Artificial Intelligence – Exercise 2

Task 1: A-Star

A graph showing cities and their connection is displayed. The air distance of the location to the target location is specified in the vertices as the heuristic **H**. The numbers at the edges represent the actual distance between the two locations. Use the A-Star algorithm to find the shortest route from Wuerzburg to Berlin. Use the attached table for this task.

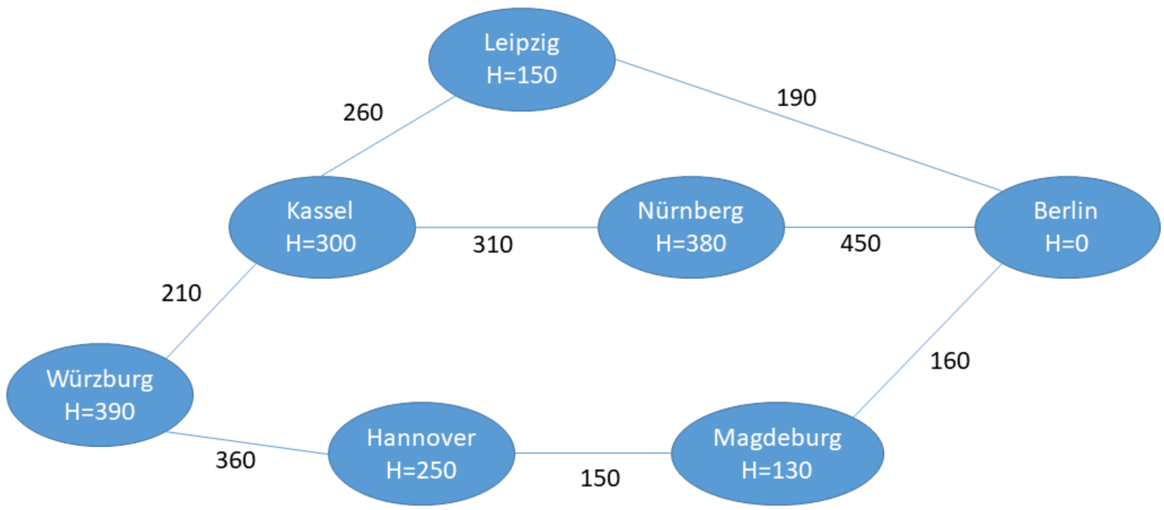


Figure 1: Map

Table 1: Table for the A-Star algorithm (Task 1)

Step	Predecessor	Costs

Task 2: Hill Climbing

Given a graph in which each state has an associated score, the hillclimbing algorithm tries to find a state with a preferably good state. If the state describes a reward, the algorithm tries to find a maxima. If instead the state describes a penalty or cost, a minima is looked for.

In the following diagram, a function is depicted as a state-score graph. Some of the points on the function are labelled alphabetically. The score shows the reward for each state in the graph.

1. State the pseudo-code for the general hillclimbing algorithm.
2. State for each of the following starting states a possible solution. Explain your solution and describe problems that might arise and how to solve them. For this you can assume, that the graph is continuous, that C and D are on the same height and the magnitude gradient to the left and right of B is equal.
   (a) Starting point B
   (b) Starting point C
   (c) Starting point D
3. Using the hillclimbing algorithm local maxima / minima can be found. One goal is to find a very high maxima / very low minima. The shape of the state-score graph as well as the starting point are rarely known. Describe some means to improve the search result despite these unknowns.

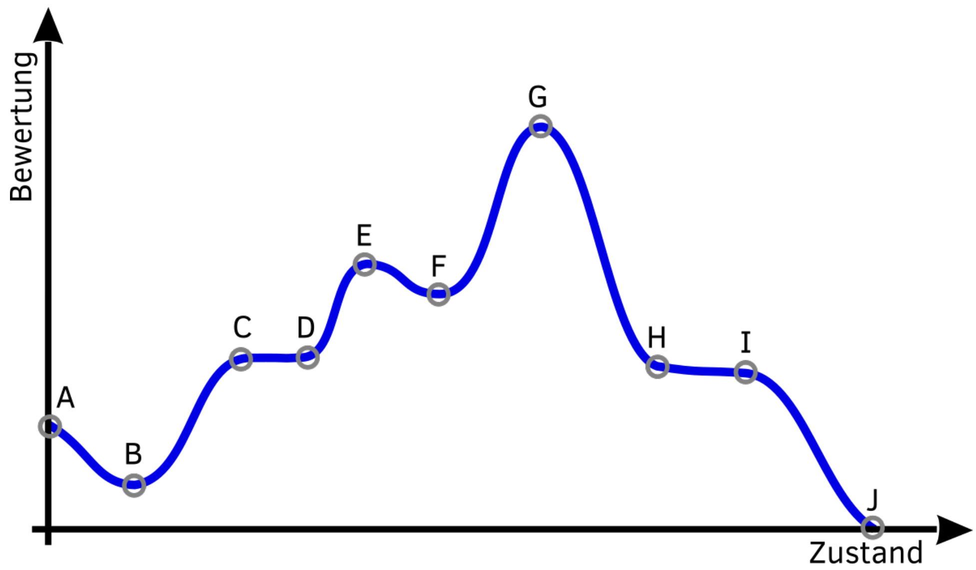


Figure 2: Hillclimbing

4. In the following we'll have a look at the 8 queens problem. In this problem, 8 queens are placed on a chess board. The goal is to find an arrangement of the queens on the board, so that no queen can take another queen in one turn. In chess, queens can take other pieces vertically, horizontally or diagonally in an arbitrary distance.
   (a) State a possible scoring function
   (b) State the transitions between one and another state
   (c) How can the choice, which transition to take, be changed in order to improve the search.

