CSPB 3104 - Park - Algorithms

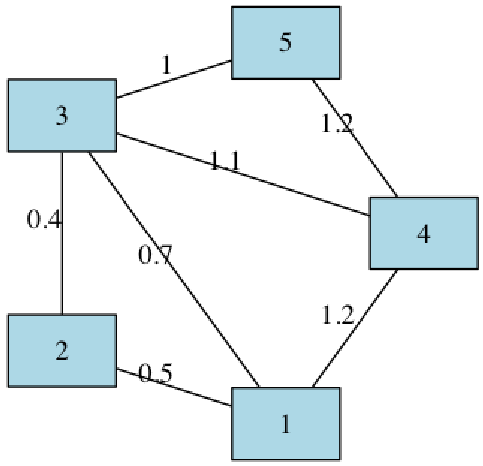
Started on	Tuesday, 2 April 2024, 9:49 PM
State	Finished
Completed on	Tuesday, 2 April 2024, 9:55 PM
Time taken	5 mins 55 secs
Marks	43.00/43.00
Grade	**10.00** out of 10.00 (**100**%)

Question **1**

Correct

Mark 5.00 out of 5.00

Consider the graph below



We treat it as a directed graph with undirected edges replaced by directed edges in both directions.

Consider the single source shortest path from source node 1. For each of the following edges

- write SP if the edge belongs to the shortest path tree but not to the minimum spanning tree of the graph,
- write MST if the edge belongs to the MST but not the shortest path tree
- write BOTH if the edge belongs to both trees
- write NONE if the edge belongs to neither

Note that the minimum spanning tree is undirected and shortest path tree is directed.

If an undirected edge belongs to the MST, assume that both the corresponding directed edges both belong to the MST.

1. Edge (1,2)

BOTH

2. Edge (1,3)

SP

3. Edge (2,3)

MST

4. Edge (3,5)

BOTH

5. Edge (1,4)

SP

Correct

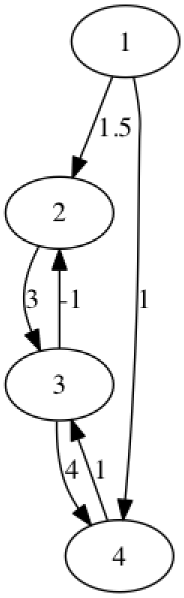
Marks for this submission: 5.00/5.00.

Question **2**

Correct

Mark 11.00 out of 11.00

Consider the graph below:



The following questions pertain to the steps of the Bellman-Ford algorithm for single source shortest path for source node 1.

(A) What is the initial distance estimate for the node 1?

0

(B) What is the initial distance estimate for the node 4?

- (•) Infinite Correct
- ( ) 0
- ( ) 10
- ( ) 3

Mark 1.00 out of 1.00

The correct answer is: Infinite

(C) Suppose, we use edge (1,4) to relax the initial distance estimate, what is the updated distance estimate for 4?

1

Subsequent to part (C), we now use edges (4,3) and (1,2) to relax.

(D) What is the new distance estimate for node 3?

2

(E) What is the new distance estimate for node 2?

1.5

(F) Which of the edges should we relax to further update the distance estimate for node 2?

(•) (3,2) Correct ( ) (1,2) ( ) (2,3) ( ) (1,4) ( ) (3,4)

Mark 1.00 out of 1.00

The correct answer is: (3,2)

(G) How many iterations will the outer loop of Bellman-Ford need to run for this graph?

3

After the Bellman-Ford algorithm has finished running, what are the distance estimates for each of the nodes?

(H) Node 1

0

(I) Node 2

1

(J) Node 3

2

(K) Node 4

1

Correct

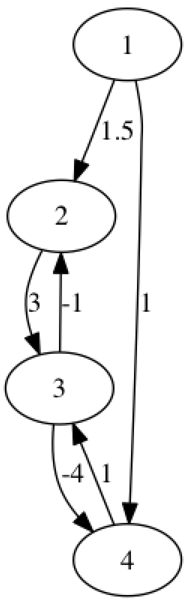
Marks for this submission: 11.00/11.00.

Question **3**

Correct

Mark 11.00 out of 11.00

Now, consider the graph shown below. It is the same graph as the previous problem with the weight of edge (3,4) modified.



Now answer the following questions about Bellman Ford algorithm.

Suppose edges are iterated in the following order for the inner loop of Bellman-Ford.

(1,2) (2,3) (3,4) (1,4) (4,3) (3,2)

It helps to have a pencil and paper with a copy of the key problem data, to work through the algorithms before/during filling in the answers below.

Starting from the initial distance estimate and iterating through the edges once in the order shown above, what are the distance estimates to the nodes in the graph:

(A) Distance estimate for node 1

0

(B) Distance estimate for node 2

0.5

(C) Distance estimate for node 3

1.5

(D) Distance estimate for node 4

0.5

Iterate through the edges once more in the same order:

(1,2) (2,3) (3,4) (1,4) (4,3) (3,2)

What are the new distance estimates?

