
# Data Structure & Algorithms

Sunbeam Infotech

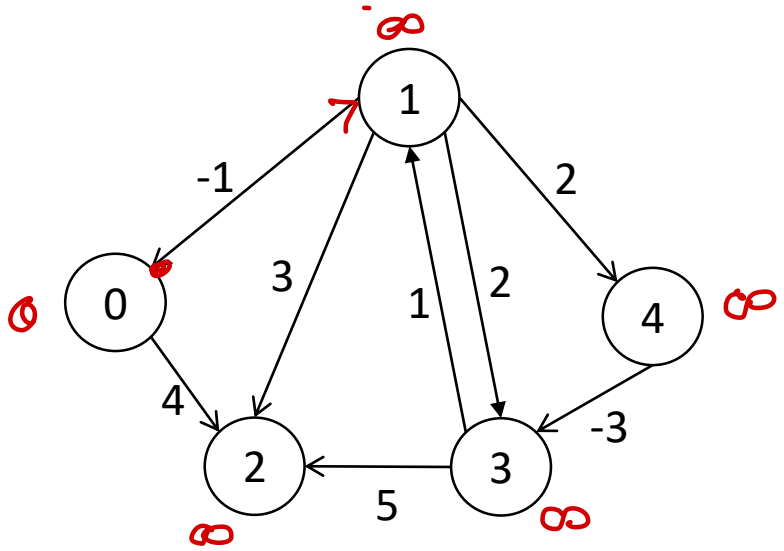
# Agenda

- Bellaman Ford algorithm
- Warshall Floyd algorithm
- Johnson algorithm
- Quiz discussion

# Bellman Ford Algorithm

- Single Source Shortest Path Algo. - DP

- Initializes distances from the source to all vertices as infinite and distance to the source itself as 0.
- Calculates shortest distance V-1 times: For each edge u-v, if dist[v] > dist[u] + weight of edge u-v, then update dist[v], so that dist[v] = dist[u] + weight of edge u-v.
- Check if negative ~~edge~~ cycle in the graph: For each edge u-v, if dist[v] > dist[u] + weight of edge uv, then graph has –ve weight cycle.
- Time complexity of algorithm is O(VE).




| Src | Des | Wt |
|---|---|---|
| 1 | 4 | 2 |
| 3 | 1 | 1 |
| 1 | 3 | 2 |
| 0 | 1 | -1 |
| 0 | 2 | 4 |
| 3 | 2 | 5 |
| 1 | 2 | 3 |
| 4 | 3 | -3 |

Dijkstra's Algo:

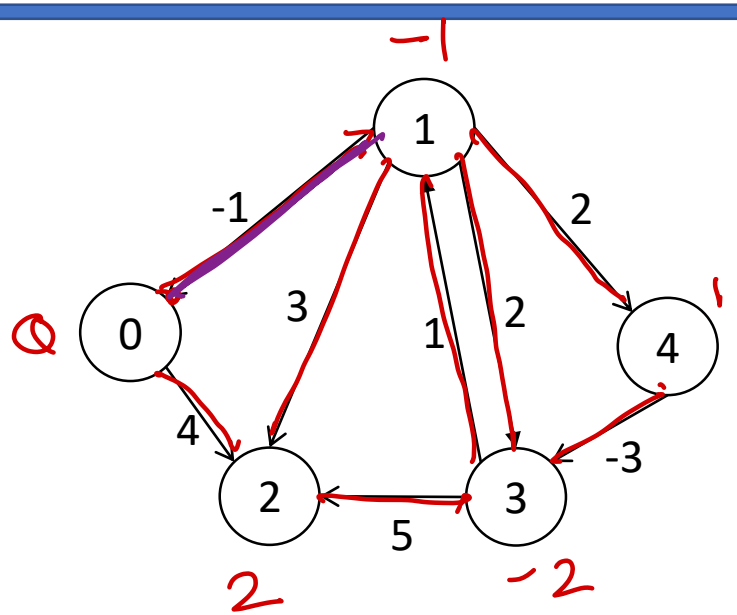
① Can't work with -ve weight edges.

