CS2040C Semester 1 2018/2019

Data Structures and Algorithms

Tutorial 11 - Shortest Paths

For Week 13 (Week Starting 12 November 2018)

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1 Introduction and Objective

In this tutorial, we will discuss the last topic for this module: Single-Source Shortest Paths (SSSP) problem and continue talking about the 'graph modeling' soft skill, i.e. ability to model a seemingly random (non-explicit-graph) problem into a graph problem (specifically the SSSP problem for this tutorial).

We will use `https://visualgo.net/en/sssp` during our discussion in this tutorial.

The SSSP problem is quite easily found in many real life applications and it is the source of many interesting Computer Science problems, as you can see in this tutorial. Again, we recommend that you put some thought into it before discussing the potential solutions with your tutor.

As today will be the last tutorial session with your tutor, we shall end each tutorial group with a class photo.

Standard Stuff

During your self-study via VisuAlgo e-Lecture and in real life class discussions, you were presented with these SSSP algorithms: Bellman-Ford's algorithm (for general case, but also the slowest), BFS (only for unweighted graph), the original version of Dijkstra's algorithm (as defined by Dijkstra himself) and the modified version of Dijkstra's algorithm which uses **Lazy Deletion** technique on a priority queue.

First (or even optional), the tutor will (re-)demonstrate the executions of these algorithms on a small directed weighted graph using `https://visualgo.net/en/sssp` from a certain source vertex s. The tutor will re-explain when a certain algorithm can be used and when the same algorithm cannot be used. The tutor may invite some students to do this live demonstration using different source vertex s and/or using different graph. If needed, the tutor will explain **Lazy Deletion** again in the

context of PS3. If the class has no issue with the basics, the tutor will proceed to discuss harder topics.

Graph Modeling Exercises, via Past Paper Discussions

Q2. Please download CS2010 Written Quiz 2 Paper and solve a question titled: Money Changer. You may download the paper here: `https://www.comp.nus.edu.sg/~stevenha/cs2040c/tests/CS2010-2011-12-S1-WQ2-medium.pdf`

Q3. A salesman frequently needs to drive from one city to another to promote his products. Since time is of the essence, he wants to use the shortest route to get from one city to another. However in every city he passes he will have to pay a toll fee. The toll fee is the same for every city and it is a positive unit. Therefore, given two different routes of the <u>same distance</u> (positive unit) to get from city A to city B, he will prefer the one which passes through <u>fewer cities</u>. An example is shown below:
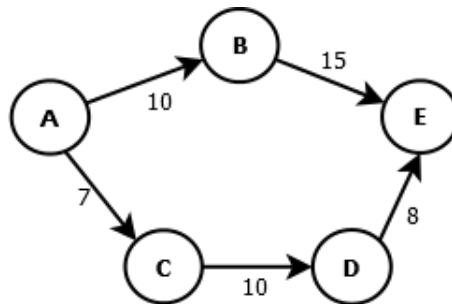
To get from A to E, route A,B,E is preferred over route A,C,D,E even though both have the same cost 25, since A,B,E goes through fewer cities.

Figure 1: An Illustration

Propose the *best* algorithm using what you have learnt so far (and a bit more), so that the salesman will choose a route from any source city A to any destination city B such that it has the shortest distance and also passes through the fewest cities. What is the running time for your algorithm?

Q4. Please download CS2040C Final Examination and solve Question C.4 and C.5: Shrinking Tunnel. You may download the paper here: `https://www.comp.nus.edu.sg/~stevenha/cs2040c/tests/CS2040C-2017-18-S1-final.pdf`.

Class Photo and CS2040C Facebook Group

Let's take a class photo with your tutor.
In addition, there is a Facebook group for previous batches of CS2040C students (maintained by Dr. Steven Halim). Now that this iteration of the module is coming to an end, we would **like to invite**

you to join this Facebook group, which contains many seniors of CS2040C and **will be used for the next iteration of CS2040C**. The link is `https://www.facebook.com/groups/NUS.CS2040C/`. Please do answer the question asked when you request to join, for verification purposes.

All the best for your final assessment of this module and of your other modules.