Intelligent Autonomous Agents and Cognitive Robotics
Exercise Sheet 1

1. What is the main difference of informed and uninformed search?

2. A basic wooden railway set contains the pieces shown in Figure 3.32. The task is to connect these pieces into a railway that has no overlapping tracks and no loose ends where a train could run off onto the floor.
   a. Suppose that the pieces fit together exactly with no slack. Give a precise formulation of the task as a search problem.
   b. Identify a suitable uninformed search algorithm for this task and explain your choice.
   c. Explain why removing any one of the "fork" pieces makes the problem unsolvable.

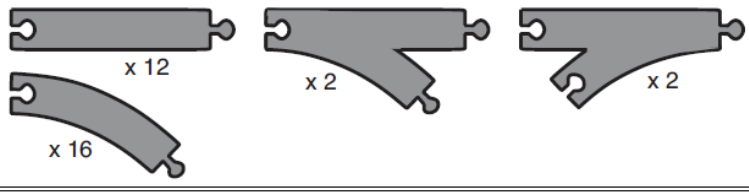

Figure 3.32 The track pieces in a wooden railway set; each is labeled with the number of copies in the set. Note that curved pieces and "fork" pieces ("switches" or "points") can be flipped over so they can curve in either direction. Each curve subtends 45 degrees.

3. Consider the problem of finding the shortest path between two points on a plane that has convex polygonal obstacles as shown in Figure 3.31. This is an idealization of the problem that a robot has to solve to navigate in a crowded environment.
   a. Suppose the state space consists of all positions (x, y) in the plane. How many states are there? How many paths are there to the goal?
   b. Explain briefly, why the shortest path from one polygon vertex to any other in the scene must consist of straight-line segments joining some of the vertices of the polygons. Define a good state space now. How large is this state space?

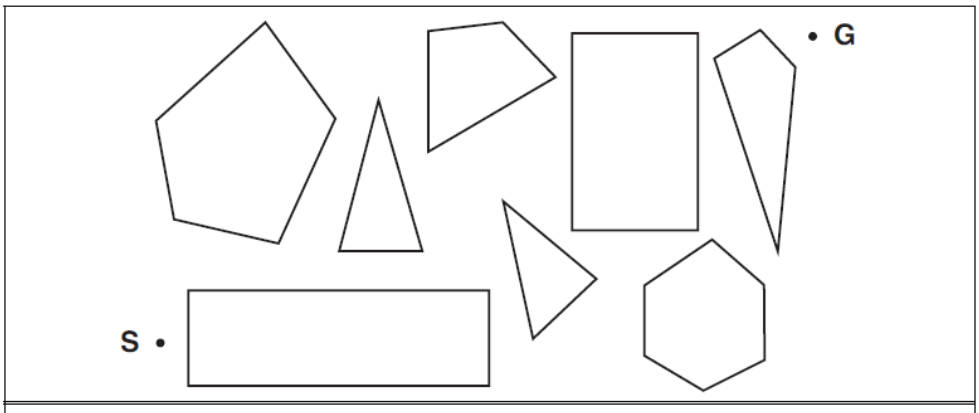

Figure 3.31 A scene with polygonal obstacles. S and G are the start and goal states.

4. The missionaries and cannibals problem is usually stated as follows. Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Find a way to get everyone to the other side without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place. A boat cannot drive alone. This problem is

famous in AI because it was the subject of the first paper that approached problem formulation from an analytical viewpoint

a. Formulate the problem precisely, making only those distinctions necessary to ensure a valid solution.
b. Draw the state graph for the problem.

c. **Implement** and solve the problem using Bread-First-Search, Depth-Limited-Search and Iterative Deepening Search. Is it a good idea to check for repeated states?

5. What are admissible heuristics? How can we create them?
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6. Informally describe all functions that are required to solve the 8-Queens problem with Local-Beam-Search
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7. Explain the principals of the local search methods
    a. simulated annealing
    b. local beam search.
    c. genetic algorithm.

8. Does it make sense to use local beam search for the Cannibal problem?

9. What are AND-OR graphs used for?

10. How can partial observability and uncertain actions be handled in state search algorithms. Explain the functions that must be implemented.

11. Give an informal description of the minimax algorithm of the lecture

12. How can minimax be extended for multiplayer games?