② O(V log V)

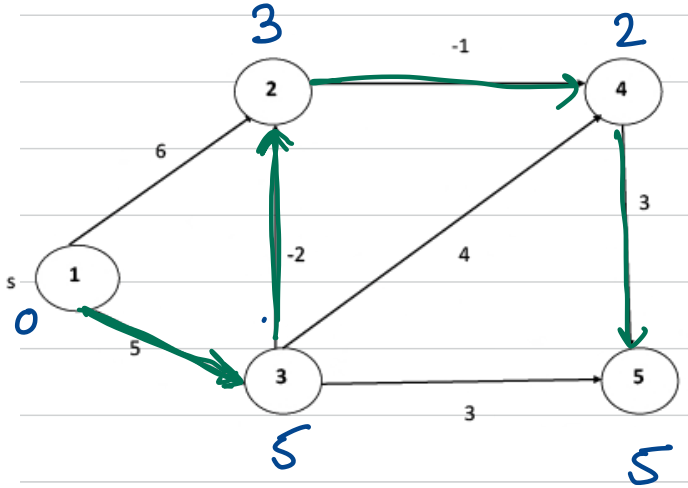
dist(v) = dist(u) + weight(u,v)

# Bellman Ford Algorithm

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| | 0 | ∞ | ∞ | ∞ | ∞ |
| P1 | 0 | -1 | 2 | ∞ | ∞ |
| P2 | 0 | -1 | 2 | -2 | 1 |
| P3 | 0 | -1 | 2 | -2 | 1 |
| P4 | 0 | -1 | 2 | -2 | 1 |




| Src | Des | Wt |
|---|---|---|
| 1 | 4 | 2 |
| 3 | 1 | 1 |
| 1 | 3 | 2 |
| 0 | 1 | -1 |
| 0 | 2 | 4 |
| 3 | 2 | 5 |
| 1 | 2 | 3 |
| 4 | 3 | -3 |




| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | 0 | ∞ | ∞ | ∞ | ∞ |
| P1 | 0 | 6 | 5 | ∞ | ∞ |
| P2 | 0 | 3 | 5 | 2 | 8 |
| P3 | 0 | 3 | 5 | 2 | 5 |
| P4 | 0 | 3 | 5 | 2 | 5 |

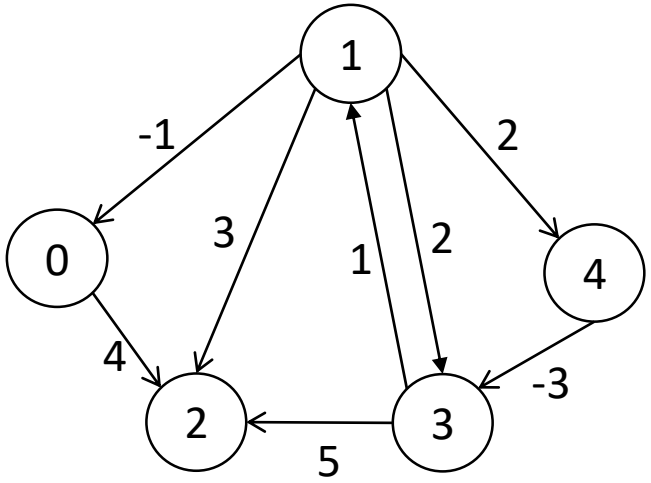
| u | v | w |
|---|---|---|
| 4 | 5 | 3 |
| 3 | 5 | 3 |
| 3 | 4 | 4 |
| 3 | 2 | -2 |
| 2 | 4 | -1 |
| 1 | 3 | 5 |
| 1 | 2 | 6 |

