Lecture 13- Shortest Paths

1. Which of the following algorithm is the most efficient for finding single source shortest paths in a Directed Acyclic Graph?
A) Dijkstra's algorithm
B) Bellman-Ford
C) BFS (Breadth-First Search)
D) Topological Sort
Answer: D) Topological Sort
Explanation: Topological Sort has complexity O(V+E), which is the most efficient algorithm among the three

Which algorithm is the most efficient for finding the shortest path in an unweighted graph?
A) Kruskal's algorithm
B) DFS (Depth-First Search)
C) BFS (Breadth-First Search)
D) Topological Sort
Answer: C) BFS (Breadth-First Search)

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2. What data structures are used in BFS to track the shortest distance (SD) and previous node (PN)?
A) Stack and Queue
B) Priority Queue and Hash Map
C) Two maps: one for SD and one for PN
D) Adjacency List and Array
Answer: C) Two maps: one for SD and one for PN

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3. Dijkstra's Algorithm is NOT suitable for graphs with:
A) Non-negative edge weights
B) Directed edges
C) Negative edge weights
D) Undirected edges
Answer: C) Negative edge weights

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4. What is the time complexity of Dijkstra's Algorithm using a binary min-heap?
A) O(V + E)
B) O((V + E) log V)
C) $O(V^2)$
D) O(E log V)
Answer: B) O((V + E) log V)

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5. During edge relaxation, if a shorter path to node *v* is found through node *u*, what happens?
A) SD[v] and PN[v] are updated
B) SD[u] is reset to infinity
C) PN[u] is set to *v*
D) The edge $u \rightarrow v$ is removed
Answer: A) SD[v] and PN[v] are updated

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6. In Dijkstra's algorithm, how is the priority queue used to select the next node to visit?
A) The node with the largest known distance is chosen first.
B) The node with the smallest Shortest Distance (SD) is chosen first.
C) Nodes are processed in alphabetical order.
D) Nodes are selected based on the number of edges.
Answer: B) The node with the smallest Shortest Distance (SD) is chosen first.

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7. In the Shortest Path Tree (SPT), what does the PN map store?
A) The shortest distance from the source
B) The previous node in the shortest path
C) The weight of edges
D) The next node to visit
Answer: B) The previous node in the shortest path

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8. What is the first step in Dijkstra's Algorithm?
A) Relax all edges
B) Initialize SD for the source node to 0 and others to ∞
C) Mark all nodes as known
D) Sort edges by weight
Answer: B) Initialize SD for the source node to 0 and others to ∞

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9. Which algorithm processes nodes in topological order for shortest paths?
A) BFS
B) Dijkstra's Algorithm
C) Bellman-Ford Algorithm
D) Topological Sort-based algorithm
Answer: D) Topological Sort-based algorithm

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10. In BFS, nodes are visited in order of:
A) Increasing edge weights
B) Decreasing distance from the source

C) Increasing distance from the source
D) Alphabetical order
Answer: C) Increasing distance from the source

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11. After running Dijkstra's Algorithm, how is the shortest path reconstructed?
A) Using the adjacency list
B) Following backpointers in the PN map
C) Sorting the SD map
D) Reversing the visit order
Answer: B) Following backpointers in the PN map

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12. What is a key advantage of using Topological Sort for shortest paths in a DAG?
A) Handles negative weights
B) Runs in linear time
C) Works for cyclic graphs
D) Uses a priority queue
Answer: B) Runs in linear time

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13. During the edge relaxation step in Dijkstra's algorithm, which condition must be met to update the shortest distance (SD) to node *v*?
A) SD[v] < SD[u] + w(u,v)
B) SD[v] > SD[u] + w(u,v)
C) SD[u] < SD[v] + w(u,v)
D) SD[v] == SD[u] + w(u,v)
Answer: B) SD[v] > SD[u] + w(u,v)

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14. **True or false: Given a graph where all edges have positive weights, the shortest paths produced by Dijsktra and Bellman Ford algorithm may be different but path weight would always be same.**
Answer: True
Explanation: Dijkstra and Bellman-Ford both work fine for a graph with all positive weights, but they are different algorithms and may pick different edges for shortest paths.