Homework 1

CSc 8530 Parallel Algorithms
Spring 2020

Due: 11:59 pm, Feb. 13, 2020

1. Consider a 3D stack of blocks; each block is a cube given as eight $[x, y, z]$ coordinates. Assume that all cubes are the same size. A configuration is valid iff:

   - There is at least one block on the "floor" (i.e., the z axis is zero for one of its faces)
   - Every other block is lying exactly on top of another block, such that there is a path to a floor block (i.e., the blocks are stacked, not floating in mid-air).

   Let **isValid**(A) be a function that takes in an $n \times 8 \times 3$ array and outputs whether or not it consists of a valid configuration.

   (a) **(10 pts)** Write **pseudocode** for a sequential version of **isValid**

   (b) **(15 pts)** Write **pseudocode** for a parallel version of this algorithm. Assume that you have as many processors available as needed.

   (c) **(15 pts)** Analyze (i.e., **prove**) the running time of both algorithms and the work of the parallel one

   (d) **Extra credit (15 pts):** Assume that the cubes can have different sizes. Write **pseudocode** for a parallel algorithm that can solve this version of the problem. Here, a cube is considered supported iff it lies completely on top of another one (i.e., a big cube cannot lie on top of a smaller one).

   Note that the most efficient algorithms (relative to others in the class) will receive full marks; less efficient ones will be marked down.

2. **(15 pts)** Suppose that two $n \times n$ matrices A and B are stored on a mesh of n^2 processors such that $P_{i,j}$ holds $A[i, j]$ and $B[j, i]$. Write **pseudocode** for an asynchronous algorithm that computes the product of A and B in $O(n)$.

3. **(15 pts)** We discussed the WT scheduling principle in the context of PRAM algorithms. **Prove** that this principle will always work in the dag model.