CS 205: Algorithm design and analysis
Fall Term, 2024

Homework 3

Due: Tuesday 10/1 at 11:59pm

Complete the following. Submit all problems using Google Classroom.

1. (5 points) Consider the following function:

```
P_Transpose(A) {
   n = A.rows
   parallel for j = 2 to n
      parallel for i = 1 to j-1
         exchange A[i][j] with A[j][i]
}
```

   Give the code that results from expanding the parallel for loops into the equivalent recursive routines.

2. (8 points) Recall the standard code for `do_it`, the expansion of a parallel for loop:

```
void do_it(int s, int e) {
    if(w == e)
        do body of loop;
    else {
        spawn do_it(s, (s+e)/2);
        do_it((s+e)/2+1, e);
        sync;
    }
}
```

   This code makes 2 recursive calls that split the range `s`–`e` into two subranges, each one half the size (up to rounding issues). Consider what happens if an uneven division is used (e.g. 1/3 vs 2/3 or 45% to 55%).

   (a) Does the span increase, decrease, or remain the same? Why? (The reasoning is worth more than the answer itself.)

   (b) Does the work increase, decrease, or remain the same? Wny? (Again, I care more about the reasoning than the answer itself.)

   I'm looking for a general reason rather than the result of specific splits. You can solve for the span and work for specific splits if that is helpful, but don't rely solely on this for your solution except as an example.

3. (8 points) You are lucky enough to intern at a climate research center. You are responsible for generating statistics about the temperature for Galesburg. Specifically, you are given a large array listing the temperature at noon for each day and told to count the number of "hot" days, i.e. the days with a noontime temperature of at least 90. Give a fast parallel algorithm using nested parallelism (i.e. spawn and sync) to count the number of array entries that are at least 90. Analyze the work and span of your algorithm.

4. (1 point) Add a statement of collaboration to the top of your submission.