Foundations of Artificial Intelligence

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Exercise Sheet 2

Due: Wednesday, May 11, 2015, before the lecture

Exercise 2.1 (A* search (8-Puzzle))

(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?

Exercise 2.2 (A* Search (Path Planning))

Consider the problem of finding the shortest path between two points on a plane that has convex polygonal obstacles (see Fig. 1). This is an idealization of the problem a robot has to solve to navigate its way around in a crowded environment.

(a) Suppose the state space consists of all positions (x, y) in the plane. How many states exist? How many paths are there to the goal?

(b) We are interested in the shortest path to the goal. This runs along the corners of the polygons and therefore consists of line segments that connect the polygon's corners. We formulate the state space to contain the corners of all polygons as well as the start and goal coordinates. State the full successor function for the states $(1, 5)$ (start) and $(3, 4)$ in the problem in Fig. 1.

(c) Suggest a suitable heuristic for A* search.

(d) Execute the first step of A* Search. Show the search nodes and the $f-$, $g-$ and $h-$ values. Which state is expanded next after the start state?

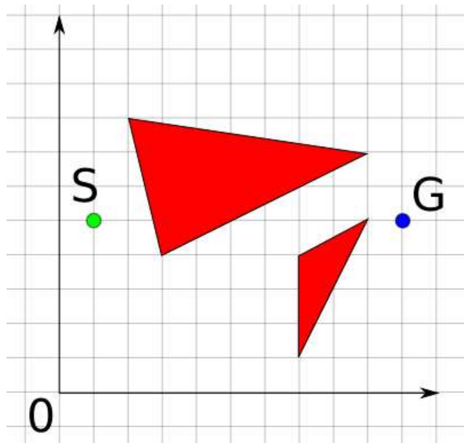

Figure 1: Robot navigation among polygons. The origin O is at coordinates $(0, 0)$. The start state is at $(1, 5)$. The goal is at $(10, 5)$.

Exercise 2.3 (Local search)

We will now use *hill-climbing* in the same setting as in 2.2 (planar robot navigation among polygonal obstacles).

(a) Explain how hill-climbing would work as a method of reaching a particular end point.

(b) Show how nonconvex obstacles can result in a local maximum for the hill-climber, using an example.

(c) Is it possible for it to get stuck with convex obstacles?

(d) Would simulated annealing always escape local maxima on this family of problems? Explain!

Exercise 2.4 (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 2.5 (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.

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.