CSE 332 Data Abstractions, Winter 2011

Homework 6

Due Friday, Feb 25, 2011 at the **beginning** of lecture. Please be sure your work is readable (either written clearly or typed). This homework has **three** problems. ***Please write your section at the top of your homework.***

Problem 1: Forkjoin Parallelism: Longest Series

Consider the problem of finding the longest sequence of some number in an array of numbers: longest sequence(i,arr) returns the longest number of consecutive i in arr. For example, if arr is {2,17,17,8,17,17,17,0,17,1} then longest sequence(17,arr) is 3 and longest sequence(9,arr) is 0.

(a) In pseudocode, give a parallel fork-join algorithm for implementing longest sequence. Your algorithm should have work O(n) and span O(log n) where n is the length of the array. Do not employ a sequential cut-off: your base case should process an array range containing one element.

Hint: Use this definition:

```
class Result {
      int numLeftEdge;
      int numRightEdge;
      int numLongest;
      boolean entireRange;
      Result(int l, int r, int m, boolean a) {
            numLeftEdge=l; numRightEdge=r;
            numLongest=m; entireRange=a;
      }
}
```

For example, numLeftEdge should represent the length of the sequence at the beginning of the range processed by a subproblem. Think carefully about how to combine results; given left and right 'Result's, how can you compute the merged 'Result'?

(b) In English, describe how you would make your answer to part (a) more efficient by using a sequential cut-off. In pseudocode, show the code you would use below this cut-off.

Problem 2: Forkjoin Parallelism: Leftmost Occurrence of Substring

Consider the problem of finding the leftmost occurrence of the sequence of characters cseRox in an array of characters, returning the index of the leftmost occurrence or -1 if there is none. For example, the answer for the sequence cseRhellocseRoxmomcseRox is 9.

(a) In English (though some high-level pseudocode will probably help), describe a fork-join algorithm similar in design to your solution in problem 1. Use a sequential cut-off of at least ~~6~~ 12 ~~(the length of cseRox)~~ (that is, problems of size 11 or smaller should be solved sequentially) and explain why this significantly simplifies your solution. Notice you still must deal with the leftmost occurrence being "split" across two recursive subproblems.

(b) Give a much simpler fork-join solution to the problem that avoids the possibility of a "split" by using slightly overlapping subproblems. Assume a larger sequential cut-off, for example 100. Give your solution precisely in pseudocode.

(See back of this page for remaining problem)

Problem 3. Amdahl's Law: Graphing the Pain

Use a graphing program such as a spreadsheet to plot the following implications of Amdahl's Law. For both part a and part b, turn in 1) the *graphs* and 2) *tables* with the data.

(a) Consider the speed-up (T_1/T_P) where P = 256 of a program with sequential portion S where the portion 1 − S enjoys perfect linear speed-up. Plot the speed-up as S ranges from .01 (1% sequential) to .25 (25% sequential).

(b) Consider again the speed-up of a program with sequential portion S where the portion 1 − S enjoys perfect linear speed-up. This time, hold S constant and vary the number of processors P from 2 to 32. On the same graph, show three curves, one each for S = .01, S = .1, and S = .25.