ICS 691: Parallel Algorithms
Homework 2

Due: Nov 13, 2014

Instructions: You may discuss the problems with other students in the class, but you must write up the solutions on your own and list the names of the students with whom you discussed each problem.

1   Independent set removal - 20 pts

Design a parallel algorithm for removing independent set of nodes in a list without computing predecessor pointers. That is given a singly-linked list, show how to remove nodes of the independent set without computing the reverse pointers. Your algorithm should run in $O(1)$ time and $O(n)$ work.

2   Integer sorting (Exercise 2.45 in JàJà) - 45 pts

Suppose we are given n integers in the range $[0, \log n - 1]$. Develop an $O(\log n)$ time EREW PRAM sorting algorithm that uses $O(n)$ operations. Can you generalize your algorithm to the case where the range is $[0, m] \geq \log n$? What is the corresponding time? Hint: Use radix sort, and start by computing the number of elements equal to i, for each i. Assume you have a solution to Problem 4 below.

3   Tree Contraction - 35 pts

(a) (15 pts) Given a binary tree, design an algorithm that labels the leaves consecutively in order from left to right and places them into contiguous array A.

(b) (5 pts) In the algorithm presented in class, why are we raking only odd-numbered leaves that are left children first? What if we rake all odd-numbered ones at once? Give an example of what goes wrong.

(c) (15 pts) Prove that in the algorithm presented in class, the parents of the nodes being raked concurrently are never adjacent in the tree.

4   BONUS: Colored prefix sums (Exercise 2.44 in JàJà) - 20 pts

Given a set of n integers, each colored with one color from $\{1, 2, \ldots, k\}$, where $k \leq \log n$, show how to obtain the prefix sums of the elements of a given color i, in the order they appear, for all i. Your algorithm should run in $O(\log n)$ time and $O(n)$ work on the EREW PRAM.