Decision Modeling (NPTEL Online Course)
Tutorial 8 (Network Models - Module 36 to Module 40)

Note: Answers are marked in Bold

1. A transportation problem has 3 sources and 4 destinations. In order to solve the problem by network simplex method, initially we need to:
   i. **Consider a spanning tree with 6 edges and obtain an initial solution**
   ii. Consider a spanning tree with 7 edges and obtain an initial solution
   iii. Consider a fundamental circuit of 4 edges and obtain flow balance
   iv. Consider a fundamental circuit of 6 edges and obtain flow balance

2. Consider the transportation problem given below. The initial solution to this problem is expressed in solid red lines. For this initial solution:
   i. Total cost = 90
   ii. Total cost = 100
   iii. Total cost = 110
   iv. **Total cost = 120**

3. Node Potentials in the Network simplex algorithms are expressed in:
   i. Demand units
   ii. Supply units
   iii. **Cost units**
   iv. Flow units

4. An usual assumption to Flow network problems is:
   i. multiple sources but a single sink
   ii. limited node capacity
iii. flow losses in the arcs
iv. no minimum limit to the flow

5. Relationship between cuts and cutsets leads to this one:
   i. all cuts are cutsets and all cutsets are cuts
   ii. all cuts are cutsets but all cutsets are not cuts
   iii. all cuts are not cutsets but all cutsets are cuts
   iv. all cuts are not cutsets and all cutsets are not cuts

6. --------------- value of flow from source to sink is equal to the ---------------value of the capacities of all the cuts in the network that separates source from the sink
   (i) Maximum, maximum
   (ii) Maximum, minimum
   (iii) Minimum, Maximum
   (iv) Minimum, Minimum

7. In the network given below, if the flow is from s to t, what is the capacity of cut \{s, 3, 4\}
   i. 15
   ii. 19
   iii. 21
   iv. 22

8. Water is to be transported from the Big Dam to the Low Valley for irrigation through a network of pipelines as shown. In the diagram, the arcs represent pipelines and numbers on arcs represent maximum permitted rate of water flow in kilo-tons per hour.
The Maximum Rate of Flow from the Big Dam to the Low Valley would be:

i. 140 kilo-tons per hour  
**ii. 150 kilo-tons per hour**  
iii. 170 kilo-tons per hour  
iv. 180 kilo-tons per hour

9. Water is to be transported from the Big Dam to the Low Valley for irrigation through a network of pipelines as shown. In the diagram, the arcs represent pipelines and numbers on arcs represent maximum permitted rate of water flow in kilo-tons per hour.

![Diagram of water transportation network](image)

For Maximum Rate of Flow from the Big Dam to the Low Valley, the flow capacity in the arc with maximum flow capacity of 30 kilo-tons per hour would be:

i. Fully utilized  
ii. Partially utilized  
iii. Not utilized at all  
iv. Not possible to calculate with certainty

10. Which of the following algorithms considers all pairs of shortest paths?

i. A* search algorithm  
ii. Dijkstra’s algorithm  
iii. Bellman-Ford algorithm  
**iv. Floyd-Warshall algorithm**

11. Dijkstra’s algorithm is based on

i. Linear programming  
ii. Genetic programming  
**iii. Dynamic programming**  
iv. Goal programming

12. In the final step of calculating Shortest Path by Dijkstra’s algorithm, the following table is obtained. What is the shortest path from l to q?
13. Consider a network with directed arcs with distances as shown.

Find the Shortest Path between Node 1 and Node 7 by using Dijkstra's algorithm. Its length would be:

i. 16
ii. 17
iii. 18
iv. 21

14. Consider a network with directed arcs with distances as shown.

Find the Shortest Path between Node 1 and Node 6 by using Dijkstra's algorithm. Its length would be:
15. Consider a network with directed arcs with distances as shown.

Find the Shortest Path between Node 1 and Node 5 by using Floyd's algorithm. Number of edges in this shortest path will be:

i. 2  
ii. 3  
iii. 4  
iv. 5

Explanations to selected problems

2. Total cost = 1 (C_{23}) * 20 (d_3) + 1 (C_{21}) * 20 (d_1) + 2 (C_{12}) * 30 (d_2) + 2 (C_{11}) * 10(d_1) = 120

7. The capacity of cut \{s, 3, 4\} = 7 + 2 + 7 + 5 = 21

8. For convenience of calculation, we represent the network as follows
After applying the maximal flow algorithm we will obtain the following matrix

<table>
<thead>
<tr>
<th>Path</th>
<th>Flow</th>
</tr>
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<tbody>
<tr>
<td>1-3-4-6</td>
<td>70</td>
</tr>
<tr>
<td>1-2-3-5-6</td>
<td>40</td>
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<tr>
<td>1-2-4-5-6</td>
<td>30</td>
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<tr>
<td>1-2-4-6</td>
<td>10</td>
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12. ‘q’ is made from ‘o’; ‘o’ is made from ‘m’; ‘m’ is made from ‘l’. Hence the shortest path is l-m-o-q

13.

<table>
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<tr>
<th>Step</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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15. Final distance matrix and route matrix is as shown below

\[
\begin{array}{ccccccc}
1 & 2 & 3 & 4 & 5 & 6 \\
1 & 4 & 2 & 5 & 3 & 8 & 9 \\
2 & 2 & 4 & 5 & 5 & 8 & 9 \\
3 & 5 & 5 & 4 & 2 & 3 & 4 \\
4 & 3 & 5 & 2 & 2 & 5 & 6 \\
5 & 8 & 8 & 3 & 5 & 2 & 1 \\
6 & 9 & 9 & 4 & 6 & 1 & 2 \\
\end{array}
\]

\[
\begin{array}{ccccccc}
1 & 2 & 3 & 4 & 5 & 6 \\
1 & 2 & 2 & 4 & 4 & 4 & 5 \\
2 & 1 & 1 & 3 & 1 & 3 & 5 \\
3 & 4 & 2 & 4 & 4 & 5 & 5 \\
4 & 1 & 1 & 3 & 1 & 3 & 5 \\
5 & 4 & 3 & 3 & 3 & 6 & 5 \\
6 & 5 & 5 & 5 & 5 & 5 & 5 \\
\end{array}
\]

Shortest path from Node 1 to Node 5 = 1-4-3-5. Hence the number of edges = 3.