# Homework #5

CS 4120-5120

Fall, 2021

Problems 1 and 7 are for 0 points and are optional. Problem 5 counts for 10 points and the others for 5 points each.

1. [0 pts.] Study and understand the "greedy-choice property" (pages 424-425). The greedy choice, if locally optimal (possibly, but not necessarily, based on past choices), should lead to a globally optimum solution, independent of future choices. How does the fractional knapsack problem satisfy the greedy-choice property?

2. [5 pts.] What is an optimal Huffman code for each of the following symbols, based on their frequencies?
   a:10      b:2      c:4      d:5      e:15      f:9      g:6      h:8      i:12      j:1
   (Although you may, you won't necessarily have to convert these frequencies into percentages!)

3. [5 pts.] Exercise 22.3-1, page 610 of your text. Make a 3-by-3 chart with row and column labels WHITE, GREY, and BLACK. In each cell $(i, j)$, indicate whether, at any point during a depth-first search of a directed graph, there can be an edge from a vertex of color $i$ to a vertex of color $j$. For each possible edge, indicate what edge types (Tree, Forward, Back, and/or Cross) it can be. Make a second such chart for depth-first search of an undirected graph.
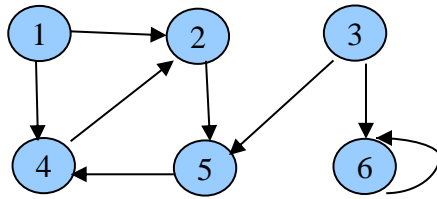
### Directed Graph:

|         | WHITE | GREY | BLACK |
|---------|-------|------|-------|
| WHITE   |       |      |       |
| GREY    |       |      |       |
| BLACK   |       |      |       |

### Undirected Graph:

|         | WHITE | GREY | BLACK |
|---------|-------|------|-------|
| WHITE   |       |      |       |
| GREY    |       |      |       |
| BLACK   |       |      |       |

4. [5 pts.]

(a) Exercise 22.2-1, page 601 of your text. Show the $d$ and $\pi$ values that result from running breadth-first search on the directed graph of Figure 22-2(a), using vertex 3 as the source.
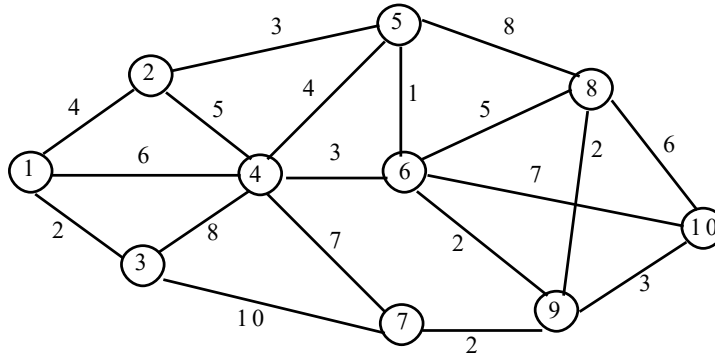


| Vertex | d | π |
|--------|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

(b) Exercise 22.2-2, page 601 of your text. Show the $d$ and $\pi$ values that result from running breadth-first search on the undirected graph of Figure 22-3, using vertex $u$ as the source.
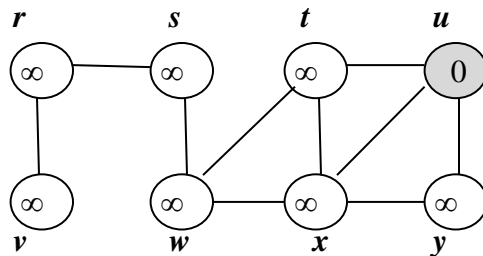


| Vertex | d | π |
|--------|---|---|
| r | | |
| s | | |
| t | | |
| u | | |
| v | | |
| w | | |
| x | | |
| y | | |

5. [10 pts.] Find the Minimum Spanning Tree for a graph $G = (V, E)$ using both the MST (Prim) algorithm and the *Kruskal*'s algorithm as described in class. Show your work.



6. [5 pts.] Exercise 24.3-1, page 662 of your text. Run Dijkstra's algorithm on the directed graph of Figure 24.2, first using vertex $s$ as the source and then using vertex $z$ as the source. In the style of Figure 24.6, show the $d$ and $\pi$ values and the vertices in set $S$ after each iteration of the **while** loop.

7. [0 pts.] Exercise 24.3-3, page 663 of your text. Suppose we change line 4 of Dijkstra's algorithm to the following:
   while $|Q| > 1$

   What is the impact of the change?