# National University of Computer & Emerging Sciences

## Sessional Examination 2 – Fall 2015

### Artificial Intelligence (CS401)

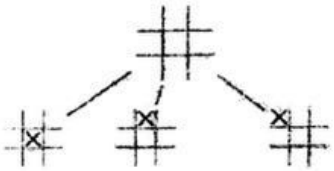
Time Allowed: 60 Min. Max. Marks: 50

Dated: Oct 21, 2015

***Instructions:*** Idem from Sessional 1.

**Question No. 1** [20 Points] [Time: 25 Min.]

1. Consider the initial game state of a tic-tac-toe game along with a first ply expended, 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 (i.e. skipping trans- configurations). [5]



2. We define $X_{n+e}$ as the number of rows, columns, or diagonals with exactly n X's and all (e) empty possibility that can be used by X. Similarly, $O_{n+e}$ is the number of rows, columns, or diagonals with just n O's X's and all (e) empty possibility that can be used by O. The utility function assigns +1 to any position with $X_{n+e} = 1$ and −1 to any position with $O_{n+e} = 1$. All other terminal positions have utility 0. For nonterminal positions, we use a linear evaluation function defined as Eval (s) = $X_{n+e}$-$O_{n+e}$ Mark on your tree the evaluations of all the positions at depth 2. [5]
3. Using the minimax algorithm, mark on your tree the backed-up values for the positions at depths 1 and 0, and use those values to choose the best starting move. [5]
4. Circle the nodes at depth 2 that would not be evaluated if alpha–beta pruning were applied, assuming the nodes are generated in the optimal order for alpha–beta pruning.[5]

**Question No. 2** [10 Points] [Time: 10 Min.]

There are four friends Ravi, Sami, Tami and Pami. In a lucky draw they have got two tickets for a show at Moulin Rouge. Obviously, this becomes a problem for them. Ravi only wants to go if Sami and Pami go to the show. Tami only wants to go if Pami is going too. Sami does not want to go because he has to complete AI homework assignment 2.

a. Using four literals in propositional logic, write a single formula that represents the situation describe above. Comments on the (grounding) semantics of the formula. [5]
b. Using formal approach of propositional logic, decide who are going for the show. [5]

**Question No. 3** [20 Points] [Time: 25 Min.]

Consider assigning colors to a checkerboard so that squares that are adjacent vertically or horizontally do not have the same color. We know that this can be done with only two colors, say red (R) and black (B).

We will limit our discussion to five squares on a 3x3 board, numbered as follows:

```
1 | 2 | 3
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4 | 5 |
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  |   |
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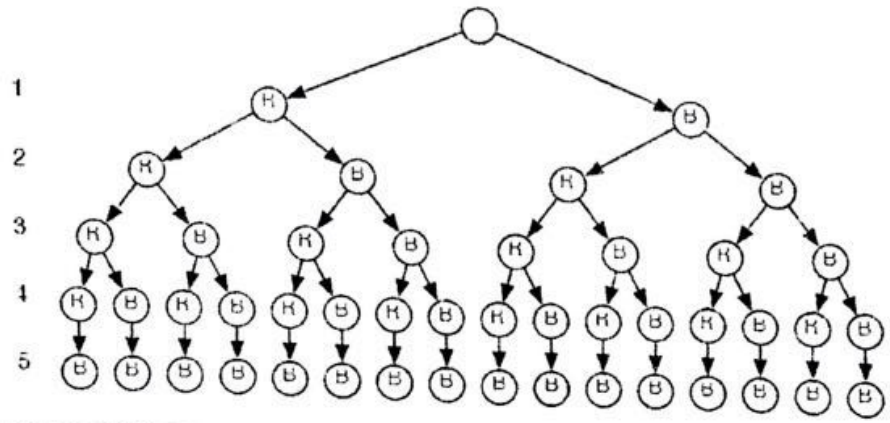
Let's look at the CSP formulation of this problem. Let the squares be the variables and the colours be the values. All the variables have domains {R, B}.

(a) If we run full constraint propagation on the initial state, what are the resulting domains of the variables? [5]

(b) Say, instead, the initial domain of variable 5 is restricted to {B}, with the other domains as before. If we now run full constraint propagation, what are the resulting domains of the variables? [5]

(c) If in the initial state (all variables have domains{R, B}, we assign variable 1 to R and do forward checking, what are the resulting domains of the other variables?
(d) Assume that during backtracking we first attempt assigning variables to R and then to B. Assume, also, that we examine the variables in numerical order, starting with 1. Also, iet the domain of variable 5 be {B}, the other domains are {R, B}. In the following tree, which shows the space of assignments to the 5 variables we care about, indicate how pure backtracking (BT) would proceed by placing a check mark next to any assignment that would be attempted during the search and crossing out the nodes where a constraint test would fail. Leave unmarked those nodes that would never be explored. [10]




Question No. 4 [Bonus: 15 Points] [Time: 0 Min.]

Random variables have which special characteristic? [5]
Why did rule-based fall out of favour? [10]
How well does probability explain things? [5]

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