CS2040C Semester 1 2020/2021

Data Structures and Algorithms

Tutorial 10 - Shortest Paths

For Week 12

Document is last modified on: October 28, 2020

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.

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 thoughts on them before discussing the potential solutions with your tutor.

Standard Stuffs

During your self-study via VisuAlgo e-Lecture and in real life class discussions, you were presented with these SSSP algorithms: BFS (only for unweighted graph), Bellman-Ford algorithm (for general case, but also the slowest), and the original version of Dijkstra's algorithm (as defined by Dijkstra himself and implemented using C++ STL set/Java TreeSet – a 'special' Priority Queue ADT that is still C++ STL/Java API-based that can be used to update/decrease key efficiently). This part is examinable.

Depending on the timing of your tutorial, you may have also seen the SSSP on Tree, and SSSP on DAG (pre-cursor to DP), that are discussed during Lecture 12b.

First, the tutor will (re-)demonstrate the executions of those 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.

Graph Modeling Exercises, via Past Paper Discussions

There are a few graph questions in recent final assessment papers. Let's discuss two of them (considering that SSSP – our typical last topic of CS2040/C – will be there in Final Assessment – but usually not going to be the hardest question) are as follows:

1. `https://www.comp.nus.edu.sg/~stevenha/cs2040c/tests/CS2010-2013-14-S1-final.pdf`, Question 4.1, Facebook Privacy Setting
2. `https://www.comp.nus.edu.sg/~stevenha/cs2040c/tests/CS2010-2015-16-S4-final.pdf`, Question C.3, Avengers Initiative
3. `https://www.comp.nus.edu.sg/~stevenha/cs2040c/tests/CS2040-2017-18-S4-final.pdf`, Question C.1, SSSP in a Special "SLL" (code the solution in C++ instead)

Hands-on 10

TA will run the second half of this session with a few to do list:

- Speedrun the last component of VisuAlgo Online Quiz:
  `https://visualgo.net/training?diff=Medium&n=5&tl=0&module=sssp`
- Share any last minute tips for VA OQ preparation based on TA's experiences
- Hands-on, about SSSP

Problem Set 5

We will end the tutorial with **high-level** discussion of PS5.
Now approaching the second week (with 2 days extension).
We can now discuss more ideas of PS5 A+B (not necessarily until the final subtask).