

**T-93.4400 Tekoälyn perusteet**

1. Describe the behaviour of depth-first, breadth-first and uniform-cost search, and compare their relative advantages and disadvantages. (2 points)  
How does “informed search” try to improve on “uninformed search”? (2 points)  
Explain how A\* search works, what its advantages are, and identify any restrictions on heuristics which can be used with it. (2 points)

2. Consider the game Tic-Tac-Toe- (noughts and crosses) on a 3\*3- board. We define  $X_n$  as the number of rows, columns, or diagonals with exactly  $n$  X's and no O's. Similarly  $O_n$  is the number of rows, columns, or diagonals with just  $n$  O's. The utility function thus assigns +1 to any position with  $X_3 = 1$  and -1 to any position with  $O_3 = 1$ . All other terminal positions have utility 0. We will use a linear evaluation function defined as

$$\text{Eval} = 3 * X_2 + X_1 - (3 * O_2 + O_1)$$

- a) Approximately how many possible games of Tic-Tac-Toe are there?
- b) Show the whole game tree starting from an empty board down to depth 2 (i.e., one X and one O on the board), taking symmetry into account. You should have 3 positions at level 1 and 12 at level 2.
- c) Mark on your tree the evaluations of all the positions at level 2.
- d) Mark on your tree the backed-up values for the positions at levels 1 and 0, using the minimax algorithm, and use them to choose the best starting move.
- e)

**4. Solve using resolution:**

Jouko, Maija, and Tauno are studying in the Theater Academy.

There each student, who is not a performance addict, is a body-building addict.

Those who are body-building addicts, dislike audience, and all those who dislike publicity, are not performance addicts.

Maija dislikes things, which Tauno likes, and likes things, which Tauno dislikes.

Tauno likes audience and publicity.

Is there in the Theater Academy a student, who is a body-building addict, but who is not a performance addict?

Use e.g. the predicates:

in-Theater-Academy( <person> )  
likes( <person>, <thing> )  
is-performance-addict( <person> )  
is-body-building-addict( <person> )

4. Explain why it is a good heuristic to choose the variable that is most *constrained*, but the value that is *least* constraining in a CSP search.

5. Let us consider the following planning problem. In the start state Rocket1, Parcel1, and Parcel2 are on the Earth. In the goal start state Parcel1 and Parcel2 are on the Moon and Rocket1 is on the Earth. We have at our disposal three operators Load(parcel, rocket), Unload (parcel, rocket), and Fly(rocket, starting-point, destination), which may be divided into two operators (for flying loaded and flying unloaded), if needed. The capacity of Rocket1 is one parcel, i.e. only one parcel can be carried at a time – not two parcels. Define the operators as STRIPS- operator schemas, code the problem using these STRIPS- operators, and solve the problem in the POP-planner style. (You do not need to write down the POP (Partial-Order Planner) code, only to show, e.g. through pictures, how the solving of this problem goes.)

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