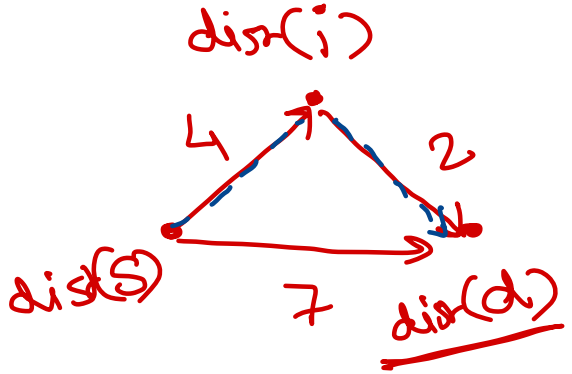
# Warshall Floyd Algorithm

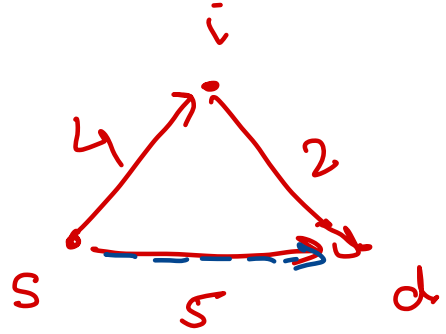
all pair shortest path.

- Algorithm
  1. Create distance matrix to keep distance of every vertex from each vertex. Initially assign it with weights of all edges among vertices (i.e. adjacency matrix).
  2. Consider each vertex (i) in between pair of any two vertices (s, d) and find the optimal distance between s & d considering intermediate vertex i.e. dist(s,d) = dist(s,i) + dist(i,d), if dist(s,i) + dist(i,d) < dist(s,d).
- Algorithm time complexity is $O(V^3)$.

| | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 0 | 0 | ∞ | 4 | ∞ | ∞ |
| 1 | -1 | 0 | 3 | 2 | 2 |
| 2 | ∞ | ∞ | 0 | ∞ | ∞ |
| 3 | ∞ | 1 | 5 | 0 | ∞ |
| 4 | ∞ | ∞ | ∞ | -3 | 0 |



Dijkstra's algo = $O(V \log V)$

if we apply Dijkstra on all vertices.

$= O(V * V * \log V)$

This is efficient than W.F.

This works only if, graph doesn't have -ve edges.

Bellman ford Time complexity = $O(VE)$.

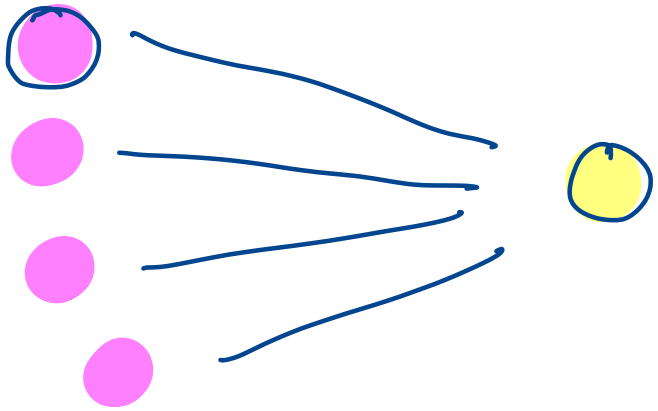
applying it for all V vertices, → $O(V^*VE)$

↓

This is much higher than WF.

# Johnson's Algorithm

- Time complexity of Warshall Floyd is $O(V^3)$.
- Applying Dijkstra's algorithm on V vertices will cause time complexity O(V * V log V). This is faster than Warshall Floyd.
- However Dijkstra's algorithm can't work with –ve weight edges.
- This can be handled by applying Bellman Ford on graph once to reweight all the edges, so that no negative edges are left in the graph. Then Dijkstra can be used on all vertices. This is Johnson's algorithm.
- Time complexity of the algorithm: $O(VE + V^2 \log V)$.



A* search algo

↳ Point to point shortest path.

# DS Quiz

# MCQ

8. To sort 44, 88, 22, 99, 55, 11, 33 in descending order using selection sort how many comparisions and swappings will be required?

