University of Nevada, Las Vegas Computer Science 477/677 Spring 2023

Answers Assignment 5: Due Saturday April 1, 2023

Name:_____

You are permitted to work in groups, get help from others, read books, and use the internet. You will receive a message from the graduage assistant, Sepideh Farivar, telling you how to turn in the assignment.

1. Write pseudocode for the Floyd-Warshall algorithm. for a weighted directed graph of n vertices. Assume that the vertices are numbered $1 \ldots n$, and that $W[i, j]$ is the weight of the edge, if any, from i to j. If there is no such edge, the value of $W[i, j]$ is given to be ∞. Your output should be two arrays, V and B (for back). The value of $V[i, j]$ is the length of the shortest path from i to j, and the value of $B[i, j]$ is the next-to-the-last vertex in the shortest path from i to j. For any vertex i, $B[i, i]$ is undefined.

   for all i and all j
   $V[i, j] = W[i, j]$ and $B[i, j] = i$
   for all j
   for all i
   for all k
   if $(V[i, j] + V[j, k] < V[i, k])$
   $V[i, k] = V[i, j] + V[j, k]$ and $B[i, k] = B[j, k]$

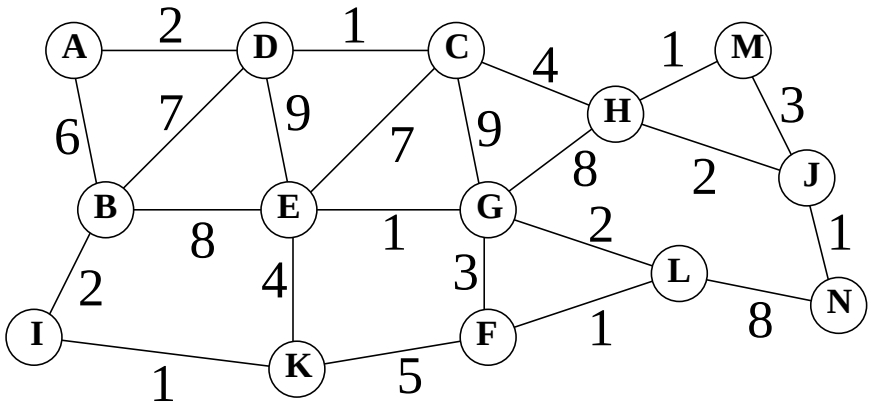
2. Write pseudocode for the Bellman-Ford algorithm. Your code should include the shortcut that ends computation if it is certain that all shortest paths have been found.

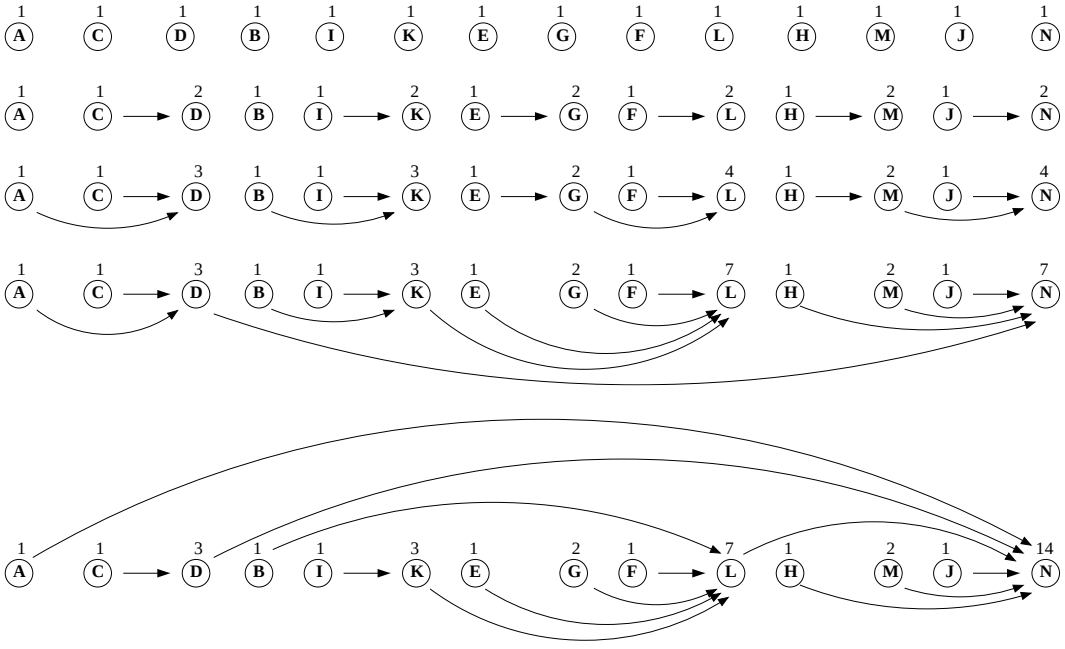
   Let the source vertex be 0 and the other vertices 1, 2, ... n. Let $W[i, j]$ be the length of the edge from i to j, which could be infinity. We compute $V[i]$, the least cost of any path from 0 to i, as well as $B[i]$, the back pointer, for each positive i. Let m be the number of arcs. Let $(x[j], y[j])$ be the j^{th} arc, and let $W[j]$ be the weight of that arc.

