

Q: Explain what adjustments if any need to be made in Dijkstra's algorithm and/or in an underlying graph to solve the following problems.

- a. Solve the single-source shortest-paths problem for directed weighted graphs.
- b. Find a shortest path between two given vertices of a weighted graph or digraph. (This variation is called the single-pair shortest-path problem.)
- c. Find the shortest paths to a given vertex from each other vertex of a weighted graph or digraph. (This variation is called the single-destination shortest-paths problem.)
- d. Solve the single-source shortest-paths problem in a graph with nonnegative numbers assigned to its vertices (and the length of a path defined as the sum of the vertex numbers on the path).

A:

- a. Algorithm only needs to consider edge directions to determine adjacent vertices.
- b. Algorithm starts at first given vertex and ends when the second given vertex is added to the graph.
- c. If the given graph is directed, first step is to reverse all the edge directions. Then, solve the single-source shortest-paths with the given destination vertex as the source vertex and then reverse all the paths (directions of the path if graph is directed) obtained in the solution.
- d. Before performing Dijkstra's algorithm, create a new graph first by replacing every vertex with two vertices connected by an edge with a weight of the nonnegative number assigned to the vertex from the original graph, and all edges with a connection from a vertex in the original graph will also be connected to its corresponding replacement in the new graph. Once the new graph exists, perform then the Dijkstra's algorithm to solve the single-source shortest-paths problem.