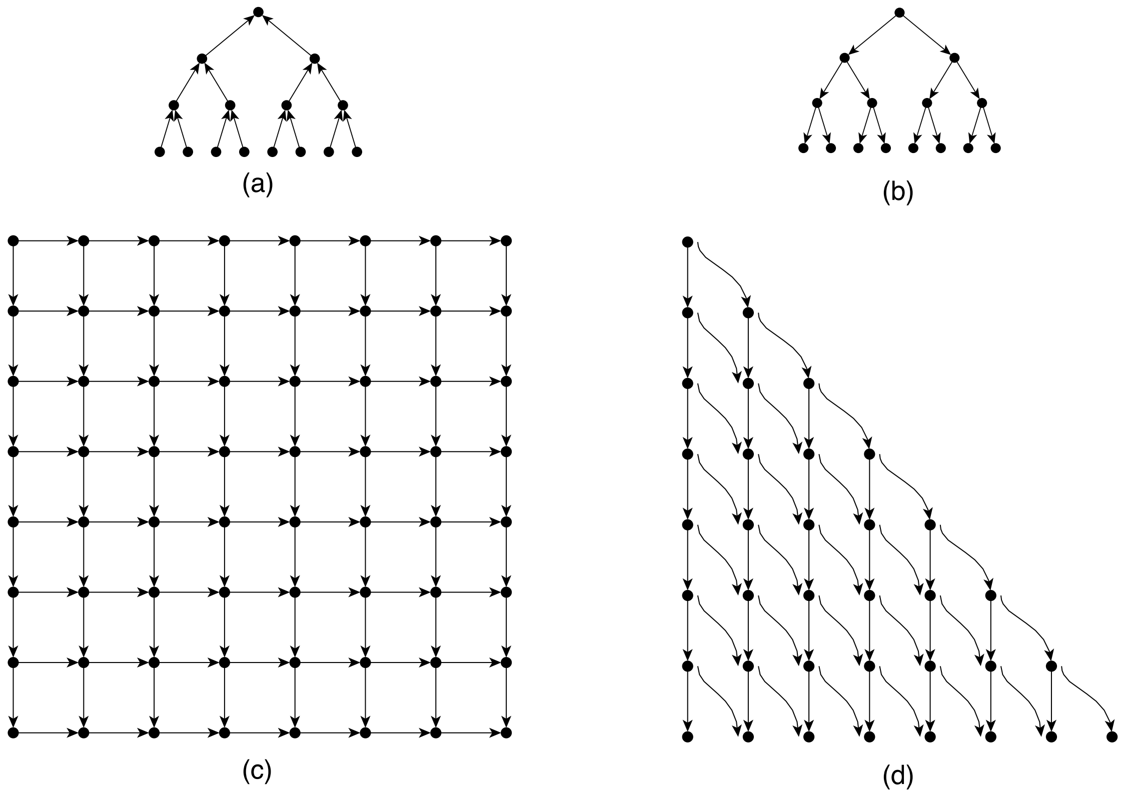
CSE 560 - Winter 2019
Assignment 3: Analytical Modeling of Parallel Programs
Due date: 23:59:59, 12th Apr. 2019

1. The figure below shows four task-dependency graphs. If N is the number of nodes in the graph, and n is an integer, then $N = 2^n - 1$ for graphs (a) and (b), $N = n^2$ for graph (c), and $N = n(n+1)/2$ for graph (d). Assuming that each task takes one unit of time and that interprocessor communication time is zero, for the algorithms represented by each of these graphs:
   (a) Compute the degree of concurrency. **[1 mark]**
   (b) Compute the maximum possible speedup if an unlimited number of processing elements is available. **[1 mark]**
   (c) Compute the values of speedup, efficiency, and the overhead function if the number of processing elements is (i) the same as degree of concurrency, and (ii) equal to half of the degree of concurrency. **[3 marks]**



2.
   (a) Using the expression $T_p = (n/p - 1) + 11 \log p$, for p = 1, 4, 16, 64, 256, 1024, and 4096, what is the largest problem that can be solved if the total execution time is not to exceed 512 time units? **[2 marks]**
   (b) In general, is it possible to solve an arbitrarily large problem in a fixed amount of time, provided that an unlimited number of processing elements is available? **[2 marks]**

3. ***Scaled speedup*** is defined as the speedup obtained when the problem size is increased linearly with the number of processing elements; that is, if W is chosen as a base problem size for a single processing element, then

$$\textit{Scaled speedup} = \frac{pW}{T_P(pW, p)}.$$

For the problem of adding n numbers on p processing elements, plot the speedup curves, assuming that the base problem for $p = 1$ is that of adding 256 numbers. Use $p = 1, 4, 16, 64$, and 256. Assume that it takes 10 time units to communicate a number between two processing elements, and that it takes one unit of time to add two numbers. Now plot the standard speedup curve for the base problem size and compare it with the scaled speedup curve.
Hint: The parallel runtime is $(n/p - 1) + 11 \log p$. **[6 marks]**

Total marks for this assignment: 15 marks
You are required to show all calculations to receive credit.