CS2010 Semester 1 2012/2013

Data Structures and Algorithms II

Tutorial 05 - Graph Traversal 2 & MST

For Week 07 (01 October - 05 October 2012)

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1 Introduction and Objective

Welcome back from recess week =). I hope you are a bit fresher now. Note: I know that if you had aimed for higher marks by attempting PS bonus, your recess week was probably not a recess week at all...

Week07 is usually a mid-semester test week in NUS. However, CS2010 is different. We have run our Quiz1 two weeks ago (Week06) and therefore this week, we will have a lighter workload.

In this tutorial, we will resume our discussion on Graph problems. We have one question from Lecture 5 (Topological Sort) and the rest are from Lecture 6 (Minimum Spanning Tree). We will also discuss PS4 Subtask 1 during this tutorial.

Note: Use `http://www.comp.nus.edu.sg/~stevenha/visualization/mst.html` to *verify* the answers of some questions in this tutorial. However during written tests, you have to be able to do this by yourself.

2 Tutorial 05 Questions

Topological Sort

Q1. Give the topological ordering of vertices of the DAG shown below. Although there are other algorithms to do topological sort, please use the DFS based algorithm as shown in Lecture 5. You can assume that neighbors are processed in increasing order. We should have a unique answer.

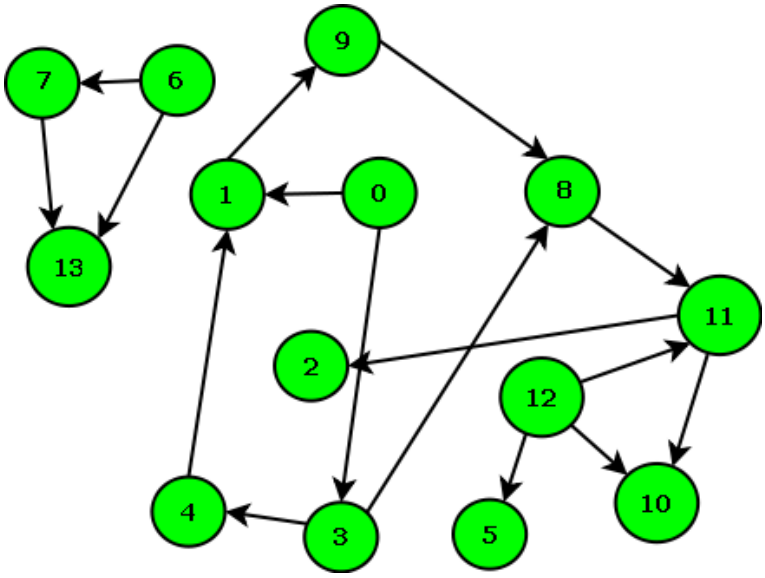

Figure 1:

Minimum Spanning Trees

Q2. In Lecture 06, you are presented with two MST algorithms: Prim's and Kruskal's algorithms. List down the similarities and differences of these two algorithms!

Q3. Give the MST of the following undirected graph, using both Prim's and Kruskal's algorithm. In Prim's algorithm, please start from node A and break ties by preferring vertices with smaller vertex label. In Kruskal's algorithm, break ties by preferring edges with smaller vertex pair labels (e.g. (A, F) is smaller than (B, C)). Show how the MST is built step by step in each case.

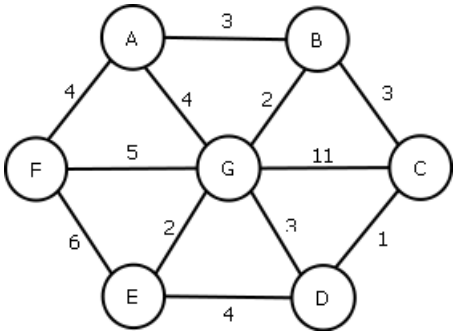

Figure 2:

Q4. An ambitious cable company has obtained a contract to wire up the government offices in the city with high speed fiber optics to create a high speed intra-net linking up all the different governmental departments. In the beginning they were confident that the minimum cost of connecting all the offices will be within budget. However, they later found they made a miscalculation, and the minimum cost is in fact too costly. In desperation, they decided to group the government offices into K groups and link up the offices in each group, but not offices between groups to save on the cost. This effectively creates K intra-nets instead of one big intra-net.

Given a budget B, V government offices, and the cost of linking up any given pair of offices, help the company design a program which will tell them what is the smallest value of K (so as to minimize the number of intra-nets), what are the offices in each of the K group and how they should be linked such that the total cost of all linking is minimized in each group and also within budget.

The program should model the problem as a graph. It should also run in $O(E \log V)$ time. Where E and V are the number of edges and vertices in the graph, respectively.

*Can you prove why your program gives the smallest number of groups such that the total cost of linking up offices is minimized and also within budget?

Q5. Please download CS2010 Final Exam paper S1, AY2011-2012 (last year's final exam) and solve a problem titled: **Vehicle Monitoring System (20 marks)**

Problem Set 4

Q6. Discussion of PS4 Subtask 1