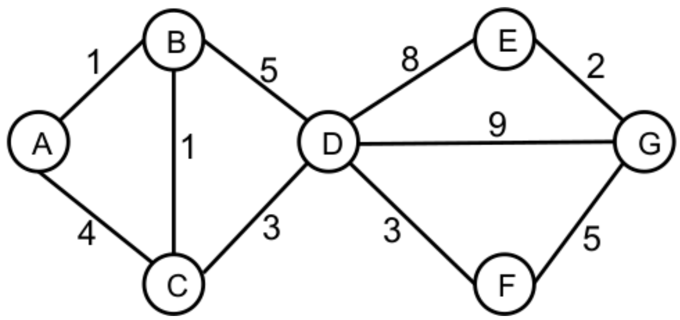
1 Uninformed Search

Consider the state space graph shown below. A is the start state and G is the goal state. The costs for each edge are shown on the graph. Each edge can be traversed in both directions.



Use the Graph Search Algorithm discussed in class. Execute the following search algorithms using priority queues, by filling in the search table for each part. Write nodes as a tuple containing a state sequence and cost (e.g. (A-B-C, 2)). Note that for Breadth first and Depth first the algorithms ignore the true "cost" so you can just use the depth of the node as the second part of the tuple and then expand nodes with either the highest or lowest depth. Break ties alphabetically. Note that all steps in the table below will not necessarily be used. You may skip any steps where a node is removed from the frontier but not expanded. Note that nodes are only expanded after they are removed from the frontier, after checking the goal test, and after checking if not in the closed set.

1. **Breadth First Graph Search.**

Step	Priority Queue	Expand
1		
2		
3		
4		
5		
6		
7		
8		

Solution:

2. **Depth First Graph Search.**

Step	Priority Queue	Expand
1		
2		
3		
4		
5		
6		
7		
8		

Solution:

3. **Uniform Cost Graph Search.**

Step	Priority Queue	Expand
1		
2		
3		
4		
5		
6		
7		
8		

Solution:

2 Heuristic Search

1. Consider the two heurisitics h_1 and h_2, only one of which is consistent. Which one is consistent?

Node	A	B	C	D	E	F	G
h_1	9.5	9	8	7	1.5	4	0
h_2	10	12	10	8	1	4.5	0

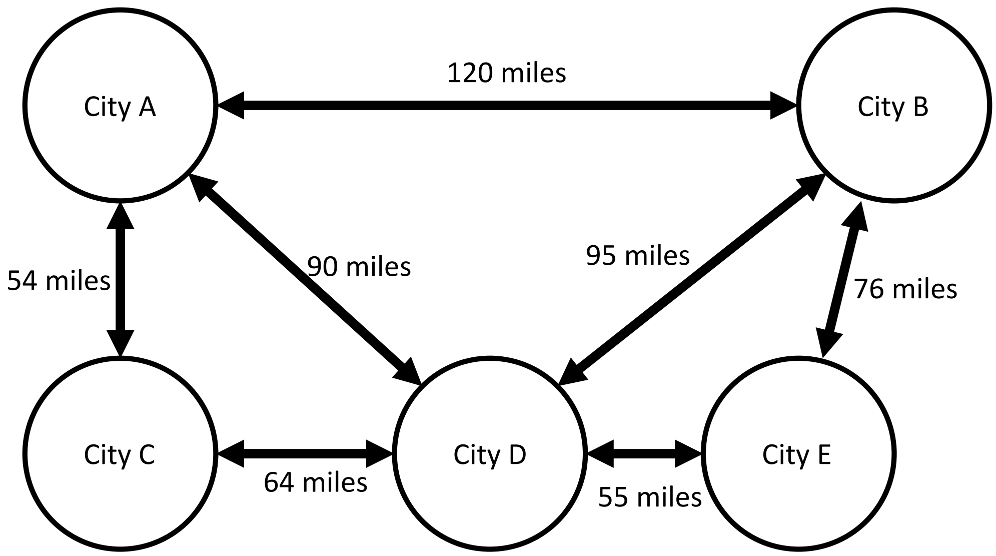
2. Then do A* search with that heuristic.

Step	**Priority Queue**	**Expand**
1		
2		
3		
4		
5		
6		
7		
8		

Solution:

3 Human-Centric Factors

Consider the following graph, which shows the connectivity via roads between five cities. The edges and their labels represent the existence and length of the roadways in between the cities.