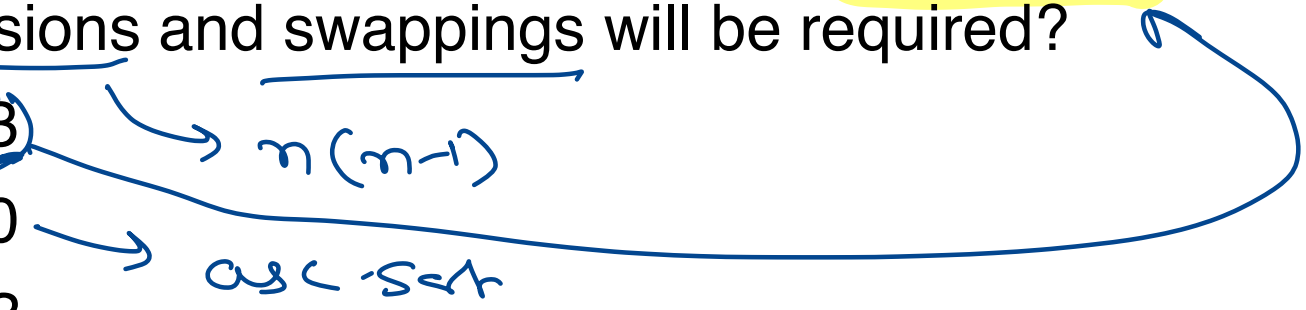
A. 42, 13

B. 42, 10

C. 49, 13

D. 49, 10

Answer: A



# MCQ

Q. Which of the following is not divide-and-conquer algorithm?

A. Quick Sort

B. Merge Sort

C. Heap Sort

D. Binary Search

Answer: C

# MCQ

Q. What is best case and worst case time complexity of insertion sort?

A. O(1), O(n^n)

B. O(n), O(n^n)

C. O(n^n), O(n^n)

D. None of these

Answer: B

# MCQ

Q. Which is postfix equivalent of a+b*(c^d-e)^(f+g*h)-i ?

A. abc^de-fg+*^*+i-

B. abcde^-fg*+*^h*+i-

C. abcd^e-fgh*+^*+i-

D. ab^-dc*+ef^gh*+i-

Answer: C

^ or $

Expanded form

# MCQ

Q. How many minimum pointers are required to delete the last node from the singly circular linked list (with head pointer) and what will be time complexity of the operation?

A. 1 pointer, O(1)

B. 2 pointer, O(n)

C. 1 pointer, O(n)

D. 2 pointer, O(1)

Answer: B

# MCQ

Q. Which of the following is application of priority queue?

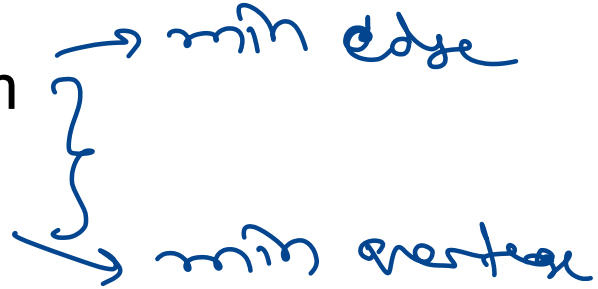
A. Heap Sort

B. Kruskal's MST algorithm

C. Prim's MST algorithm

D. All of the above

Answer: D



# MCQ

Q. If temp is pointer to a node in doubly linked list, what is use of following code?

```
temp->next->prev = temp->prev;
temp->prev->next = temp->next;
```

