Graphs

Due date: May 15, 11:59pm

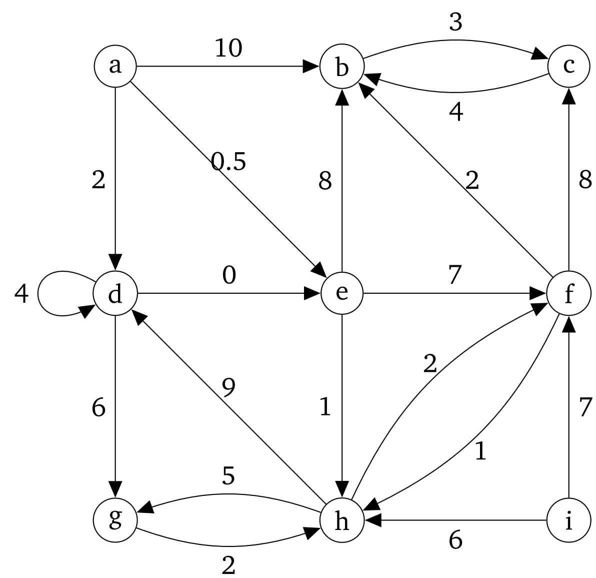
Instructions:

Submit your responses to the "Exercise 4" assignment on Gradescope here: https://www.gradescope.com/courses/97095. Make sure to log in to your Gradescope account using your UW email address to access our course.

These problems are meant to be submitted individually. If you want to discuss these problems with a partner or group, make sure that you're writing your answers individually later on. Check our course's collaboration policy if you have questions.

1. Running Dijkstra's algorithm

Consider the following graph:

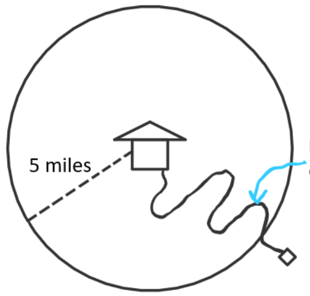


Run Dijkstra's algorithm on this graph to compute the SPT for this graph starting on node a. To do this, fill out the table below and be sure to show your work (cleanly cross out old values for distance and predecessor edge when updating existing values. For an example of this, see the Week 6 section slides example of Dijkstra's algorithm). In Gradescope, you'll just list out all the proposed distances / predecessor edges as a list in chronological order, where the last item in the list is the actual best distance / predecessor edge.

vertex	distance	predecessor edge	processed
a	0	None	
b	∞		
c	∞		
d	∞		
e	∞		
f	∞		
g	∞		
h	∞		
i	∞		

2. Graph modeling

Imagine you have a goal to visit one new place each day but you've already seen everything within a 5-mile circular radius of your house. Today you want to find some path to a new place (i.e. a place that's outside your 5-mile radius). Below is an image describing what we mean by 5-mile radius.



Warning: when you design your graph and choose your algorithm, consider the possibility that you could still travel 5 miles in distance but still be contained within the the 5 miles circular radius by taking very windy / long paths that either back track or go perpendicular to the radius of the circle. You'll want to be precise with how you describe your algorithm and graph so that you don't compute paths that terminate inside the 5 mile radius.

Explain how you would model this scenario as a graph to help plan a route that goes outside of the 5 mile radius.

(a) What do your vertices represent? If you store extra information in each vertex, what is it?

(b) What do your edges represent? Your answer may be a real-world object or an abstract description of what edges will exist. If you store extra information in each edge, what is it?

(c) Is your graph directed or undirected? Briefly explain why in 1-2 sentences.

(d) Is your graph weighted or unweighted? Briefly explain why in 1-2 sentences.

(e) Do you permit self-loops (i.e. edges from a vertex to itself)? Parallel edges (i.e. more than one copy of an edge between the same location)? Briefly explain why in 1-2 sentences?

(f) If there are any other relevant details about your model, describe them here:

(g) Describe how you would use DFS to discover the path to a place outside of the 5 mile radius, and return that path. Your answer should include a description of how you use any information in the graph described above and a description of how you stop your algorithm.

(h) What is the tight big-Theta bound for the worst-case running time of your algorithm? Assume your graph has N nodes (vertices) and M edges.