**Advanced Topics in Intelligent Systems (Multi Agent Systems)**

**Homework 2**

**Problem1**

a) Show the perfect information game in extensive form for this problem.

Please find the images attached. The utility values were not given, they can be found in the induced normal form table below.

b) Show the induced normal form for this problem (20X20 matrix)

Player1: top to bottom

[0, 0, 0], [0, 0, 1], [0, 0, 2], [0, 0, 3], [0, 1, 0], [0, 1, 1], [0, 1, 2], [0, 2, 0], [0, 2, 1], [0, 3, 0], [1, 0, 0], [1, 0, 1], [1, 0, 2], [1, 1, 0], [1, 1, 1], [1, 2, 0], [2, 0, 0], [2, 0, 1], [2, 1, 0], [3, 0, 0]

Player2: left to right

[0, 0, 0], [0, 0, 1], [0, 0, 2], [0, 0, 3], [0, 1, 0], [0, 1, 1], [0, 1, 2], [0, 2, 0], [0, 2, 1], [0, 3, 0], [1, 0, 0], [1, 0, 1], [1, 0, 2], [1, 1, 0], [1, 1, 1], [1, 2, 0], [2, 0, 0], [2, 0, 1], [2, 1, 0], [3, 0, 0]

[9, 6][6, 8][6, 7][6, 6][9,5][3, 10][6, 6][3,10][6,6][3, 9][6, 8][6, 7][3, 9][3, 10][3, 9][3, 9][6, 7][6, 6][6, 6][6, 6]

[8, 6][6, 8][6, 7][6, 6][8, 5][3, 10][6, 6][5,7][8, 4][5, 6][5, 8][6, 7][3, 9][5, 7][5, 7][5, 6][5, 7][6, 6][5, 6][8, 3]

[7, 6][7, 6][7, 6][6, 6][7, 5][4, 8][7, 5][4, 7][7, 4][4, 6][4, 8][7, 5][4, 8][4, 7][4, 7][4, 6][4, 7][7, 4][4, 6][7, 3]

[6, 6][6, 6][6, 6][6, 6][6, 5][3, 8][6, 5][3, 7][6, 4][3, 6][3, 8][6, 5][3, 8][3, 7][3, 7][3, 6][3, 7][6, 4][3, 6][6, 3]

[11, 3][5, 8][8, 4][5,6][9, 5][5, 8][6, 6][3,10][6, 6][3, 9][8, 5][5, 7][5, 6][5, 8][3, 9][3, 9][8, 4][5, 6][6, 6][5, 6]

[10, 3][5, 8][8, 4][5,6][8, 5][5, 8][6, 6][5, 7][8, 4][5, 6][7, 5][5, 7][5, 6][7, 5][5, 7][5, 6][7, 4][5, 6][5, 6][7, 3]

[9, 3][6, 6][9, 3][5, 6][7, 5][6, 6][7, 5][4, 7][7, 4][4, 6][6, 5][6, 5][6, 5][6, 5][4, 7][4, 6][6, 4][6, 4][4, 6][6, 3]

[10, 3][4, 8][7, 4][4,6][10,3][4, 8][7, 4][4, 9][6, 6][3, 9][7, 5][4, 7][4, 6][4, 8][4, 7][4, 8][7, 4][4, 6][7, 4][4, 6]

[9, 3][4, 8][7, 4][4, 6][9, 3][4, 8][7, 4][6, 6][8, 4][5, 6][6, 5][4, 7][4, 6][6, 5][6, 5][6, 5][6, 4][4, 6][6, 4][6, 3]

[9, 3][3, 8][6, 4][3, 6][9, 3][3, 8][6, 4][3, 9][6, 5][3, 9][6, 5][3, 7][3, 6][3, 8][3, 7][3, 8][6, 4][3, 6][6, 4][3, 6]

[8, 6][8, 5][5, 7][8, 3][8, 5][5, 7][5, 6][5, 7][5, 6][5, 6][8, 6][6, 7][5, 7][3, 10][5, 7][3, 9][6, 7][6, 6][6, 6][6,6]

[7, 6][8, 5][5, 7][8, 3][7, 5][5, 7][5, 6][7, 4][7, 4][7, 3][7, 6][6, 7][5, 7][5, 7][7, 5][5, 6][5, 7][6, 6][5, 6][8, 3]