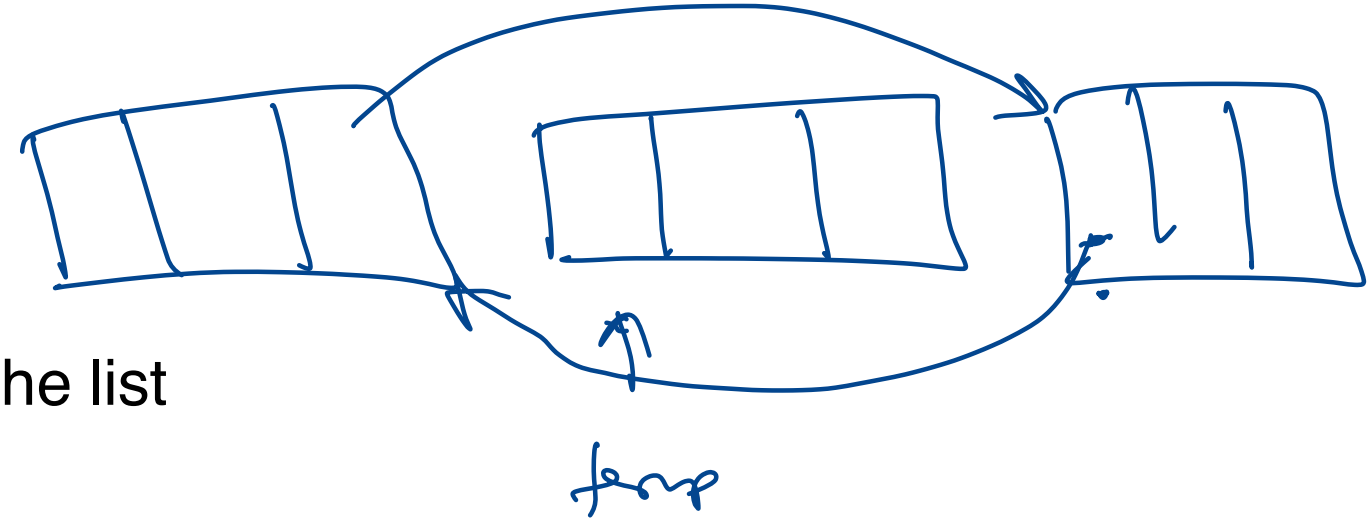
A. Delete node from the list

B. Detach node from the list

C. No changes are done in the list

D. Swap next and previous nodes from the list

Answer: B



# MCQ

Q. Which balancing tree is preferred, if frequent addition & deletion is needed?

A. AVL tree

B. RB tree

C. Binary Search tree

D. None of these

Answer: B

# MCQ

Q. What is true about Prim's & Dijkstra's algorithms?

A. Prim's algorithm is for un-directed graph, while Dijkstra's algorithm is for directed graph.

B. Prim's algorithm can be used to find minimum length wire needed to connect all points in electronic circuit, while Dijkstra's algorithm can be used to find minimum distance from a given point to all other points in the circuit.

C. Both algorithms yield tree with V-1 edges.

D. All the above

Answer: D

# MCQ

Q. What is limitation of Bellman Ford algorithm?

A. It cannot work with directed graph.

B. It cannot find shortest path in the graph if it contains negative weight edge.

C. It cannot find shortest path in the graph if it contains negative weight cycle.

D. It cannot be implented using recursion.

Answer: C

# MCQ

Q. How many edges and cycles will be available in DFS spanning tree?

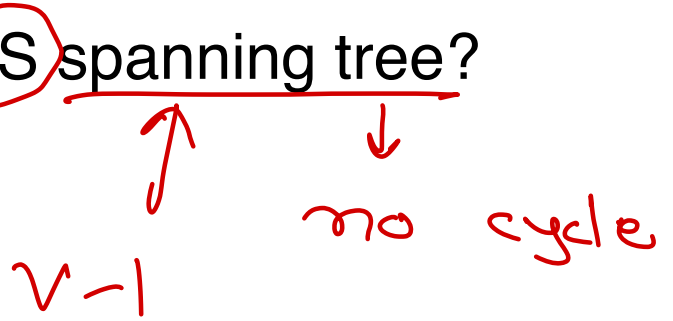
A. V, 1

B. V-1, 0

C. V-1, 1

D. Depends on graph vertices and edges

Answer: B



# MCQ

Q. Given a non-weighted graph with V = {0, 1, 2, 3, 4, 5, 6, 7} and E = {(0,1), (0,3), (1,2), (3,4), (3,7), (4,5), (4,6), (4,7), (5,6), (6,7)}, what is shortest distance between 0-7 and 2-6?

