Homework #5

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CS 4120-5120 Due: Wed, Dec 01, 2021

Accepted until Mon, Dec 06, 2021

Fall, 2021 30 points

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!)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A | B | C | D | E | F | G | H | I | J |
| 00 | 01001 | 0101 | 11110 | 10 | 1110 | 11111 | 011 | 110 | 01000 |

1. [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** | Forward  Cross  Tree  Back | Cross  Back | Cross  Forward  Tree |
| **GREY** | Cross  Back | Forward  Back  Tree | Cross  Forward  Tree |
| **BLACK** | Cross  Back | Cross  Back | Forward  Cross  Tree  Back |

**Undirected Graph:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **WHITE** | **GREY** | **BLACK** |
| **WHITE** | Forward  Cross  Tree  Back |  |  |
| **GREY** | Forward  Cross  Tree  Back | Forward  Tree  Back |  |
| **BLACK** | Forward  Cross  Tree  Back | Forward  Cross  Tree  Back | Forward  Cross  Tree  Back |

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4. [5 pts.]

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

|  |  |  |
| --- | --- | --- |
| 1 | 2 | 3 |
| 4 | 5 | 6 |

|  |  |  |
| --- | --- | --- |
| ***Vertex*** | ***d*** | ***π*** |
| **1** | Infinity | Null |
| **2** | 3 | 4 |
| **3** | 0 | Null |
| **4** | 2 | 5 |
| **5** | 1 | 3 |
| **6** | 1 | 3 |

1. Exercise 22.2-2, page 601 of your text. Show the *d* and π values that result from running breadth-first search on the undirected graph of Figure 22-3, using vertex *u* as the source.

***r s t u***

∞

∞

∞

0

∞

∞

∞

∞



***v w x y***

|  |  |  |
| --- | --- | --- |
| ***Vertex*** | ***d*** | ***π*** |
| ***r*** | 4 | S |
| ***s*** | 3 | W |
| ***t*** | 1 | U |
| ***u*** | 0 | Null |
| ***v*** | 5 | R |
| ***w*** | 2 | T |
| ***x*** | 1 | U |
| ***y*** | 1 | U |

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1. [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.

1 2 2 2 2 3 3 3 4 4 5 5 6 6 7 7 8 8 10

A picture containing lamp, arranged

Description automatically generatedA picture containing lamp, arranged

Description automatically generated



A picture containing lamp, arranged

Description automatically generatedA picture containing lamp, arranged

Description automatically generated



A picture containing shape

Description automatically generated

1. [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 π values and the vertices in set *S* after each iteration of the **while** loop.

A picture containing clock, watch

Description automatically generated

s as initial vertex



|  |  |
| --- | --- |
| **D** | ***π*** |
| 0 | Null |
| 3 | S |
| 5 | T |
| 9 | Y |
| 11 | x |

A picture containing clock, watch

Description automatically generated

z as initial vertex



|  |  |
| --- | --- |
| **D** | ***π*** |
| 0 | Null |
| 3 | Z |
| 6 | S |
| 7 | T |
| 8 | T |

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1. [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?

The change makes it so that the while loop executes (absolute value V)-1 times. Which doesn’t affect the answer because even doing it one less time, we can still get the correct answer from the loop.