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EECS 117

HW1: Part 2

(a) Consider the transpose algorithm shown in Exercise 27.1-7 of the CLRS reading (page 792 or PDF page 23). Argue that this transpose algorithm is correct.
The transpose algorithm is correct. The algorithm begins at the element in the first row, second column because all elements on the diagonal don't need to be exchanged. The for loops traverse the array in the upper triangle, exchanging the value with the corresponding element in the bottom triangle. The first parallel for will divide up the columns of the array among processors and the second, nested parallel for will divide up the exchanging among processors. There is no racing because each exchange is independent.

(b) Now do exercise 27.1-7, which is to analyze the work, span, and average available parallelism of this algorithm.

27.1-7
Consider the following multithreaded pseudocode for transposing an n x n matrix A in place:

P-TRANSPOSE(A)
n = $A.rows$
  parallel for j = 2 **to** n
    parallel for i = 1 **to** j - 1
      exchange a_{ij} with a_{ji}

Analyze the work, span, and parallelism of this algorithm.

Work: Nested for loops

$$T_1(n) = \frac{1}{2}(n-1)n = \frac{1}{2}(n^2 - n) = O(n^2)$$

Span: Nested parallel for loops

$$T_\infty(n) = O(log\, n)$$

Parallelism:

$$\frac{T_1}{T_\infty} = \frac{O(n^2)}{\mathrm{O}(\log \mathrm{n})} = O(\frac{n^2}{\log \mathrm{n}})$$

(c) Do exercise 27.1-8 of the CLRS reading as well (same page).

27.1-8

Suppose that we replace the **parallel for** loop in line 3 of P-TRANSPOSE (see Exercise 27.1-7) with an ordinary **for** loop. Analyze the work, span, and parallelism of the resulting algorithm.

```
P-TRANSPOSE(A)
1 n = A.rows
2     parallel for j = 2 to n
3         for i = 1 to j - 1
4             exchange a_ij with a_ji
```

Analyze the work, span, and parallelism of this algorithm.

Work: Nested for loops

$$T_1(n) = \frac{1}{2}(n-1)n = \frac{1}{2}(n^2 - n) = O(n^2)$$

Span: for loop nested in a parallel loop

$$T_\infty(n) = O(n)$$

Parallelism:

$$\frac{T_1}{T_\infty} = \frac{O(n^2)}{\mathrm{O(n)}} = O(n)$$