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Problem 1

1. Parallel computing modules and algorithms that allow modern computers to tackle problems using these specific models and significantly lower processing times. The seven dwarfs are Structured Grids, Unstructured Grids, Fast Fourier Transform, Dense Linear Algebra, Sparse Linear Algebra, Particles, and Monte Carlo.

2. A point in the algorithm that is required for the thread to reach for the rest of the algorithm to proceed with the rest of the process

3. Memory hierarchy determines how data is accessed, whether data should be stored in volatile memory for quick access or in non-volatile memory for long-term storage.

4. A set of successive instructions performed by the computer that sometimes overlap with each other. Often the first set of instructions must be done before another thread can perform the same instruction.

5. A race condition is met when two threads start using the same shared variable. Locks are used to avoid using the shared variable at incorrect times and getting an incorrect result.

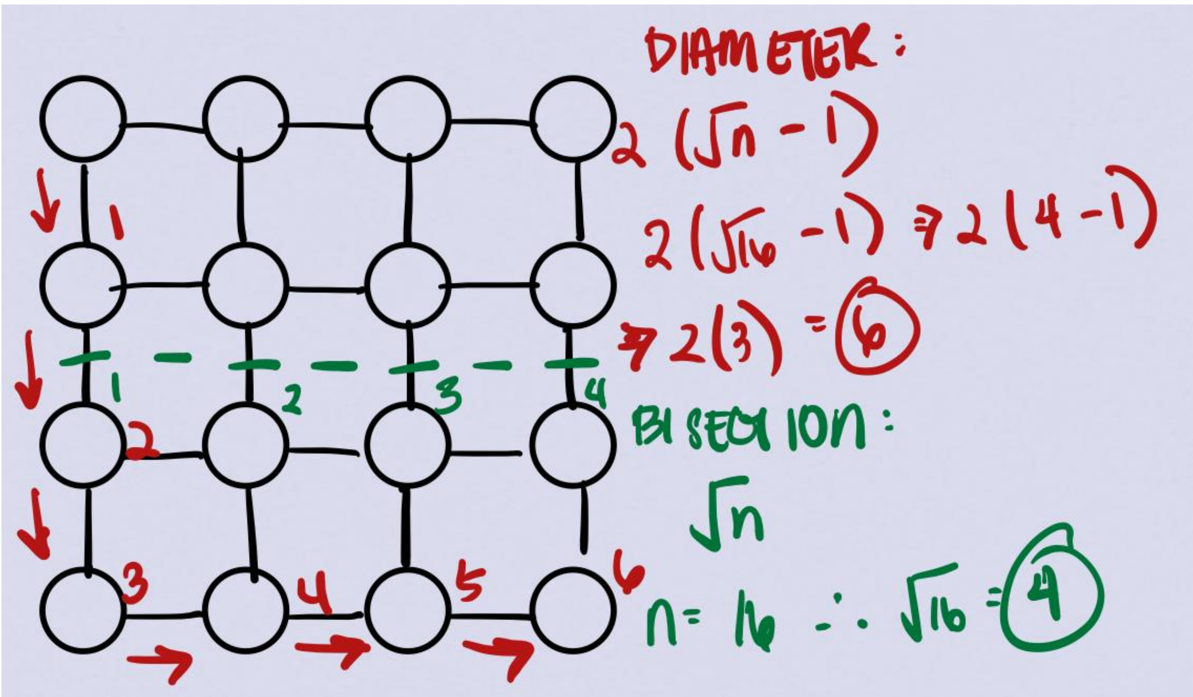
6. Dissimilar execution times of instructions for each thread in parallel computing can lead to load imbalance

7. An abstraction of programs that allows parallel instructions on parallel machines

8. Strong scaling is the speedup of a fixed set of instructions with respect to the number of processors; determined by Amdahl’s law. Weak scaling is the speedup of a scaled set of instructions with respect to the number of processors; determined by Gustafson’s law

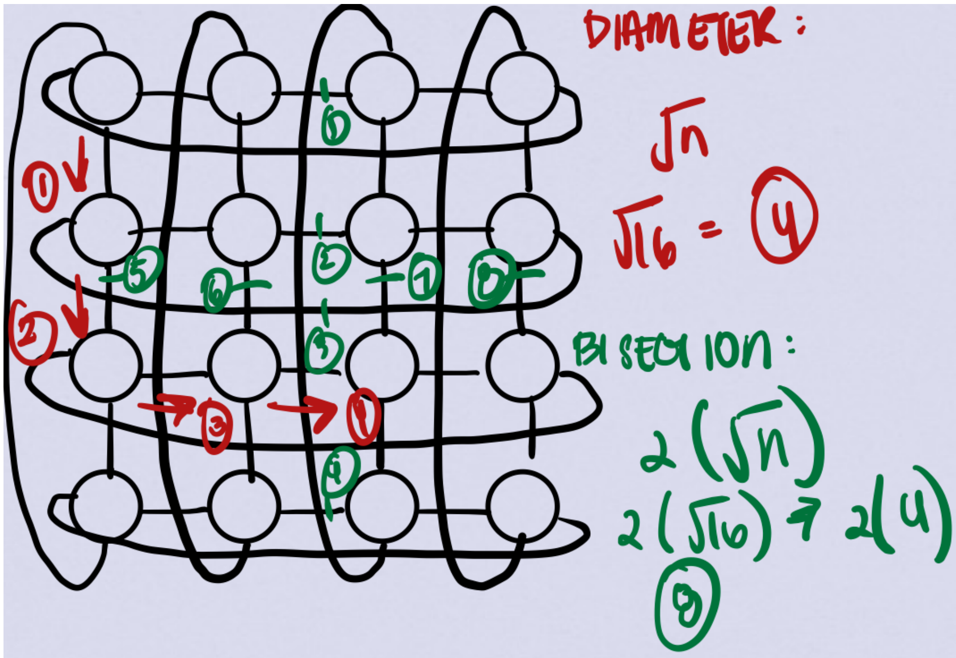
Problem 2

1. The diameter is the shortest path between a pair of nodes with the farthest distance in the network. The bisection width is the minimum number of links that need to be deleted from the network and partitioned into two equal parts.

