1. Let G be a directed graph with (possibly negative!) edge weights, and let s be an arbitrary vertex of G. Suppose every vertex $v \neq s$ stores a pointer $pred(v)$ to another vertex in G.

   Describe and analyze an algorithm to determine whether these predecessor pointers define a single-source shortest path tree rooted at s. Do ***not*** assume that the graph G has no negative cycles.

   [Hint: There is a similar problem in head-banging, where you're given distances instead of predecessor pointers.]

2. Let G be a directed graph with positive edge weights, and let s and t be an arbitrary vertices of G. Describe an algorithm to determine the *number* of different shortest paths in G from s to t. Assume that you can perform arbitrary arithmetic operations in $O(1)$ time. *[Hint: Which edges of G belong to shortest paths from s to t?]*

3. Describe and analyze and algorithm to find the second smallest spanning tree of a given undirected graph G with weighted edges, that is, the spanning tree of G with smallest total weight except for the minimum spanning tree.

CS 473 Fall 2013 — Homework 8 Problem 1

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1. Describe and analyze an algorithm to determine whether a given set of predecessor pointers define a single-source shortest path tree rooted at s.

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2. Describe an algorithm to determine the number of different shortest paths in a given directed graph from one given vertex s to another given vertex t.

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3. Describe and analyze and algorithm to find the second smallest spanning tree of a given undirected graph with weighted edges.
