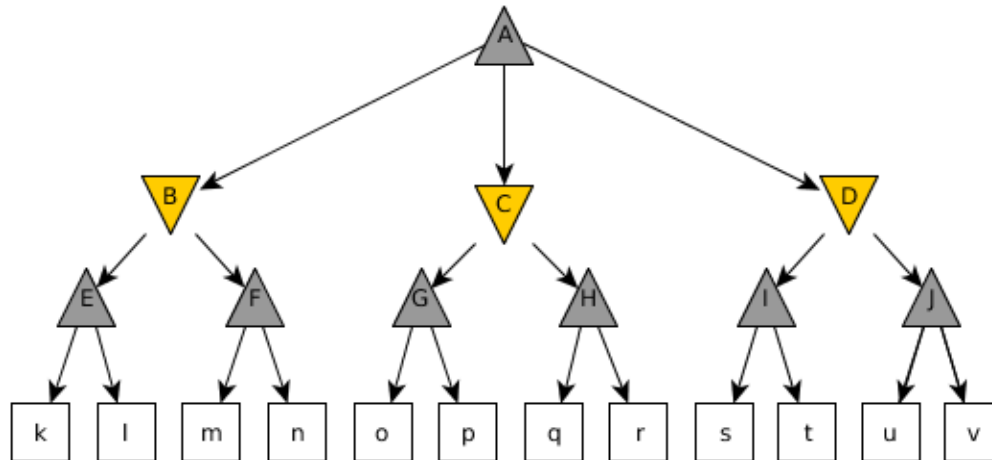# Introduction into Artificial Intelligence

Mid-term 2. – Group A

A. Solve these problems on paper:

1. The evaluation function assigns the following numbers to the leaves of the tree: [[[6, 0], [-2, 1]], [[-3, -5], [3, 5]], [[-7, -4], [4, -6]]]. Give a good strategy for the 'Maximum' player using the Mini-max algorithm.

2. The evaluation function assigns the following numbers to the leaves of the tree: [[[-7, -3], [1, -2]], [[4, -1], [-6, 5]], [[-5, -4], [6, 2]]]. Which nodes will not have a value determined because of pruning? (The nodes in the figure are examined from left to right.)

3. We have constraints A, B, C, D, E, F ∈ {1,2,3,4,5,6}, 3 * A − 1 < C, A < B, B = 3 * E, 3 * E > D, F < D, C < F. Give the possible domain for each variable after checking arc consistency.

B. There are 26 slots in a row on the table. 2 players take turns on placing down 1 rock in one of the slots. A player can only place a rock in a blank slot where its left neighbor is also blank. The player who would be next and can't put a rock in a slot loses the game. Implement this game using the provided name_neptuncode.py file. Follow the instructions in the code. (5 points)

1. **Description:**

   $H = \{0, 1\}$

   0 – blank slot, 1 – there is a rock in the slot

2. **Set of game states:**

   $B \subseteq H^{26}$

   $[b_1, b_2, \ldots, b_{26}] \in H^{26}$

   $b_i \in H \qquad i = [1, 2, \ldots, 26]$

   $$B = \left\{ [b_1, b_2, \ldots, b_{26}] \,\middle|\, \begin{array}{l} [b_1, b_2, \ldots, b_{26}] \in H^{26} \wedge \\ \bigwedge_{i=2}^{26} b_i = 1 \supset b_{i-1} = 0 \end{array} \right\}$$

   (if there is a rock in a slot, the left neighbor should be blank)

3. **Initial game state:**

   $b_0 \in B \qquad b_0 = [0, 0, \ldots, 0]$ *(all 26 slots are blank)*

4. **End game state:**

   $$V = \left\{ [b_1, b_2, \ldots, b_{26}] \,\middle|\, [b_1, b_2, \ldots, b_{26}] \in B \wedge \bigwedge_{i=2}^{26} b_i = 0 \supset b_{i-1} = 1 \right\}$$

   (for each blank slot there is a rock in the left neighbor, meaning the player can't place the next rock)

5. **Set of steps:**

   $L = \{ l_i \,|\, i \in \{1, 2, \ldots, 26\} \}$

   $\text{dom}(l_i)$

   $= \left\{ [b_1, b_2, \ldots, b_{26}] \,\middle|\, [b_1, b_2, \ldots, b_{26}] \in B \wedge b_i = 0 \wedge b_{\max(i-1, \, 0)} = 0 \right\}$

   (the slot where we want to put the rock is empty and left neighbor slot is also empty)

6. **Effect definition:**

   $l_i([b_1, b_2, \ldots, b_{26}]) = ([e_1, e_2, \ldots, e_{26}])$

   $$e_p = \begin{cases} 1 & if\ p = i \\ b_p & otherwise \end{cases} \qquad p = 1, \ldots, 26$$