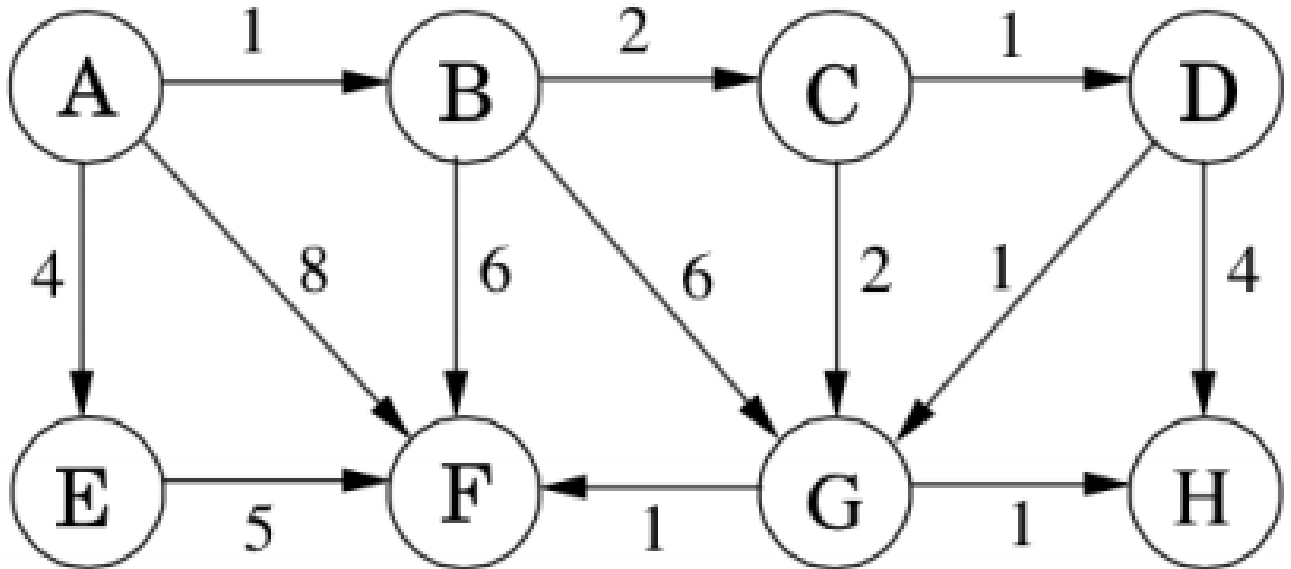
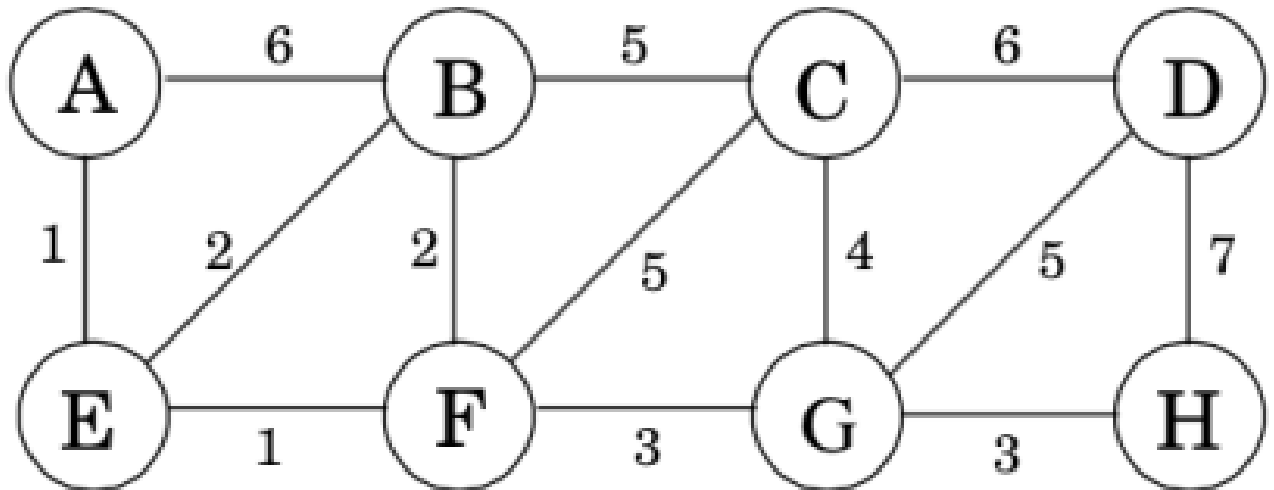


1.



2.



3. Often there are multiple shortest paths between two nodes of a graph. How do you need to modify Dijkstra's algorithm so that it finds the number of shortest paths.
4. Recall that the correctness proof of Dijkstra's algorithm assumes that the weights of the edges are non-negative. Give a small example digraph with some negative edges where Dijkstra's algorithm does not find the shortest path.

5.

Consider an undirected graph $G = (V, E)$ with nonnegative edge weights $w_e \geq 0$. Suppose that you have computed a minimum spanning tree of G , and that you have also computed shortest paths to all nodes from a particular node $s \in V$.

Now suppose each edge weight is increased by 1: the new weights are $w'_e = w_e + 1$.

- (a) Does the minimum spanning tree change? Give an example where it changes or prove it cannot change.
- (b) Do the shortest paths change? Give an example where they change or prove they cannot change.

6. KT, Problem 2, p. 189