University of Washington
Department of Computer Science and Engineering
CSE 521, Spring 1998

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Homework 5, **Due May 6, 1998**

Problem 1. Kruskal's Algorithm :

Page 510, Exercise 24.2-4. Remember that you can sort in linear time if the elements are from a restricted range (see chapter 9).

Problem 2. Prim's Algorithm :

Page 510, Exercise 24.2-5. I don't see how to improve the basic result in the case where edge weights are restricted to the range $1 \ldots |V|$ (but maybe you do!).

Problem 3. Dijkstra's Algorithm :

Page 532, Exercises 25.2-5 and 25.2-6

Problem 4. Stacking blocks:

Suppose that there are n types of blocks, and an unlimited supply of blocks of each type. Each type-i block is a rectangular solid with linear dimensions (x_i, y_i, z_i). A block can be oriented so that any two of its three dimensions determine the dimensions of a base and the other dimension is the height. In building a tower, one block may be placed on top of another block as long as the two dimensions of the base of the upper block are each *strictly* smaller than the corresponding base dimensions of the lower block. (Thus, for example, blocks oriented to have equal-sized bases cannot be stacked.) Design an efficient algorithm to determine the tallest tower that can be built.

(Note: it is important to have two blocks of each type (the stacking restriction seems to rule out using more than two blocks of each type). The problem is NP-complete if there is only one block of each type.)

Problem 5. Arbitrage:

Page 546, Problem 25-3

Problem 6. Shortest, cheapest path problem:

Consider the shortest path problem, where edges have both costs and lengths, and the question (given integers C and L) is to determine if there is a path from s to t with total cost at most C and total length at most L.

Prove this problem is NP-complete. (Hint: you may use negative costs, although the problem does remain NP-complete if the costs and lengths are positive.)

Give an algorithm for the problem which has run time which is polynomial in L and n. You may assume that the graph is acyclic, and the lengths are positive integers.