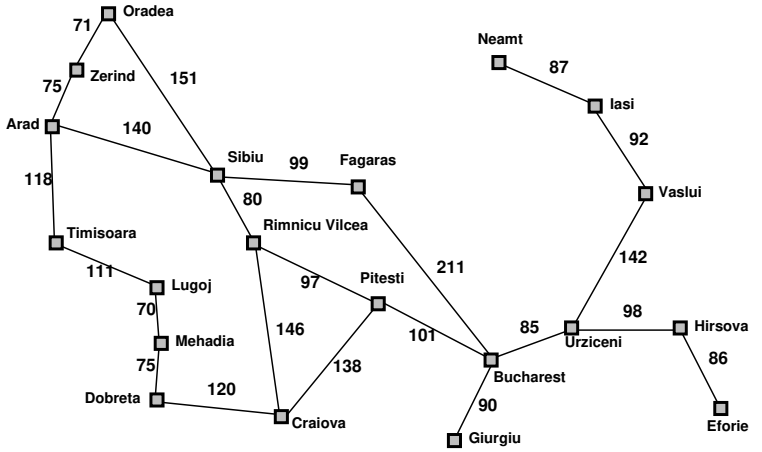
COMP3411 Tutorial - Week 3
Search

Question 1

This exercise uses the route-finding example with the Romanian map from Russell & Norvig (Artificial Intelligence: A Modern Approach).



Straight−line distance to Bucharest	
Arad	366
Bucharest	0
Craiova	160
Dobreta	242
Eforie	161
Fagaras	178
Giurgiu	77
Hirsova	151
Iasi	226
Lugoj	244
Mehadia	241
Neamt	234
Oradea	380
Pitesti	98
Rimnicu Vilcea	193
Sibiu	253
Timisoara	329
Urziceni	80
Vaslui	199
Zerind	374

For the route from Arad to Bucharest, what order are nodes in the state space expanded for each of the following algorithms when searching for the shortest path between Arad and Bucharest? Where there is a choice of nodes, take the first one by alphabetical ordering. Make sure you understand the key properties of the different algorithms, as listed below.

1. Depth-first search (efficient use of space but may not terminate
2. Breadth-first search (space inefficient, guaranteed to find a solution)
3. Uniform-cost search (similar to breadth-first, but order nodes by cost)
4. Iterative deepening depth-first search (space efficient, but repeated work)
5. Greedy best-first search (efficient, not guaranteed optimal solution)
6. A∗ search with straight-line distance heuristic (space inefficient, guaranteed optimal solution)

For breadth-first search, stop the search when the goal state is generated and use a check to ensure that nodes with the same state as a previously expanded node are not added to the frontier. For the other search algorithms, stop the search when the goal state is expanded. For uniform-cost search include a check that nodes with the same state as a previously expanded nodes are not added to the frontier (as in breadth-first search) and a test so that only one node for a given state is stored on the frontier (that with the shortest path to that state), and for depth-first search use cycle checking along a path to avoid repeated states that may lead to infinite branches.

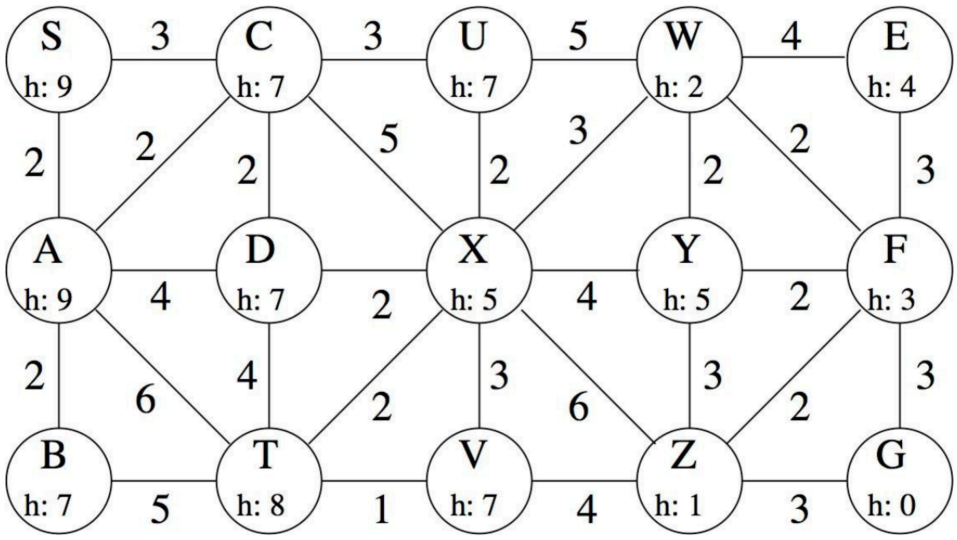
Which algorithm is suitable in practice for solving route-finding problems such as this?

Question 2

Suppose the heuristic value for Fagaras is 178 rather than 176, and the value for Pitesti is 98 rather than 100. What difference does this make?

Question 3 - Heuristic Path Search

Consider the task of finding a path from start state *S* to goal state *G*, given the distances and heuristic values in this diagram:



For each of the following strategies, list the order in which the state are expanded. Whenever there is a choice of states, you should select the one that comes first in alphabetical order. In each case, you should skip any states that have previously been expanded, and you should continue the search until the goal node is expanded.

1. Breadth First Search
2. Depth First Search
3. Uniform Cost Search [Hint: first compute for each state in the graph]
4. Greedy Search, using the heuristic shown
5. A*Search, using the heuristic shown

Question 4 - Relationships Between Search Strategies

Prove each of the following statements, or give a counterexample:

1. Breadth First Search is a special case of Uniform Cost Search.
2. Breadth First Search, Depth First Search and Uniform Cost Search are special cases of best-first search.
3. Uniform Cost Search is a special case of A*Search.

Question 5 - Heuristic Path Algorithm

The heuristic path algorithm is a best-first search algorithm in which the objective function is:

$$f(n) = (2 - w) \cdot g(n) + w \cdot h(n), \text{ where } 0 \leq w \leq 2$$

What kind of search does this perform when $w = 0$; when $w = 1$; when $w = 2$?

For what values of w is the algorithm complete? For what values of w is it optimal, assuming h is admissible?