Universität des Saarlandes
Fachrichtung 6.2 – Informatik
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2nd Theoretical Assignment in Artificial Intelligence (WS 2006/2007)

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Exercise 2.1 **(5 P)**

Explain P. Winston's (1980) claim:

More knowledge means less search.

Can too much knowledge be problematic?

Exercise 2.2 **(20 P)**

Cyclic graphs with marked nodes can be represented as follows: $edge(m, z, n)$ illustrates that an edge is drawn from node m to node n with the mark z (in the following, this notation describes a fact).

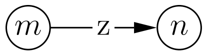


Figure 1: Example: edge from m to n with the mark z

1. Describe the following graph as a set of facts using this notation: (5 P)
   $1 \rightarrow^A 2 \rightarrow^B 3 \rightarrow^C 4 \rightarrow^B 5 \rightarrow^A 6$
2. Add these facts (i.e., the corresponding edges) to the following database: (10 P)

   axiom: $edge(m, z, n) \rightarrow palindrome(m, n)$
   $edge(m, z, m') \wedge edge(n', z, n) \wedge palindrome(m', n') \rightarrow palindrome(m, n)$

   theorem: $palindrome(1, 6)$

   Illustrate the search space as AND/OR tree to prove the theorem $palindrome(1, 6)$.
3. Which palindromes cannot be identified by this axiom? How could the database be extended to repair this fault. (5 P)

Hint: palindromes are words that result in the same word regardless if you read it forwards or backwards. For example, the graph $1 \rightarrow^A 2 \rightarrow^B 3 \rightarrow^C 4 \rightarrow^B 5 \rightarrow^A 6$ represents the word $ABCBA$.

Exercise 2.3 **(20 P)**

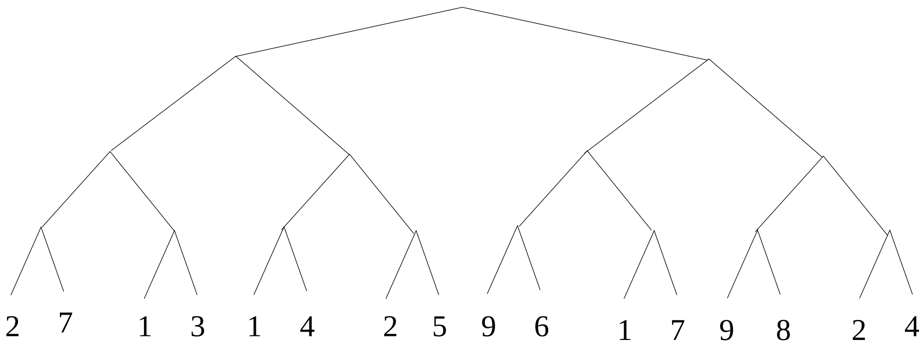
Examine the following version of the NIM-game:
Consider a heap with three and a heap with two matches. Two players, MAX and MIN, drag alternate one or more matches from **one** of the two heaps. MAX moves first. The player wins who has to move next and no more matches are available (vice versa: the player loses who has to take the last matches).

1. Illustrate the whole search space of this game. (5 P)
2. Evaluate the "win-situation" for MAX with +1 and MIN with -1. For all nodes, compute the values of the parent nodes. (5 P)

3. Can you identify a perfect strategy to win the game? If so, describe this strategy. If not, why? (5 P)
4. Assume, MAX can only project the results of two moves. Specify a function that leads to the same situation of the game. Name the disadvantages of this function. (5 P)

Exercise 2.4 **(10 P)**

MAX and MIN are playing a game. Assume that MAX is allowed to move next. The projection of the next four moves results in the following evaluated search space:



1. Identify the parent value for each node. Which move does MAX select next? Which leaf node does MAX expect to reach? (5 P)
2. Apply the alpha-beta strategy to this tree. In which order are the values evaluated? Which parts of the tree can be deleted? (5 P)

Exercise 2.5 **(25 P)**

Consider the following problem:

> *Three missionaries and three cannibals are all together on one side of a river. There is one boat that can carry either one or two persons. How can they all cross the river such that there are never less missionaries than cannibals on either side of the river?*

1. How would you represent a state of that search problem? (10 P)
2. Which abstraction did you use in order to obtain an adequate representation? (10 P)
3. Draw the complete search tree for that problem. (Hint: Do not expand further the tree for states that occur for the second time on one path of the tree.) (5 P)

Exercise 2.6 **(20 P)**

Consider the 4-queens problem, where four queens are positioned on a 4×4-chess board such that no queen threatens any other queen.

1. A procedure positions the queens row by row in the leftmost unthreatened column. The procedure performs backtracking; whenever a state is reached with no possibilities left to continue, then the search continues from the last choice point with unexplored ("next-leftmost") alternatives.
   Which states of the search space are generated until a solution is reached? (10 P)
2. The procedure is enhanced by the following heuristics: Let $D(i, j)$ be the length of the larger diagonal for the position (i, j). In every row i, the column j is chosen, for which $D(i, j)$ is minimal. A little example will explain the concept of the larger diagonal. The position $(1, 3)$ has the two following diagonals: D_1 goes from $(1, 3)$ to $(3, 1)$, so it has a length of 3 (3 fields traversed) and D_2 goes from $(1, 3)$ to $(2, 4)$, so it has a length of 2 (2 fields traversed).
   Which states of the search space are generated until a solution is reached? (10 P)