

# Other Graph Algorithms

Now that you are familiar with Dijkstra's algorithm for finding the shortest path in a graph, you are well-equipped to understand more graph algorithms. This document will discuss two other important algorithms: Depth-First Search (DFS) and the Bellman-Ford algorithm.

## 1.1 Depth-First Search

Depth-First Search (DFS) is an algorithm for traversing or searching tree or graph data structures. DFS uses a stack (or sometimes recursion, which uses the system stack implicitly) to explore the graph in a depthward motion until it hits a node with no unvisited adjacent nodes, then it backtracks.

The procedure is as follows:

1. Push the root node into the stack.
2. Pop a node from the stack, and mark it as visited.
3. Push all unvisited adjacent nodes into the stack.
4. Repeat steps 2 and 3 until the stack is empty.

DFS is particularly useful for solving problems like connected-component detection in graphs and maze-solving.

## 1.2 Bellman-Ford Algorithm

The Bellman-Ford Algorithm is another shortest path algorithm like Dijkstra's. However, unlike Dijkstra's Algorithm, Bellman-Ford can handle graphs with negative weight edges.

The algorithm works as follows:

1. Assign a tentative distance value for every node: set it to zero for our initial node and to infinity for all other nodes.
2. For each edge  $(u, v)$  with weight  $w$ , if the current distance to  $v$  is greater than the

distance to  $u$  plus  $w$ , update the distance to  $v$  to be the distance to  $u$  plus  $w$ .

3. Repeat the previous step  $|V| - 1$  times, where  $|V|$  is the number of vertices in the graph.
4. After the above steps, if you can still find a shorter path, there exists a negative cycle.

If the graph does not contain a negative cycle reachable from the source, the shortest paths are well-defined, and Bellman-Ford will correctly calculate them. If a negative cycle is reachable, no solution exists, but Bellman-Ford will detect it.

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*This is a draft chapter from the Kontinua Project. Please see our website (<https://kontinua.org/>) for more details.*

# Answers to Exercises





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