CSE 332 Data Abstractions, Winter 2013

Homework 5

Due: **Friday, Feb 22, 2013** at the BEGINNING of lecture. Your work should be readable as well as correct. You should refer to the written **homework** guidelines on the course website for a reminder about what is acceptable pseudocode. You may enjoy the fact that homework Five has THREE (wait really, only 3?) thrilling questions!! Please write your **section** at the top of your homework.

Problem 1: Graph Representations

Suppose a directed graph has a million nodes, most nodes have only a few edges, but a few nodes have hundreds of thousands of edges:

a) In what way(s) would an adjacency-matrix representation of this graph lead to inefficiencies?

b) In what way(s) would an adjacency-list representation of this graph lead to inefficiencies?

c) Design a representation for this sort of graph that avoids all the inefficiencies in your answers to parts (a) and (b).

Problem 2: Topological Sort

Weiss, problem 9.1 (the problem is the same in the 2nd and 3rd editions of the textbook): "Find a topological ordering for the graph in figure 9.79." For each step, show the in-degree array and the queue.

Problem 3: Dijkstra's Algorithm

a) Weiss, problem 9.5(a) (the problem is the same in the 2nd and 3rd editions of the textbook). Use Dijkstra's algorithm and show the results of the algorithm in the form used in lecture — a table showing for each vertex its best-known distance from the starting vertex and its predecessor vertex on the path. Also show the order in which the vertices are added to the "cloud" of known vertices as the algorithm progresses.

b) If there is more than one minimum cost path from v to w, will Dijkstra's algorithm always find the path with the fewest edges? If not, explain in a few sentences how to modify Dijkstra's algorithm so that if there is more than one minimum path from v to w, a path with the fewest edges is chosen.

c) Give an example where Dijkstra's algorithm gives the wrong answer in the presence of a negative-cost edge but no negative-cost cycles. Explain briefly why Dijkstra's algorithm fails on your example. The example need not be complex; it is possible to demonstrate the point using as few as 3 vertices.

d) Suppose you are given a graph that has negative-cost edges but no negative-cost cycles. Consider the following strategy to find shortest paths in this graph: uniformly add a constant k to the cost of every edge, so that all costs become non-negative, then run Dijkstra's algorithm and return that result with the edge costs reverted back to their original values (i.e., with k subtracted). Give an example where this technique fails and explain why it does so. Also, give a general explanation as to why this technique does not work.