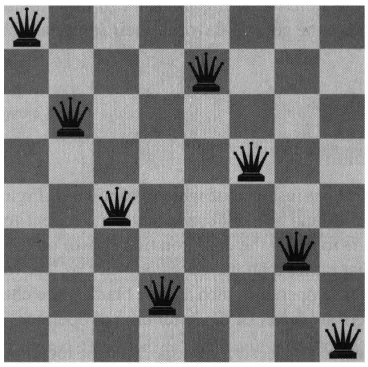
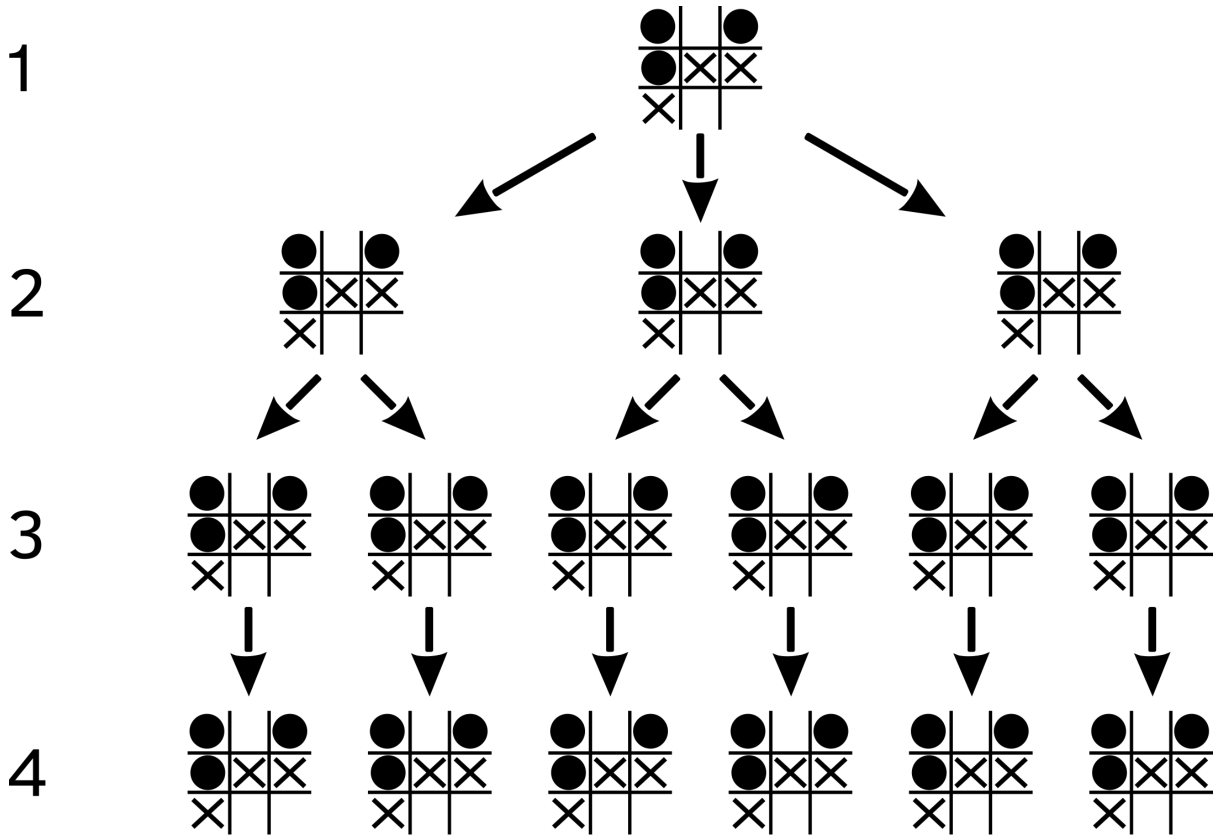


Figure 3: 8 Damen

Task 3: Minimax

In the following a possible (incomplete) decision tree of a Tic Tac Toe game is shown. In this game two players take turns marking a tile of the 3x3 playing board. The first player to place his symbol three times horizontally, vertically or diagonally wins. If no player can do this until the field is full, the game will be a tie.



1. Complete the figure. For this, draw every possible game step from layer two to layer four. Start with the "x" in layer two.
2. Specify and mark winning, loosing and tied states of player "x".
3. Rate the won games with a 1, lost games with -1 and tied games with 0. Determine the best move for player x in layer 2 using the normal Min-Max algorithm. Especially, label the Min- and Max-Layers.
4. Perform the min-max algorithm on the tree with the help of alpha-beta pruning and mark branches that you can ignore by crossing out their arrows.
5. Suppose you want to use the Min-Max algorithm for a complete Tic Tac Toe game, but you have very little memory available, so that not all states of the lower levels can be kept in memory. Since the paths cannot be searched until the end of the game, it is no longer possible to distinguish between winning and losing moves. Describe a strategy to be able to use the algorithm anyway.

Task 4: Expectiminimax

Explain, why it is also possible to prune the random steps in the Expectiminimax algorithm and what the necessary conditions are for this to work.