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**Modified Warshall** (All Pair Shortest Path)

Theory :

The Floyd-Warshall algorithm, named after its creators Robert Floyd and Stephen Warshall, is a fundamental algorithm in computer science and graph theory. It is used to find the shortest paths between all pairs of nodes in a weighted graph. This algorithm is highly efficient and can handle graphs with both positive and negative edge weights, making it a versatile tool for solving a wide range of network and connectivity problems.

Algorithm :

step 1 :

Initialize the solution matrix same as the input graph matrix as a first step.

Step 2 :

Then update the solution matrix by considering all vertices as an intermediate

vertex.

Step 3 :

The idea is to pick all vertices one by one and

updates all shortest paths which include the picked vertex as an intermediate vertex in the shortest path.

Step 4 :

When we pick vertex number k as an intermediate vertex, we already have considered vertices {0, 1, 2, .. k-1} as intermediate vertices.

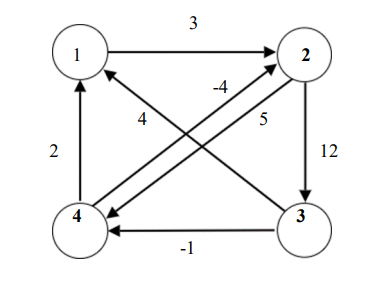
Step 5 :

For every pair (i, j) of the source and destination vertices respectively, there are two possible cases.

1 .k is not an intermediate vertex in shortest path from i to j. We keep the value of dist[i][j] as it is.

2. k is an intermediate vertex in shortest path from i to j. We update the value of dist[i][j] as dist[i][k] + dist[k][j], if dist[i][j] > dist[i][k] + dist[k][j]

**Problem :** Find the all pair shortest path for the following graph (source vertex is 1)

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**Solution :**

A0 :

1 2 3 4

|  |  |  |  |
| --- | --- | --- | --- |
| 0 | 3 | ∞ | ∞ |
| ∞ | 0 | 12 | 5 |
| 4 | ∞ | 0 | -1 |
| 2 | -4 | ∞ | 0 |

1

2

3

4

Find the matrix for vertex 1

A1 considering 1 as an intermiadiatary vertex

A1 :

1 2 3 4

|  |  |  |  |
| --- | --- | --- | --- |
| 0 | 3 |  |  |
|  | 0 | **12** | **5** |
| 4 | **7** | 0 | **-1** |
| 2 | **-4** |  | 0 |

1

2

3

4

1) A0 [2,3] A0 [2,1] + A0 [1,3]

12 <  + 

2) A0 [2,4] A0 [2,1] + A0 [1,4]

5 <  + 

* + 1. A0 [3,2] A0 [3,1] + A0 [1,2]

 4 + 3

 > 7

* + 1. A0 [3,4] A0 [3,1] + A0 [1,4]

-1 < 4 + 

5) A0 [4,2] A0 [4,1] + A0 [1,2]

-4 2 + 3

-4 < 5

6) A0 [4,3] A0 [4,1] + A0 [1,3]

 = 2 + 

Find the matrix for vertex 2

A2 considering 2 as an intermiadiatary vertex

A2 :

1 2 3 4

|  |  |  |  |
| --- | --- | --- | --- |
| 0 | 3 |  |  |
|  | 0 | **12** | **5** |
| 4 | **7** | 0 | **-1** |
| 2 | **-4** |  | 0 |

1

2

3

4

1. A1 [1,3] A1 [1,2] + A1 [2,3]

 3 + 12

 > 15

1. A1 [1,4] A1 [1,2] + A1 [2,4]

 3 + 5



1. [3,1] A1 [3,2] + A1  [2,1]

4 < 7 + 

1. [3,4] A[3,2] + A

-1 < 7 + 

1. [4,1] A [4,2] + A



2 

1. [4,3] A[4,2] + A

 -4 + 12

Find the matrix for matrix of vertex 3

A3 considering 3 as an intermiadiatary vertex

A3  :

1 2 3 4

|  |  |  |  |
| --- | --- | --- | --- |
| 0 | 3 | 5 | 8 |
| 16 | 0 | 12 | 5 |
| 4 | 7 | 0 | -1 |
| 2 | -4 | 8 | 0 |

1

2

3

4

1. A2 [1,2] A2 [1,3] + A2  [3,2]

3 < 15 + 7

1. ) A2 [1,4] A2 [1,3] + A2[ 3,4]

8 < 15 + (-1)

1. A2 [2,1] A2 [2,3] + A2  [3,1]

∞ 12 + 4

∞ > 16

1. A2 [2,4] A2 [2,3] + A2 [3,4]

5 12 + (-1)

5 > 11

1. A2  [4,1] A2  [4,3] + A2  [3,1]

2 < 8 + 4

1. A2 [4,3] A2  [4,2] + A2  [2,3]

-4 < 8 + 7

Find the matrix for matrix of vertex 4

A4 considering 4 as an intermiadiatary vertex

A4 :

1 2 3 4

|  |  |  |  |
| --- | --- | --- | --- |
| 0 | 3 | 5 | 8 |
| 14 | 0 | 12 | 5 |
| 1 | 3 | 0 | -1 |
| 2 | -4 | 8 | 0 |

1

2

3

4

1 A4 [1,2] A4 [1,4] + A4  [4,2]

3 8 + 4

3 < 12

* 1. A4  [1,3] A4 [1,4] + A4 [ 4,3]

5 8 + 8

5 < 16

* 1. A4 [2,1] A4 [2,4] + A4 [4,1]

16 12 + 2

16 > 14

* 1. A4 [2,3] A4 [2,4] + A4 [4,3]

12 5 + 8

12 < 13

* 1. A4 [3,1] A4 [3,4] + A4 [4,1]

4 -1 + 2

1. > 1

6 A4 [3,2] A4  [3,4] + A4 [4,2]

7 -1 + 4

7 > 3