Department of CSE, The University of Texas at Arlington

CSE5351/4351: Parallel Processing

Fall Semester, 2015

Homework Assignment 2

Q 1. (20 points) A sequential implementation of the Sieve of Earthosthenes marks about 2.2 million cells in order to compute all primes less than 1 million. Estimate the maximum speedup achievable by the control-parallel (shared memory) version of the Sieve of Erathosthenes as it finds all the primes less than 1 million.

Q 2. (20 points) Assume the communication network connecting the message passing multiprocessor system for solving the Sieve of Eratosthenes (using the data parallel approach taught in the class) supports concurrent message passing. Propose a faster method of communication which is better than $\lambda(P - 1)$.

(a) Describe the faster communication algorithm (7 points)
(b) Describe its time expression (6 points)
(c) Analyze the execution time and speedup on 1, 2, 3, ..., 16 processors of the new Sieve algorithm that will use your communication scheme, assuming n = 1,000,000 and $\lambda = 100X$. (7 points)

Q 3. (**20 points**) Since 2 is the only even prime, one way to save memory and improve the speed of the sequential Sieve of Eratosthenes algorithm is to have the elements of the Boolean array represent only odd numbers. In this scheme, the first sieve step would mark multiples of the prime number 3. Then
(a) Estimate the reduction in execution time of the sequential algorithm resulting from this improvement for $n = 1{,}000$, and $n = 1{,}000{,}000$ (5 point).
(b) The improved sequential algorithm can be used as the basis for an improved data-parallel algorithm. Using the machine model of non-shared distributed memory, and assuming $\lambda = 100X$, estimate the execution time of the improved data-parallel algorithm for 1, 2,..., 16 processors (5 points).
(c) Compute the speedup of the improved data-parallel algorithm over the improved sequential algorithm. Compare this speedup with the speedup estimated for the original data-parallel algorithm (5 points).
(d) Why does the improved data-parallel algorithm achieve different speedup than the original data-parallel algorithm? (5points).

Q 1. (20 points) The task graph shown in figure below represents an image processing application. Each bubble represents an inherently sequential task. There are 12 tasks: an input task, 10 computation tasks, and an output task. Each of the 12 tasks can be accomplished in 1 unit of time on one processor. The input task must complete before any computational tasks begin. Likewise, all 10 computational tasks must complete before the output task begins. The input task consumes the entire bandwidth of the input device. The output task consumes the entire bandwidth of the output device.

(a) What is the maximum speedup that can be achieved if this problem is solved on two processors? (Hint: Processors do not have to receive the message elements in order.) (4 points)

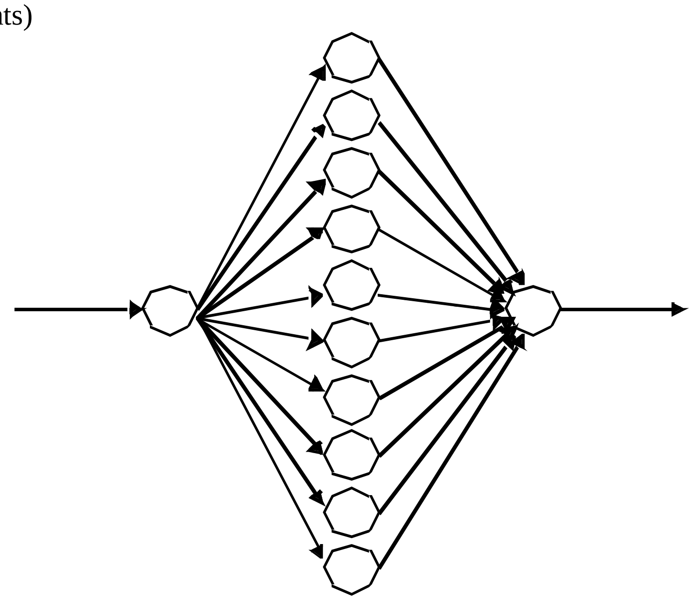
(b) What is an upper bound on the speedup that can be achieved if this problem is solved with parallel processors? (4 points)

(c) What is the smallest number of processors sufficient to achieve the speedup given in part (b)? (3 points)

(d) What is the maximum speedup that can be achieved solving five instances of this problem on two processors? Continue to assume that there is one input device and one output device. (3 points)

(e) What is an upper bound on the speedup that can be achieved solving 100 instances of this problem with parallel processors? Continue to assume that there is one input device and one output device. (3 points)

(f) What is the smallest number of processors sufficient to achieve the speedup given in part (e). (3 points)



Q 5. (20 points) Describe major differences between SIMD and MIMD computers and their advantages and disadvantages over each other).

SUBMISSION: WHAT, WHEN & HOW

(1) This assignment is due on or before October 13, 2015
(2) Use MS Word to create your assignment and email it to the instructor sheheryar.arshad@mavs.uta.edu