Foundations of Artificial Intelligence

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Exercise Sheet 2

Due: Wednesday, May 8, 2013

Exercise 2.1 (Formalizing problems)

Formalize the following problems as precisely as possible, by defining the initial state, the state space, the set of actions, the goal test and the path cost function:

- You want to drive from Freiburg to Berlin by car. You carry with you an up-to-date highway map of Germany and a list of traffic jams in certain highway segments. Your car is not equipped with an automated navigation system.
- You have to color a map of Europe with only four colors. In order for the national borders to be recognizable, no two neighboring countries may be assigned the same color.
- A monkey is situated in a room equipped with a box. Some bananas are dangling from the ceiling, out of reach of the monkey. The monkey would like to eat the bananas.

Exercise 2.2 (Uninformed Belief Space Search)

You have to sort three blocks of different sizes, which are lined up at positions 0, 1, and 2, by increasing size. Unfortunately, you can neither see the blocks nor move them yourself. However, you can give another person instructions of the following form: "Compare the blocks at positions i and j and swap them if this is necessary to bring them in the correct order relative to each other" (instruction a_{ij}). Initially, you know nothing about the ordering of the blocks. Produce a sequence of instructions after which you can be sure that the blocks are ordered correctly. Show how your belief state evolves over time.

Exercise 2.3 (Path costs)

So far, we have assumed in the lecture that path costs are not negative. In this exercise, we would like to discuss negative path costs and cyclic paths.

(a) Suppose that a negative lower bound $c < 0$ is placed on the cost of any given step, i.e. negative costs are allowed, but the cost of a step cannot be less than c. Does this allow *uniform-cost* search to avoid searching the whole tree? If so, why?

(b) Suppose that there is a sequence of operators that form a loop, so that executing the set in some order results in no net change to the state. If all of these operators have negative costs, what does this imply about the *optimal* behaviour for an agent in such an environment.

Exercise 2.4 (A* search)

(a) Trace the operation of A* search in the following 8-puzzle configuration:

2	8	3
1	6	4
7		5

Goal State:

1	2	3
8		4
7	6	5

Show the sequence of search nodes the algorithm will consider and the f, g, and h score for each node when used with the Manhattan distance heuristics.

(b) Calculate the h and f values for each search state from part (a) but using the "Misplaced Tiles" heuristics. How could the use of this heuristics influence the search?

The exercise sheets may and should be worked on in groups of three (3) students. Please write all your names and the number of your exercise group on your solution.