Artificial Intelligence
Exercises for Tutorial 2 on Search

Introduction

The following multiple choice questions are examples of typical questions one can expect on the AI exam. The questions on the AI exam are also multiple choice, but for this tutorial one has to explain the answers given. Moreover at the end one can find some open questions.
After the tutorial the answers to the MC will be available on Canvas.

Questions

1. Consider the following statements about agent architectures and search:

   (i) Search is **not** programmable on a simple reflex agent.

   (ii) Search is **not** programmable on a goal based agent.

   Which of the following claims is true?

   (a) Both statements (i) and (ii) are false.
   (b) Only statement (i) is true
   (c) Only statement (ii) is true
   (d) Both statements (i) and (ii) are true.

2. Consider the following statements about search:

   (i) A difference between uninformed and informed search strategies is that the former does not use a heuristic function.

   (ii) Uninformed search strategies always yield the optimal path from start state to the goal.

   Which of the following claims is true?

   (a) Both statements (i) and (ii) are false.

(b) Only statement (i) is true

(c) Only statement (ii) is true

(d) Both statements (i) and (ii) are true.

3. Underlying each search problem is a *search graph* in which the states are the vertices of the search graph and the edges (connections) are determined by the possible actions; there is an edge from s to s' with label a in the search graph, if and only if there is an action a which leads from state s to state s'. These two conditions together completely define the *search graph*. A cycle in the search graph is a vertex (state) s and a non-empty sequence of actions as such that if we start in s and execute the sequence of actions as then we will end up in s again. Consider the following statements about search problems and graphs:

   (i) If the Depth First Tree Search Algorithm does not terminate on a given search problem then the corresponding search graph is infinite or contains cycles.

   (ii) If the corresponding search graph is infinite or contains cycles then the Depth First Tree Search Algorithm does not terminate on the corresponding search problem.

   Which of the following claims is true?

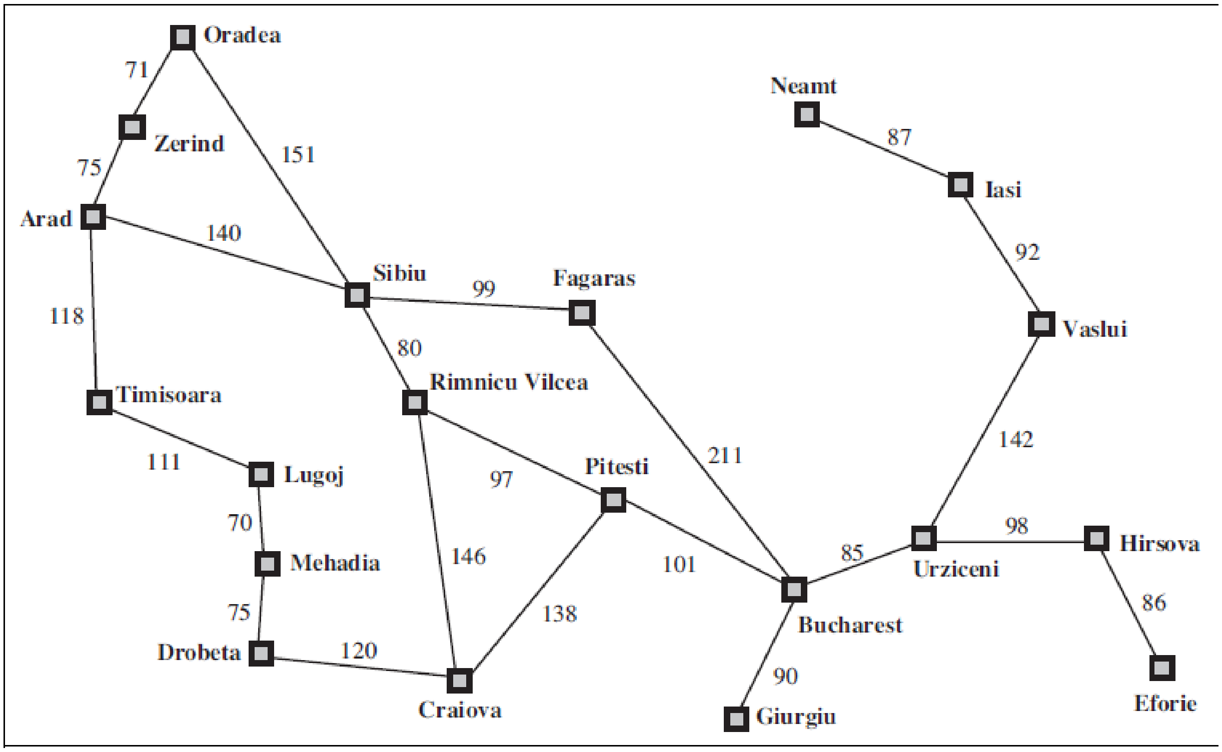
   (a) Both statements (i) and (ii) are false.

