

CSE 512/CS 554 Homework Assignment 1

Due January 29, 2008

1. (a) If one worker can dig a post hole in one hour, can sixty workers dig the post hole in one minute? Why?
(b) If one worker can drive a railroad spike with a sledgehammer in two minutes, can two workers with sledgehammers drive the spike in one minute? Why?
(c) What accounts for the difference between the answers to parts (a) and (b)?
2. Suppose an automobile assembly line has 15 stations, each of which requires six minutes for a given car. How long does it take to build a single car? How long does it take to build 10 cars? 100 cars? 1000 cars? Explain your answers.
3. A conventional oven can bake one potato in one hour or six potatoes in one hour. A microwave oven can bake one potato in ten minutes or six potatoes in one hour. Explain these different behaviors in terms of the physical processes involved. What analogies can you draw with serial and parallel computers?
4. Suppose that a classroom of p students, each sitting at a desk, is to compute the sum of n numbers, each of which is written on an index card. In one unit of time a given student can either add two numbers and write the sum on a card, or pass a card to another student at an *adjacent* desk (i.e., at most an arm's length away). Assuming that $n \geq p$, derive an expression for the minimum time to compute the overall sum. Specify the initial distribution of cards and the arrangement of desks assumed in your answer.
5. Suppose that four composers who live in four different cities agree to collaborate in composing a string quartet having four movements. Discuss the relative merits of the following possible divisions of labor among the composers, particularly with reference to their load balance and their communication requirements.
 - (a) Composer 1 writes the first movement, *allegro*.
Composer 2 writes the second movement, *andante*.
Composer 3 writes the third movement, *scherzo*.
Composer 4 writes the fourth movement, *presto*.
 - (b) Composer 1 writes the 1st violin part for all four movements.
Composer 2 writes the 2nd violin part for all four movements.
Composer 3 writes the viola part for all four movements.
Composer 4 writes the cello part for all four movements.
 - (c) Composer 1 writes all notes played on the first string for each of the four instruments.

Composer 2 writes all notes played on the second string for each of the four instruments.

Composer 3 writes all notes played on the third string for each of the four instruments.

Composer 4 writes all notes played on the fourth string for each of the four instruments.

6. Derive an expression — a reasonably simple function of the number of nodes p — for the *average* distance (in hops) between any two nodes (i.e., the average over all pairs of *distinct* nodes) in each of the following networks.
 - (a) 1-D mesh
 - (b) 1-D torus (ring)
 - (c) 2-D square mesh
 - (d) hypercube
7. For a 3-cube, draw pictures of three *edge-disjoint* spanning trees (i.e., for broadcasting, no edge is used at the same stage in more than one tree). All three trees should have the same root and minimum height.