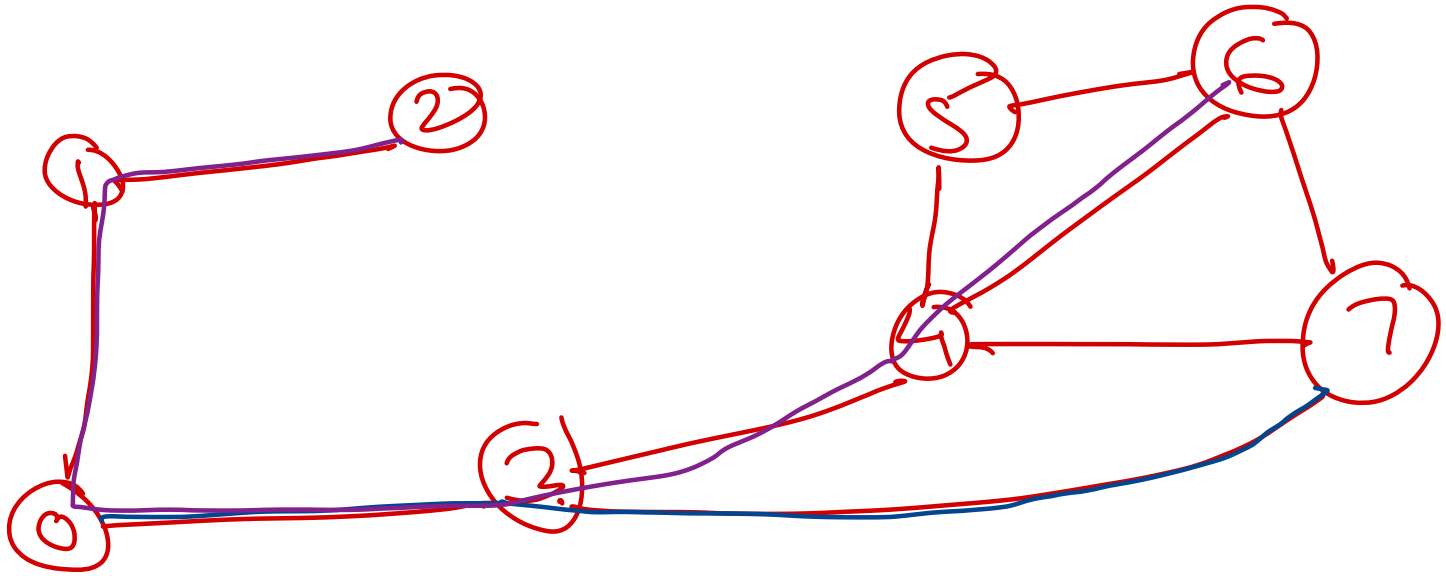
A. 3, 5

B. 2, 6

C. 3, 6

D. 2, 5

Answer: D



# MCQ

Q. In a complete directed graph with V = { A, B, C, D, E, F, G }, how many edges will be there?

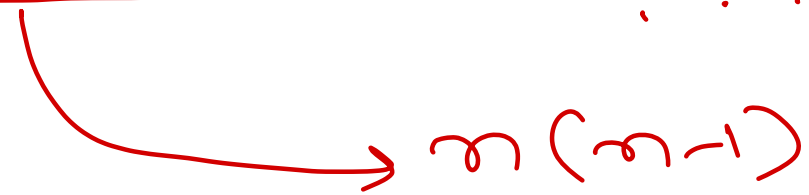
A. 6

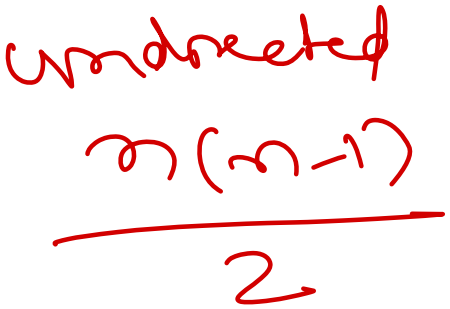
B. 21

C. 42

D. Can't say

Answer: C



# MCQ

14. Checking Bi-Partite graph is variation of which of the following algorithm?

A. BFS

B. DFS

C. Union-find

D. None of these

Answer: A

# MCQ

Q. Which of the following cannot give shortest path between two vertices in the graph?

A. Dijkstra's algorithm

B. Bellman Ford algorithm

C. Warshall Floyd algorithm

D. None of these

Answer: D


1. C - any lang.
2. C++ - OOP
3. OS
4. DS

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COM
Symbian

# Thank you!

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