CS 205: Algorithm design and analysis
Fall Term, 2024

Homework 5

Due: Friday 10/18 at 11:59pm

Complete the following. Submit all problems using Google Classroom.

1. (12 points) Each of the following can be solved using a graph algorithm we studied (BFS, DFS, shortest path/Dijkstra's, MST, topological sorting). For each problem, describe the graph (what are the vertices and edges?) and what algorithm you would use.

   (a) You're playing a new game with some of your friends and you're trying to figure out the strategy. During each turn, you can select from a set of available resources and then potentially use resources that you've collected to build units. There are several ways to win, but they each involve having some collection of units. Your choices on each turn depend on what you've built so far and will also depend on actions by the other players, who will make moves to interfere with your progress if they perceive that you're close to winning. Based on all this information, you have estimated the number of turns it will take you to buy each possible next unit for each set of current units. Using this, compute your fastest winning strategy; the order to buy units that reaches a winning configuration in as few turns as possible.

   (b) One of the big challenges of being a student is scheduling your time because there are so many different things to do, some of which must be done in a specific sequence. For example, CS 205 requires you to read before taking a RQ and both of these must be completed before you work on your HW. Similarly, a history class might require a paper, but to do that, first you need to find relevant sources, read them, and then generate an outline. What you want to create is a program that will take all this information and generate a schedule listing things to do in order. Obviously, this order must take into account the required sequences for the activities. How would your program create such a schedule?

2. (8 points) You are tasked with booking campus entertainment for Union Board. This seems like it would be fun, but it turns out to be a lot of work. In particular, there are a bunch of dates for which you need to secure entertainment. You also have a collection of acts that you can book, either single people (e.g. an illusionist or a standup comic) or groups (e.g. an acrobatic troupe or a choir). Since the acts travel around to different schools, each of them is only available for a subset of the dates. In addition, the acts are divided into categories (e.g. comedy, music, movie, etc) and you are given a limit for each of these categories which is the maximum number of acts of that type which you are allowed to book. You can assume that each act falls into exactly one category.

   Give an algorithm based on network flow to determine if it is possible to book acts for all the desired dates while obeying these constraints. If so, your algorithm should generate the schedule.

3. (1 point) Add a statement of collaboration to the top of your submission.