   (b) Only statement (i) is true

   (c) Both statements (i) and (ii) are true.

   (d) Only statement (ii) is true.

4. Consider the simplified roadmap of Romania. The number above a road gives the road distance between the connecting cities.



Assume that a tourist wants to drive from Zerind to Bucharest and they apply A* graph search to find the shortest route, with the following straight-line heuristic function:

Arad	366	**Mehadia**	241
Bucharest	0	**Neamt**	234
Craiova	160	**Oradea**	380
Drobeta	242	**Pitesti**	100
Eforie	161	**Rimnicu Vilcea**	193
Fagaras	176	**Sibiu**	253
Giurgiu	77	**Timisoara**	329
Hirsova	151	**Urziceni**	80
Iasi	226	**Vaslui**	199
Lugoj	244	**Zerind**	374

What will be third node expanded in the A* graph search algorithm? The start node corresponding to Zerind will be the first. Draw a search tree as you expand the nodes, using a computation of $f(n) = g(n) + h(n)$ for each newly added node n to determine which node to expand next.

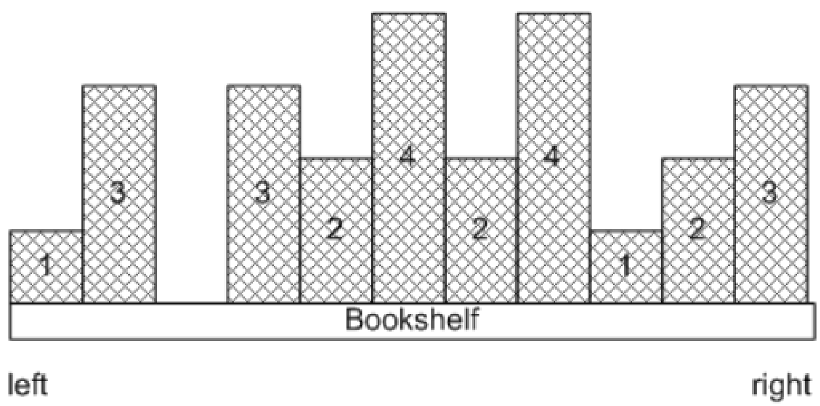
(a) The node corresponding to Oradea.

(b) The node corresponding to Sibiu.

(c) The node corresponding to Rimnicu Vilcea.

(d) None of the above.

5. Consider the problem of arranging books on a bookshelf using minimal energy in such a way that the books are ordered from left to right in increasing weight. The empty place(s) should at the far right. A possible configuration of such a problem is depicted below. The numbers indicate the weights of the books.



The legal moves are:

- Moving a book to an adjacent free space. Energy cost: the weight of the book
- Moving a book over exactly 1 book to the free space. Energy cost: $2\times$ the weight of the book.

A corresponding heuristic "cost to go" function $h(n)$ is defined as follows. A book is called "misplaced" of there is a lighter book to the right. Now $h(n)$ is the sum of weights of the misplaced books in the state (configuration) corresponding to node n. What is the h value for the node n corresponding to configuration above?

(a) 18

(b) 16

(c) 14

(d) 12

6. Assume that A* search is applied to the above problem. The start state is the node to configuration above. A bookshelf configuration can be coded as a sequence of numbers in which the number codes the weight of the book and the place in the sequence codes the place on the bookshelf. The empty place is coded by the number

0. For instance the configuration above can be coded as $[1, 3, 0, 3, 2, 4, 2, 4, 1, 2, 3]$. Which node will be expanded after the initial node of the search tree corresponding to the start state?

(a) the node corresponding to configuration $[1, 0, 3, 3, 2, 4, 2, 4, 1, 2, 3]$

(b) the node corresponding to configuration $[1, 3, 3, 0, 2, 4, 2, 4, 1, 2, 3]$

(c) the node corresponding to configuration $[1, 3, 2, 3, 0, 4, 2, 4, 1, 2, 3]$

(d) the node corresponding to configuration $[0, 3, 1, 3, 2, 4, 2, 4, 1, 2, 3]$

7. Once again consider the above search problem, the "cost to go" function h and the following statements about h:

(i) h is admissible.

(ii) h is consistent.

Which of the above statements are true?

(a) Only statement (i) is true.

(b) Both statements (i) and (ii) are true.

(c) Only statement (ii) is true.

(d) Both statements (i) and (ii) are false.