Jessie, who resides in City A, needs to travel to City B. Jessie has a medical condition that frequently produces life-threatening symptoms at unpredictable times that requires treatment in an emergency room. There are emergency rooms in each of the five cities, but medical care is non-existent on the roads themselves.

Please consider and thoughtfully answer the following questions with respect to the above graph:

(a) From just looking at the graph, what path do you think Jessie should take to get from City A to City B? Explain your choice *and how it relates to Jessie's specific considerations*.

(b) i. Using the edge costs given in the graph, what path is returned using the UCS algorithm with the traditional objective function (shortest cumulative distance)?

ii. Based on your answer to question 1 and (2a), do you think that the shortest cumulative distance on the path from City A to City B is the right objective function to use when considering the optimal route for Jessie? Why or why not?

(c) Imagine you are working with a team that is trying to train assistive AI to help Jessie decide on routes to travel safely between cities. Your teammates propose the following objective functions and you need to decide whether these objective functions will enable good outcomes for Jessie. Carefully critique each objective function by answering the questions provided *(note: some of these algorithms require additional information to solve - your team has only proposed the objective function)*.

Objective function 1: Since we do not want Jessie to take longer roads, an objective function could be to minimize the sum of the cube of each distance between cities to punish longer edge traversals, i.e.,
Edge Cost = Distance^3.

i. Do you think this objective function is appropriate for this context when considering your answer to question 1? Why or why not?

ii. Given just the information provided by your teammate, can we use UCS with this objective function? If so, what path is returned? If not, explain why not.

iii. Given just the information provided by your teammate, can we use A* with this objective function? If so, what path is returned? If not, explain why not.

Objective function 2: An objective function could be to minimize the maximum distance between any two adjacent cities on the path (i.e., we define the overall cost of each path to be the longest edge on that path, and the objective is to minimize this value).

i. Do you think this objective function is appropriate for this context when considering your answer to question 1? Why or why not?

ii. Given just the information provided by your teammate, can we use UCS with this objective function? If so, what path is returned? If not, explain why not.

(d) So far, we've been considering a *specific* graph. However we want our algorithms to work for any arbitrary graph.

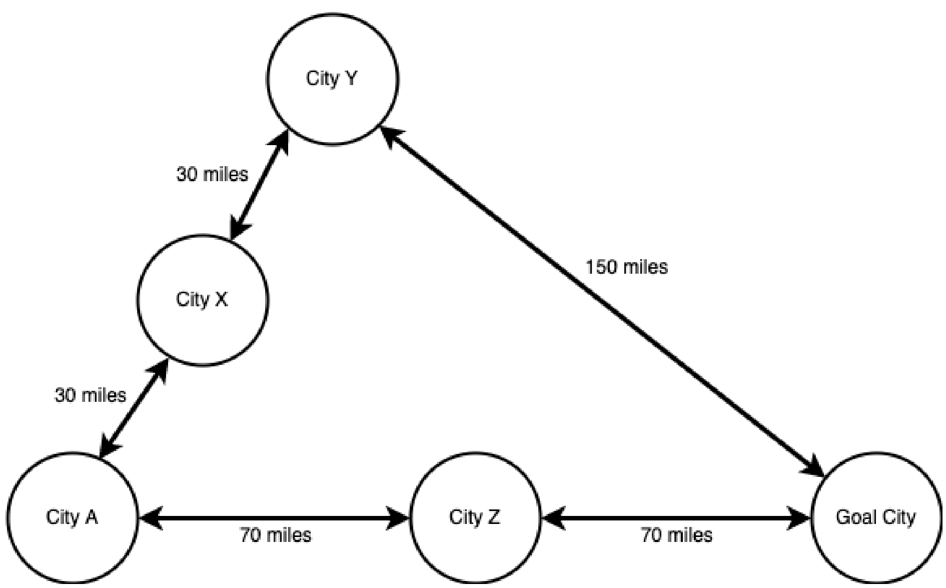
i. Describe an objective function that you think is most appropriate for this scenario (use or modify one of the objective functions given above or come up with your own).

