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Fachrichtung 6.2 – Informatik
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3rd Theoretical Assignment in Artificial Intelligence (SS 2005)

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Exercise 3.1: **10 P**

Minsky claims to stem from Charles the Great. Which way is easier to check the claim: to show that Charles the Great is an ancestor of Minsky or to show that Minsky is a descendant of Charles the Great? Explain.

Exercise 3.2: **10 P**

1. Which two advantages do breadth-first search have over depth-first Search? (5 P)
2. Why does one nevertheless use depth-first Search or similar procedures (like iterative deepening) in practical applications? (5 P)

Exercise 3.3: **25 P**

Tic-Tac-Toe is a game for two players. The board is a square of $3 * 3$ fields. Each player is assigned a type of token ($\times$ or $\circ$). Initially the board is empty. The players play in turn and place a token on an empty field. A player wins, if she/he has first aligned three of her/his tokens either in a row, a column, or on one of the two diagonals. The game ends when a player wins or when there are no more empty fields.

1. Draw the search tree for Tic-Tac-Toe up to level 2. Take into account symmetric game states, i.e. those states that can be transformed into each other by rotation and mirroring. (5 P)
2. Give an estimation on the number of possible different Tic-Tac-Toe games. (5 P)
3. Develop an evaluation function for the Tic-Tac-Toe game. (5 P)
4. Indicate the values of your evaluation function for each node of the search tree at level 2. Use these values to compute the values of the nodes on level 1 and 0 using the Min-Max algorithm. (5 P)
5. Indicate all nodes in the search tree that would not have been considered when using Alpha-Beta pruning (see Russell/Norvig, 2nd edition, p. 167/191). (5 P)

Exercise 3.4: **25 P**

We consider a variant of the Tic-Tac-Toe game, called *blind Tic-Tac-Toe*, where the players cannot see the board. When it is a player's turn, she/he proposes her/his move to a game master, who controls the board and notifies the players when to game is over and gives the

result. If a player wants to place a token on a field that is empty, the respective token is set on that field. Otherwise the player has to chose a different move. Any kind of communication between one player and the game master (indicate move/accept/reject move) is hidden from the other player.

1. Draw the search tree for blind Tic-Tac-Toe up to level 2. Take into account symmetric game states, i.e. those states that can be transformed into each other by rotation and mirroring. (5 P)

2. Develop an evaluation function for blind Tic-Tac-Toe. (10 P)

3. Assume you want to develop an agent which is very good at playing that game. Do you think the EXPECTIMINIMAX algorithm (see Russell/Norvig, 2nd edition, p. 177) is an adequate approach or would you prefer another variant of the Min-Max algorithm? Sketch how you would use that algorithm. (10 P)

Exercise 3.5: **30 P**

A set of cities and their connecting roads is given in the following table (Meaning of the entries: from city A there is a road to B of length 3km, a road to C of length 2km, and one to D of length 8km, etc.):

City	Connecting roads (to-city,length)
A	(B,3)(C,2)(D,8)
B	(A,3)(C,2)(F,2)
C	(A,2)(B,2)(E,9)
D	(A,8)(E,3)(F,2)
E	(C,9)(D,3)(F,6)(G,4)
F	(B,2)(D,2)(E,6)(G,10)
G	(E,4)(F,10)

We are looking for a shortest route to go from A to G. The evaluation function h should assume that the cities are aligned in alphabetical order at a respective distance of 1km, i.e. $h(A) = 6, h(B) = 5, \ldots, h(F) = 1$.

1. What is the shape of the search tree after having expanded 4 nodes using the uniform-cost strategy? Indicate in which order the nodes are expanded. (5 P)

2. What could a hill-climbing search for that problem look like? Assume the initial state is the route A-B-C-E-F-G. The state transitions consists of either adding, removing or replacing exactly one city. Which route could the hill-climbing strategy find? Which problems can occur? (5 P)

3. Describe the (complete) search tree for the greedy search strategy based on the evaluation function h. Indicate in which order the nodes are expanded. (10 P)

4. Describe the (complete) search tree for the A*-algorithm using the evaluation function h. Indicate in which order the nodes are expanded. Indicate how the (complete) search tree would look like when using an evaluation function h' which assumes the cities are at 5km from one another, i.e. $h'(A) = 30, \ldots, h'(F) = 5$). Compare the obtained solutions. How does this depend from h'?

   Hint: Note that the A*-algorithm terminates only when selecting a goal node for expansion, and not when generating that goal-node! (10 P)