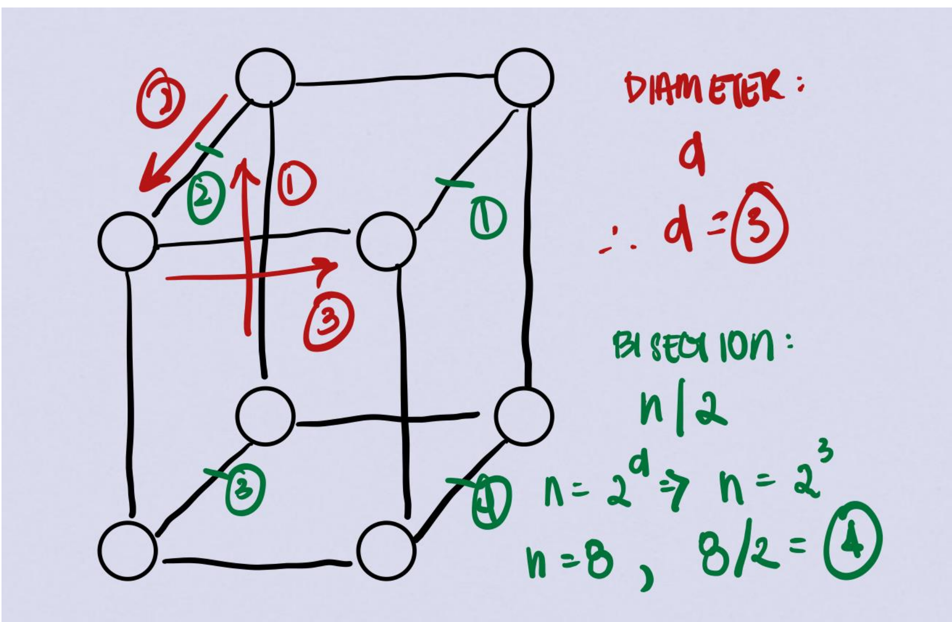


2.

a. 2D Torus



b. Hypercube



Problem 3

1. The time it will take to find the solution would depend on how deep the tree is, because depth-first search is performed by going down the tiers of the tree instead of going through the width of the tree.

2. If we divide the tree into two parts, p1 will finish before p0 because the algorithm is searching for both sides at the same time, and it will find the solution quicker. The decrease in the time it takes to search for the solution is linear and the desired result of decreased time is achieved.

Problem 4

1. Faster processor speeds can be achieved by adding more transistors into a single die, however, there can only be so many transistors in a die – which is also the reason we are starting to see the end of Moore's Law. So, for us to continue to move processing speeds forward, it is more feasible to design multicore architectures and shift over to parallel computing.

This change in basic assumptions scales not only the distributed and high availability systems but also the home desktop and the everyday mobile device.

2. Locality matters in parallel code because without locality latency starts to increase, especially in multicore and memory-distributed systems. Since there are more devices in the system if data is not stored locally, the time it takes for one device or processor to access data from another will significantly increase the time it takes for the code or algorithm to perform the task.

3. Algorithms are designed to serve specific architectures. If an algorithm designed for one system is used on another system, then it is not guaranteed that it will perform as quickly if it were used on the system it was designed for.

4.

a. There could be two reasons as to why the algorithm is experiencing a slowdown; latency, disparity in performance between the processor and the graphics processor or the parallel algorithm itself may not be properly implemented for graphics processor usage. If the graphics processor is connected to a PCIe bus slower than itself, then the data shared between itself, and the processor is going to experience latency in doing the parallel algorithm.

The disparity between the processor and the graphics processor could also affect the processing time of algorithm since if the graphics processor is slower than the processor, then the graphics processor becomes the bottle neck in the parallel algorithm process. The first two reasons could also happen at the same time and cause the slowdown of the algorithm.

b. As stated above one of the issues could be the performance disparity between the processor and the graphics processor, therefore replacing the graphics processor with a faster one should improve the performance of the system.

Problem 5

1. Due to the graph having a billion vertices, the best data structure is adjacency matrix. Since we are using an adjacency matrix data structure, it is easy and quick for us to check whether nodes have a direct edge. However, using adjacency matrix does have its disadvantages, especially with space complexity. Since our graph is undirected, then redundant, which means that we have stored both the forward and backward moving edges.

2.

a. They would not gain better performance on a serial machine since serial machines perform tasks one after the another instead of doing them at the same time. Which means that instead of dividing the work in half and perform both halves at the same time, the serial machine will divide the whole graph into two but still perform the second half once the first half is done.

b. I do not agree due to my previous statement, if done with adjacency matrix although it will take more memory, there should not be any reason accessing the data should be affected, despite the larger memory allocation.

Citation

Saeed, Fahad. "Lecture 2 (Part 3) PowerPoint (PPT)." Canvas, 2020. PowerPoint Presentation.

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