efficiency. The cause is likely due to slowdown in sequential algorithm at large sizes.