CIS 303 Algorithm Analysis and Design
Assignment 9, Problems:
Chapter 9, Searching; and Ch. 11, Graphs

Your Name Here

May 15, 2023

Scoring Summary

Question	Points	Score
1	5	
2	5	
3	5	
4	3	
5	3	
6	10	
7	10	
8	10	
Total:	51	

Directions:

- This is an individual assignment. 51 points.
- Solution must be typeset in LaTeX. Hand-drawn figures are fine, as long as they are neat and easy to read. Please submit ONLY ONE FILE! If you take photos of hand-drawn figures, put them into your LaTeX as images (that is, put them in line in your document as much as possible). You will submit the assignment in Moodle.
- **Important Reminder:** You are supposed to be writing your own solution for homework. Using solutions from any source other than your own brain is cheating. This does not mean that you can't look up information or ideas, you just can't copy solutions or parts of solutions.

1. (5 points) Assume that you have a seven-slot closed hash table (the slots are numbered 0 through 6). By filling in the table below, (a) Show the final hash table that would result if you used the hash function $h(K) = K \ mod\ 7$ and **linear probing** on this list of numbers: 28, 6, 9, 14, and (b) After inserting all keys, for each empty slot, give the probability that the slot will be the next one filled. Assume that $p(K, i) = i$.

Solution:

Slot	(a) Value Stored	(b) Probability Filled Next
0		
1		
2		
3		
4		
5		
6		

2. (5 points) Assume that you have an ten-slot closed hash table (the slots are numbered 0 through 9). Show the final hash table that would result if you used the hash function $h(K) = K \ mod \ 10$ and **pseudo-random probing** on this list of numbers: 3, 12, 9, 2, 79, 44. The permutation of offsets to be used by pseudo-random probing will be: 2, 4, 9, 3, 1, 7, 6, 5, 8. After inserting all keys, for each empty slot, give the probability that the slot will be the next one filled.

Solution:

Slot	(a) Value Stored	(b) Probability Filled Next
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		

3. (5 points) Using closed hashing, with double hashing to resolve collisions, insert the following keys into a hash table of 13 slots (the slots are numbered 0 through 12). The hash functions to be used are h_1 and h_2, defined below. Show the hash table after all eight keys (listed below) have been inserted. Show how h_1 and h_2 produce the slot for each key. That is, show the values returned by the hash functions. If a collision occurs when inserting a key, show in detail how h_2 produces the probe sequence. *Note:* Function $Rev(K)$ reverses the decimal digits of K. For example, $Rev(37) = 73$; $Rev(7) = 7$.

$h_1(K) = K \ mod \ 13$
$h_2(K) = Rev(K + 1) \ mod \ 7$

Keys: 2, 27, 8, 18, 41, 21

Solution:

Slot	Value Stored	How the slot was produced
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

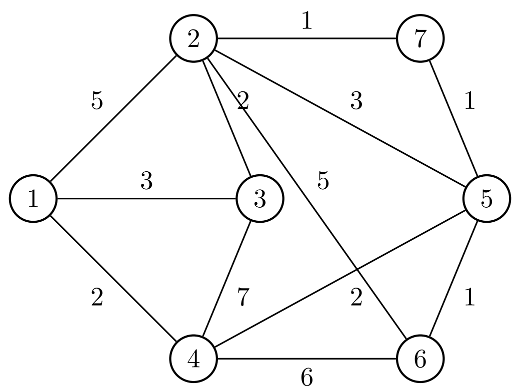

Figure 1: Graph for problems 4. 5. 6, 7.

4. (3 points) Show the Depth First Search for the graph in Figure 1 starting at the vertex labeled 1. Assume that the lowest unmarked vertex (*i.e.,* the vertex with the lowest label; do not use edge costs for this problem) is always chosen first.

Solution: Your solution here.

5. (3 points) Show a Breadth First Search beginning at the vertex labeled 1 for the graph in Figure 1, assuming that lowest number vertices (*i.e.,* the vertex with the lowest label; do not use edge costs for this problem) enter the queue first.

Solution: Your solution here.

6. (10 points) List the order in which the edges of the graph in Figure 1 are visited when running **Prim's MST algorithm** starting at vertex 3. If there are two equal candidate edges, take the one that has the smallest vertex label. Show the vertices and edges selected after each iteration of the loop. The first step is shown below.

Vertices = {3}, Edges = {}

Solution: Your solution here.

7. (10 points) List the order in which the edges of the graph in Figure 1 are visited when running **Kruskal's MST algorithm**. If there are two equal candidate edges, consider them in the order of the one that has the smallest vertex label. Show the partition of vertices and edges selected after each iteration of the loop. The first step is shown below.

   Partitions = {{1}, {2}, {3}, {4}, {5}, {6}}; Edges = {}

   Solution: Your solution here.

8. (10 points) Show the shortest paths generated by Dijkstra's shortest paths algorithm beginning at vertex A in the graph in Figure 2. Show the trace of each vertex, its distance from B, and the path so far after each iteration of the `while` loop, that is, after each vertex becomes "known". Underline or bold known vertices. I have provided the initialization and the first iteration to get you started and show you the format. **You are REQUIRED to use the trace format that I have given you. I will not accept a different format.**

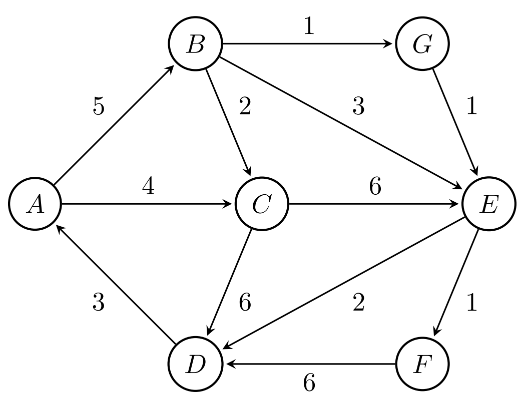

Figure 2: Graph for problem 8.

   Solution:

Iteration	Vertex	A	B	C	D	E	F	G
Init.	**Distance**	0	∞	∞	∞	∞	∞	∞
	Path	A	–	–	–	–	–	–
1	**Distance**							
	Path							
2	**Distance**							
	Path							
3	**Distance**							
	Path							
4	**Distance**							
	Path							
5	**Distance**							
	Path							
6	**Distance**							
	Path							
7	**Distance**							
	Path							