(E) Distance estimate for node 2

-2.5

(F) Distance estimate for node 3

-1.5

(G) Distance estimate for node 4

-2.5

Iterate through the edges once more in the same order:

(1,2) (2,3) (3,4) (1,4) (4,3) (3,2)

What are the new distance estimates?

(H) Distance estimate for node 2

-5.5

(I) Distance estimate for node 3

-4.5

(J) Distance estimate for node 4

-5.5

(K) Now that three iterations of the algorithm have concluded, identify an edge in the graph that can be used to relax and update the distance estimates further:

- (3,4) Correct
- (1,2)
- (1,4)
- (2,3)
- (4,3)
- (3,2)

Mark 1.00 out of 1.00

The correct answer is: (3,4)

Correct

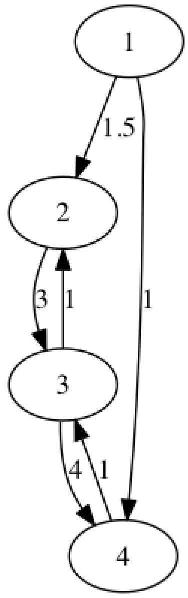
Marks for this submission: 11.00/11.00.

Question **4**

Correct

Mark 11.00 out of 11.00

Consider the graph below which modifies the graph in the previous problems with all positive weights.



We will now work through the steps of Dijkstra algorithm for computing single source shortest path with the source vertex 1.

Working out the detailed steps of the algorithm on pencil/paper is highly recommended as you fill in the answers below.

(A) What is the vertex with the lowest estimate at the beginning of the algorithm? Enter the vertex id in the space below:

1

(B) Once the vertex in part (A) has been added, which of the edges below is among the edges that are relaxed?

- (x) (1,2) Correct
- ( ) (2,3)
- ( ) (3,4)
- ( ) (4,3)
- ( ) (3,2)

Mark 1.00 out of 1.00

The correct answer is: (1,2)

What are the distance estimates for various nodes after the vertex chosen in (A) is added to the set S?

(C) Node 2

- (x) 1.5 Correct
- ( ) 1
- ( ) Infinite
- ( ) 2
- ( ) 3
- ( ) 4

Mark 1.00 out of 1.00

The correct answer is: 1.5

(D) Node 3

- (x) Infinite Correct
- ( ) 1

- 1.5
- 2
- 3
- 4

Mark 1.00 out of 1.00

The correct answer is: Infinite

(E) Node 4

- (selected) 1 Correct
- 1.5
- Infinite
- 2
- 3
- 4

Mark 1.00 out of 1.00

The correct answer is: 1

(F) What is the next vertex chosen from the priority queue? Enter the vertex id in the space below 4

(G) Which node gets its distance estimate updated as a result of the answer in (F)? 3

(H) What is the next vertex chosen from the priority queue? Enter the vertex id in the space below: 2

(I) What is the final vertex taken out of the priority queue? Enter the vertex id in the space below:

3

(J) How many vertices were dequeued from the priority queue during the course of the algorithm's execution on this graph? 4

(K) How many edge relax operations are carried out during the course of the algorithm's execution on this graph?

4

Correct

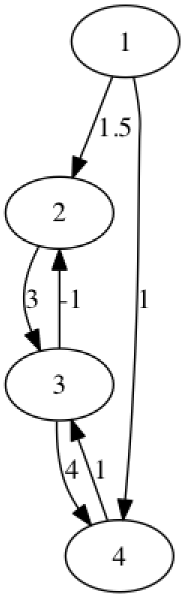
Marks for this submission: 11.00/11.00.

Question **5**

Correct

Mark 5.00 out of 5.00

Now consider the graph with a negative edge shown below.



Once again, our goal is to run Dijkstra's algorithm to compute single source shortest path.

At the start node 1 is dequeued from the priority queue and added into the set S, what are the updated distance estimates for each of the remaining nodes? Enter the answer in the box either as a number or enter INFINITE to denote infinity distance

(A) Node 2

1.5

(B) Node 3

INFINITE

(C) Node 4

1

Next, node 4 is dequeued and node 3's cost is updated to 2.

(D) Which node is dequeued next? Enter id in the space below

2

(E) What goes wrong in step (D) with Dijkstra's algorithm?

- (selected) The dequeued node's shortest path distance is not correct because of a negative weight edge Correct
- Nothing is wrong: Dijkstra's algorithm can work until completion on this graph
- The second smallest node in the priority queue should be dequeued whenever the graph has negative weight edgee
- Dijkstra's Algorithm works fine since there are no negative weight cycles

Mark 1.00 out of 1.00

The correct answer is: The dequeued node's shortest path distance is not correct because of a negative weight edge

Correct

Marks for this submission: 5.00/5.00.