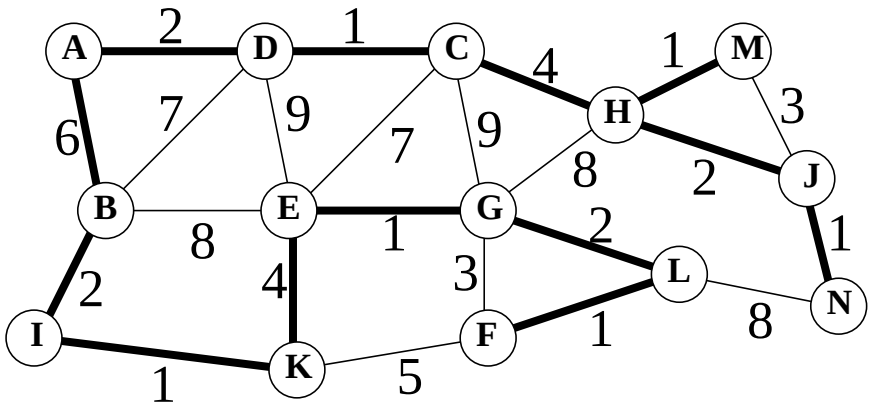
```
for all i from 1 to n
  V[i] = ∞
V[0] = 0
changed = true
while(changed)
 {
   changed = false
   for all j from 1 to m
     if (V[x[j]] + W[j] < V[y[j]])
       {
         V[y[j]] = V[x[j] + W[j]
         B[y[j]] = x[j]
         changed = true
       }
 }
```

If no least cost path has more than d edges, the code will run in $O(md)$ time if the graph has no negative cycle. However, it will run forever if the graph has a negative cycle. The code can be modified to detect negative cycles, but then it will execute in $\Theta(nm)$ time. I suspect that in practical cases, d is a lot smaller than n.

3. Walk through Kruskal's algorithm to find the minimum spanning tree of the weighted graph shown below. Indicate the steps of Union/Find.







6. Walk through the steps of heapsort for the array UBRYPQSVFMT. Show the array after each exchange.

1	2	3	4	5	6	7	8	9	10	11
U	B	R	Y	P	Q	S	V	F	M	T
U	B	R	Y	T	Q	S	V	F	M	P
U	B	S	Y	T	Q	R	V	F	M	P
U	Y	S	B	T	Q	R	V	F	M	P
U	Y	S	V	T	Q	R	B	F	M	P
Y	U	S	V	T	Q	R	B	F	M	P
Y	V	S	U	T	Q	R	B	F	M	P
P	V	S	U	T	Q	R	B	F	M	Y
V	P	S	U	T	Q	R	B	F	M	Y
V	U	S	P	T	Q	R	B	F	M	Y
V	U	S	P	T	Q	R	B	F	M	Y
M	U	S	P	T	Q	R	B	F	V	Y
U	M	S	P	T	Q	R	B	F	V	Y
U	T	S	P	M	Q	R	B	F	V	Y
F	T	S	P	M	Q	R	B	U	V	Y
T	F	S	P	M	Q	R	B	U	V	Y
T	P	S	F	M	Q	R	B	U	V	Y
B	P	S	F	M	Q	R	T	U	V	Y
S	P	B	F	M	Q	R	T	U	V	Y
S	P	R	F	M	Q	B	T	U	V	Y
B	P	R	F	M	Q	S	T	U	V	Y
R	P	B	F	M	Q	S	T	U	V	Y
R	P	Q	F	M	B	S	T	U	V	Y
B	P	Q	F	M	R	S	T	U	V	Y
Q	P	B	F	M	R	S	T	U	V	Y
M	P	B	F	Q	R	S	T	U	V	Y
P	M	B	F	Q	R	S	T	U	V	Y
P	M	B	F	Q	R	S	T	U	V	Y
F	M	B	P	Q	R	S	T	U	V	Y
M	F	B	P	Q	R	S	T	U	V	Y
B	F	M	P	Q	R	S	T	U	V	Y