Analysis of Algorithm

Practical no 9

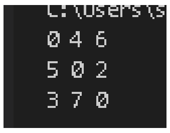
Floyd-Warshall Algorithm

Code :

```
public class FloydWarshalls {
  static void floydWarshall(int[][] graph) {
    int V = graph.length;
    if(V < 2)
      return;
    // Add all vertices one by one to
    // the set of intermediate vertices.
    for (int k = 0; k < V; k++) {
      // Pick all vertices as source one by one
      for (int i = 0; i < V; i++) {
        // Pick all vertices as destination
        // for the above picked source
        for (int j = 0; j < V; j++) {
          // If vertex k is on the shortest path from
          // i to j, then update the value of graph[i][j]
          if ((graph[i][j] == -1 || graph[i][j] > (graph[i][k] + graph[k][j])) && (graph[k][j] != -1 && graph[i][k]
!= -1))
            graph[i][j] = graph[i][k] + graph[k][j];
        }
      }
    }
  }

  public static void main(String[] args) {
    int[][] graph = {
      {0,4,11},
      {6,0,2},
      {3, Integer.MAX_VALUE,0}
    };
    floydWarshall(graph);
    for (int i = 0; i < graph.length; i++) {
      for (int j = 0; j < graph.length; j++) {
        System.out.print(graph[i][j] + " ");
      }
      System.out.println();
    }
  }
}
```

<u>Output :</u>



```
C:\Users\s
0 4 6
5 0 2
3 7 0
```

<u>Analysis :</u>

The **Floyd-Warshall algorithm** is a well-known algorithm used to find the shortest paths between all pairs of vertices in a weighted graph. In this case, you provided a Java implementation of the algorithm that works with a graph where:

- graph[i][j] represents the weight of the edge from vertex i to vertex j.
- If there is no direct edge between i and j, the value is represented as -1 (which is treated as infinity in the algorithm).
- The algorithm assumes that the graph can have at most V vertices, where V is the size of the graph (i.e., graph.length).

 Input Graph: The graph is represented as a 2D array where:

- graph[i][j] gives the weight of the edge from vertex i to vertex j.
- If there is no edge between i and j, we store -1 to represent "infinity" (or the absence of an edge).

 Algorithm Logic:

- We iterate through all possible intermediate vertices k, and for each pair of source (i) and destination (j), we check if the path through vertex k is shorter than the current known path from i to j.
- If the path through k is shorter, we update graph[i][j].

⍰ **Condition Check**:

- graph[i][j] == -1 checks if there's no existing path between i and j (in which case it's treated as infinity).
- graph[i][j] > (graph[i][k] + graph[k][j]) checks if the path through vertex k is shorter than the current known distance.
- (graph[k][j] != -1 && graph[i][k] != -1) ensures that both paths (from i to k and from k to j) are valid (i.e., not -1).

⍰ **Graph Update**:

- If the condition holds true, we update graph[i][j] to the shorter path found via k.

⍰ **Time Complexity**: The algorithm always runs in **$O(V^3)$** time because of the three nested loops, each running V times.

⍰ **Space Complexity**: The space complexity is **$O(V^2)$** due to the storage required for the graph.