Foundations of Artificial Intelligence

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Exercise Sheet 2

Due: Wednesday, May 21, 2014

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 solve Rubik's Cube.
  `http://en.wikipedia.org/wiki/Rubik%27s_Cube`
- 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.

Exercise 2.2 (Uninformed Belief Space Search)

A robot lives in a world consisting of two rooms which are separated by an electric door. On the wall of each room is a button that can toggle the door. If the door is closed, a push on the button will open it while it will shutter it otherwise. The robot can move left or right, whereby the movement will end in the same room in case the robot moves against a wall or a closed door. The sensors of the robot fail. Nevertheless, the robot wants to get to the right room.

Produce a sequence of instructions after which you can be sure that the robot safely arrives in the right room. Show how your belief state evolves over time.

Exercise 2.3 (Search algorithms)

Prove each of the following statements:

(a) Breadth-first search is a special case of uniform-cost search.

(b) Breadth-first search, depth-first search, and uniform-cost search are special cases of best-first search.

(c) Uniform-cost search is a special case of A* search.

Exercise 2.4 (A* search)

Solve the following puzzle with the help of the A* Algorithm. This puzzle centers around numbers between 100 and 999. Initially, two number S and G are given, as well as a set Bad of numbers. A turn consists of transforming one number into another by adding 1 to a digit or by subtracting 1 to a digit. A valid move would be e.g. from 678 to 679 or from 234 to 134. Each move costs 1. Additionally there are the following constraints:

- It is not allowed to add to the digit 9 or to subtract from the digit 0.
- It is not allowed to execute a move that transforms the current number into a number from the Bad set.
- A player must not change the same digit in two consecutive turns.

Solve the puzzle, by transforming S into G with the fewest number of moves.

(a) Formulate a state description of the problem so as to apply the A* algorithm.

(b) Define an *admissible* heuristic which can be used for this A* search problem.

(c) Use the heuristic from (b) to execute the first three *nodeexpansions* of the A* search for $S = 567, G = 777$ and $Bad = \{666, 667\}$. Mark in the search tree all legal successors of the expanded nodes.

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.