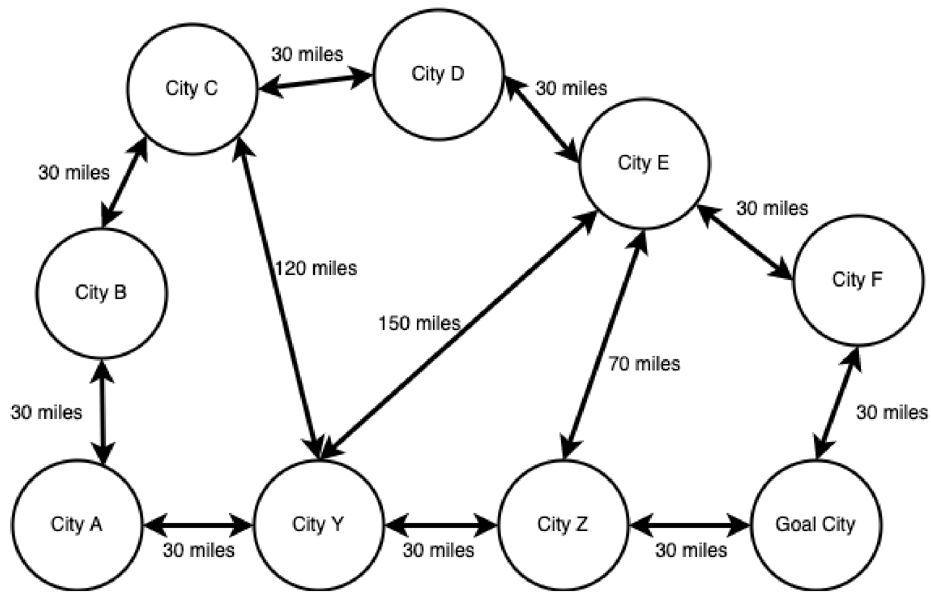
ii. Determine which, if any, of the search algorithms we've covered will still be optimal for this objective for any arbitrary graph.

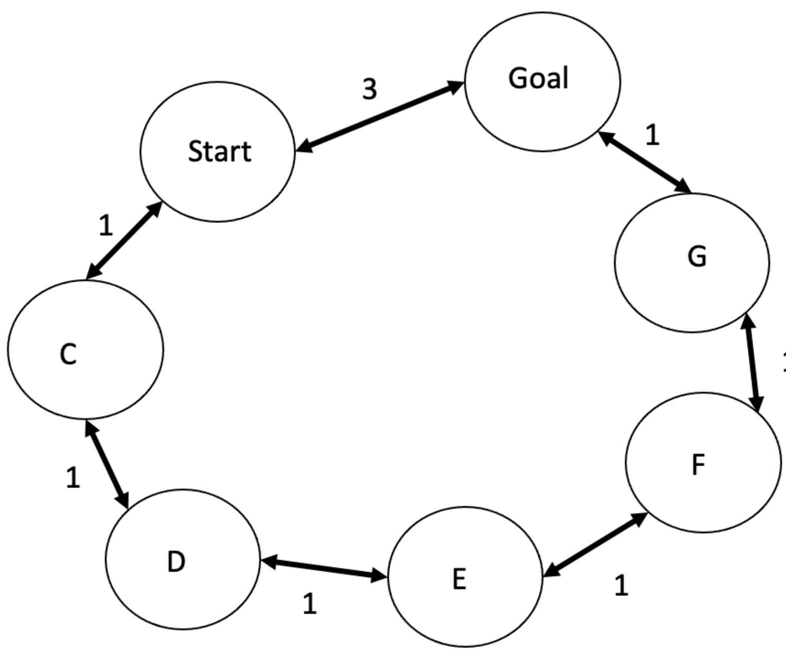
iii. Justify your answer with a discussion of the kinds of paths the algorithm might choose between in an unknown, arbitrary graph.

Optional: you may find it helpful to consider a few specific graphs when considering all arbitrary graphs. I've included a few such graphs at the end of this document to help you think about this.

(e) In this problem, we are modeling this situation solely based on distances between cities and locations of emergency rooms. What is another example of a human-centric factor that we would need to consider when modeling the optimal path for Jessie that demonstrates the complex nature of defining an "optimal" path in real life?




City C
City D
City E
City F
City B
City A
City Y
City Z
Goal City
30 miles
30 miles
30 miles
30 miles
120 miles
150 miles
70 miles
30 miles
30 miles
30 miles
30 miles
30 miles
30 miles


Start
Goal
C
D
E
F
G
3
1
1
1
1
1
1
1