# COMP9414: Artificial Intelligence
# Solutions Week 3: Search

1. State space: set of cities on Romania map
   Initial state: Arad
   Successor function: $s(x)$ is the set of cities adjacent to $x$ on the map
   Goal state: Bucharest
   Path cost: Sum of the costs of distances between the cities on the path

   (i) (Depth-first) Arad, Sibiu, Fagaras, Bucharest (note that the solution is found on the first branch only because of the rule for ordering the successors alphabetically; **this is not usually the case!**)

   (ii) (Breadth-first) Arad, Sibiu, Timisoara, Zerind, Fagaras, Bucharest (assuming that the search stops once the goal state is generated and that when expanding a node, previously expanded nodes are checked to ensure that nodes with states already explored are not added to the frontier, e.g. Arad which is generated via the paths Arad → Sibiu → Arad and Arad → Sibiu → Oradea → Zerind → Arad)

   (iii) (Uniform-cost) Arad (0), Zerind (75), Timisoara (118), Sibiu (140), Oradea (146), Rimnicu Vilcea (220), Lugoj (229), Fagaras (239), Mehadia (299), Pitesti (317), Craiova (366), Drobeta (374), Bucharest (418) (assuming a check that nodes with states previously generated are not added to the frontier, except when they have lower path cost than a node with that state already on the frontier, in which case the node with higher path cost is removed, so ignore Oradea (291) reached via Sibiu, and Sibiu (297) reached via Zerind and Oradea)

   (iv) (Iterative deepening) Arad, Arad, Sibiu, Timisoara, Zerind, Arad, Sibiu, Fagaras, Oradea, Rimnicu Vilcea, Timisoara, Lugoj, Zerind, Oradea, Arad, Sibiu, Fagaras, Bucharest (assuming a cycle check on each path, so omit Arad reached via Arad → Sibiu → Arad)

   (v) (Greedy) Arad (366), Sibiu (253), Fagaras (178), Bucharest (0)

   (vi) (A*) Arad (366), Sibiu (393), Rimnicu Vilcea (413), Pitesti (415), Fagaras (417), Bucharest (418) (unexpanded states on the frontier are Timisoara (447), Zerind (449), Craiova (526), Oradea (671)) – for example, $f$(Rimnicu Vilcea) = $g$(Rimnicu Vilcea) + $h$(Rimnicu Vilcea) = 140 + 80 + 193 = 413 (remember to use the **total path cost** from Arad to Rimnicu Vilcea here)

2. Fagaras (415) is expanded before Pitesti (417)