[6, 6][9, 3][6, 6][8, 3][6, 5][6, 5][6, 5][6, 4][6, 4][6, 3][6, 6][7, 5][6, 6][4, 7][6, 5][4, 6][4, 7][7, 4][4, 6][7, 3]

[10, 3][7, 5][7, 4][7,3][8, 5][7, 5][5, 6][5, 7][5, 6][5, 6][10, 3][5, 7][7,4][5, 8][5, 7][3, 9][8, 4][5, 6][6, 6][5, 6]

[9, 3][7, 5][7, 4][7, 3][7, 5][7, 5][5, 6][7, 4][7, 4][7, 3][9, 3][5, 7][7, 4][7, 5][7, 5][5, 6][7, 4][5, 6][5, 6][7, 3]

[9, 3][6, 5][6, 4][6, 3][9, 3][6, 5][6, 4][6, 6][5, 6][5, 6][9, 3][4, 7][6, 4][4, 8][6, 5][4, 8][7, 4][4, 6][7, 4][4, 6]

[7, 6][7, 5][4, 7][7, 3][7, 5][4, 7][4, 6][4, 7][4, 6][4, 6][7, 6][7, 5][4, 7][4, 8][4, 7][4, 7][7, 6][6, 6][7, 5][6, 6]

[6, 6][7, 5][4, 7][7, 3][6, 5][4, 7][4, 6][6, 4][6, 4][6, 3][6, 6][7, 5][4, 7][6, 5][6, 5][6, 4][6, 6][6, 6][6, 5][8, 3]

[9, 3][6, 5][6, 4][6, 3][7, 5][6, 5][4, 6][4, 7][4, 6][4, 6][9, 3][6, 5][6, 4][6, 6][4, 7][4, 7][9, 3][5, 6][7, 5][5, 6]

[6, 6][6, 5][3, 7][6, 3][6, 5][3, 7][3, 6][3, 7][3, 6][3, 6][6, 6][6, 5][3, 7][3, 8][3, 7][3, 7][6, 6][6, 5][6, 5][6, 6]

**Problem 2**

1. Let us consider a subtree where Agent 1 decides to play 3 in the First Round [3,0,0]

Considering all the strategies we get the following Utility values

Strategies of Player2, the Utility values of [Player1, Player2 ] and who wins In each case:

[0, 0, 0], [0, 0, 1], [0, 0, 2], [0, 0, 3], [0, 1, 0], [0, 1, 1], [0, 1, 2], [0, 2, 0], [0, 2, 1], [0, 3, 0], [1, 0, 0], [1, 0, 1], [1, 0, 2], [1, 1, 0], [1, 1, 1], [1, 2, 0], [2, 0, 0], [2, 0, 1], [2, 1, 0]

[6, 6] [6, 5] [3, 7] [6, 3] [6, 5] [3, 7] [3, 6] [3, 7] [3, 6] [3, 6] [6, 6] [6, 5] [3, 7] [3, 8] [3, 7] [3, 7] [6, 6] [6, 5] [6, 5]

Draw Agent1 Agent2 Agent1 Agent1 Agent2 Agent2 Agent2 Agent2 Agent2 draw Agent1 Agent2 Agent2 Agent2 Agent2 draw Agent1 Agent1

Please find the code of InducedNormalForm.java to find the normal form created for a specific part of the subtree where Agent1 plays 3 first, Induced Normal form was created and strategies where Nash Equilibrium is calculated from Backward Induction.java

In this case the solution would be [6,6] where Agent1 plays [3,0,0] and Agent2 plays [0,0,0]

1. Implement a more general solution for the two-player version of the problem for arbitrary values of m and n

(i.e. for arbitrary numbers of rounds and arbitrary start purses).

Here, Backward Induction is used to find the subgame perfect Nash equilibrium and we can input the values of m and n.

Here, The strategies must be given as input and using these strategies the solution can be evaluated.

PS: Please remove the comments mentioned in the code before execution of 2 a)

Javac BackwardInduction.java

Java BackwardInduction

Javac InducedNormalForm.java

Java InducedNormalForm