COSC1125/1127 Artificial Intelligence
School of Computer Science and IT
RMIT University
Semester 1, 2017

Tutorial Sheet 1
Search

- Open Discussion: What is Artificial Intelligence?
- Watch the videos:
  - Holy Grail of AI: https://www.youtube.com/watch?v=tlS5Y2vm02c
  - Humans Need Not Apply: https://www.youtube.com/watch?v=7Pq-S557XQU
  - Artificial Intelligence: https://www.youtube.com/watch?v=oYqXQw2CryI
  - The long-term future of AI: https://www.youtube.com/watch?v=CK5w3wh4G-M

Exercises

1. (RN) Define in your own words the following terms: state, state space, search tree, search node, goal, action, successor function, and branching factor.

Answer

A **state** is a situation that an agent can find itself in. We distinguish two types of states: world states (the actual concrete situations in the real world) and representational states (the abstract descriptions of the real world that are used by the agent in deliberating about what to do).
A **state space** is a graph whose nodes are the set of all states, and whose links are actions that transform one state into another.
A **search tree** is a tree (a graph with no undirected loops) in which the root node is the start state and the set of children for each node consists of the states reachable by taking any action.
A **search node** is a node in the search tree.
A **goal** is a state that the agent is trying to reach.
An **action** is something that the agent can choose to do.
A **successor function** described the agents options: given a state, it returns a set of (action, state) pairs, where each state is the state reachable by taking the action.
The **branching factor** in a search tree is the number of actions available to the agent.

2. (RN) Whats the difference between a world state, a state description, and a search node? Why is this distinction useful?

Answer

A world state is how reality is or could be. In one world state were in Arad, in another were in Bucharest. The world state also includes which street were on, whats currently on the radio, and the price of tea in China. A state description is an agents internal description of a world state. Examples are In(Arad) and In(Bucharest). These descriptions are necessarily approximate, recording only some aspect of the state.
We need to distinguish between world states and state descriptions because state description are lossy abstractions of the world state, because the agent could be mistaken about21 how the world is, because the agent might want to imagine things that arent true but it could make true, and because the agent cares about the world not its internal representation of it. Search nodes are generated during search, representing a state the search process knows how to reach. They contain additional information aside from the state description, such as the sequence of actions used to reach this state. This distinction is useful because we may generate different search nodes which have the same state, and because search nodes contain more information than a state representation.

3. Consider this problem: We have one 3 litre jug, one 5 litre jug and an unlimited supply of water. The goal is to get exactly one litre of water into either jug. Either jug can be emptied or filled, or poured into the other.

   For this problem give:

   (a) An appropriate data structure for representing a state.

   (b) The initial state.

   (c) The final states (there are 2 “classes”).

   (d) A specification of the operators (or actions) which includes the preconditions that must be satisfied before the operator can be used and the new state generated.

   (e) Draw the full state space.

   (f) What is the solution to the problem.

4. Does a finite state space always lead to a finite search tree? How about a finite state space that is a tree?

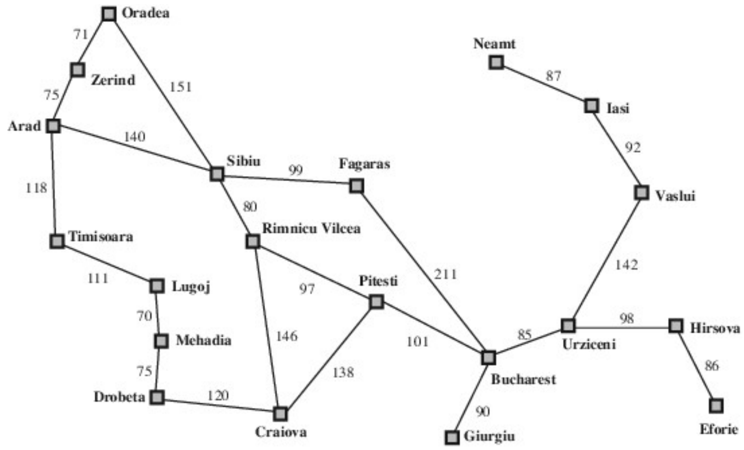
Answer

Finite state can yield an infinite state if there are loops in the state space; if the state space is a tree then there are no loops and the search tree will be finite

5. Consider the problem of getting from Arad to Bucharest in Romania. For this problem give:

   - State descriptions.
   - Initial State.
   - Final State.
   - Operators.

- The part of the search space that is realized in memory and the order of node expansion if uniform cost search is used.



6. (RN) Which of the following are true and which are false? Explain your answers.

   - Depth-first search always expands at least as many nodes as A search with an admissible heuristic.
   - $h(n) = 0$ is an admissible heuristic for the 8-puzzle.
   - A is of no use in robotics because percepts, states, and actions are continuous.
   - Breadth-first search is complete even if zero step costs are allowed.
   - Assume that a rook can move on a chessboard any number of squares in a straight line, vertically or horizontally, but cannot jump over other pieces. Manhattan distance is an admissible heuristic for the problem of moving the rook from square A to square B in the smallest number of moves.

Answer

- *False*: a lucky DFS might expand exactly d nodes to reach the goal. A largely dominates any graph-search algorithm that is guaranteed to find optimal solutions.
- *True*: $h(n) = 0$ is always an admissible heuristic, since costs are nonnegative.
- *False*: A* search is often used in robotics; the space can be discretized or skeletonized.
- *True*: depth of the solution matters for breadth-first search, not cost.
- *False*: a rook can move across the board in move one, although the Manhattan distance from start to finish is 8.

7. *You say more?* Lots of cool exercise in RN book, chapter 3....