Artificial Intelligence (UCS411) PROJECT SUBMISSION

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# Problem Statement:

The target variable is to create tic tac toe using python.

# Description of the problem:

This simple game comes with an elegant user interface and game options using mouse & keyboard stokes. Users can choose to play Player1 vs Player2 (Multiplayer) or Player vs Computer (Artificial Intelligence).

**Theory**

**1.** **Introduction**

Tic-Tac-Toe is one of the paper-and-pencil games. This game requires two players in

3x3 grid with Player 1 acts as “O” and Player 2 acts as “X”, or vice versa (Figure 1).

The objective of this game is to take place of three connecting grids in a horizontal,

vertical, or diagonal way/fork.

This game was first introduced at ancient time, however there is no evidence who

invented it and which year. Some people think this game was invented at Ancient

Egypt, and then Roman Empire called this game “Terni Lapili”. The grid drawing for

the game had been found chalked all over the ancient city’s ruins. [1]

Terni Lapili was resurfaced in England with the name “Nought and Crosses” in 1864.

This resurfaced version is the modern of Tic-Tac-Toe game that people know until this

present day. [1]

In 1952, Alexander S. Douglas for the EDSAC computer at University of Cambridge

developed a computerized Tic-Tac-Toe game called “OXO”. This was the first video

game of Tic-Tac-Toe and it has AI inside, therefore human could play against the

computer opponent. [2]

Figure 1. Tic-Tac-Toe game [3]

**2.** **Game Strategy**

Tic-Tac-Toe game has many strategies that can be used. The main point of the strategy

is the players have to block the opponent fork, either horizontally, vertically, or

diagonally, while the players have to find their own fork to win.

In combinatorial study, suppose “X” moves first, then the game is won as follows:[4]

• 91 distinct positions are won by X.

• 44 distinct position are won by O.

• 3 distinct positions are draw.

**3. Artificial Intelligence Implementation**

Artificial Intelligence (AI) can be used for this game in order to play only single player,

in other words human against computer. There are many samples of this game with AI

on the internet, and each sample has its own algorithm for AI and it depends on the

developer, which kind of algorithm will be used. One of AI algorithms that can be used

for Tic-Tac-Toe is Minimax algorithm. Based on [5], this algorithm is a reliable

algorithm for Tic-Tac-Toe game. By using this strategy, computer will avoid the loser

condition against human.

The sample of Tic-Tac-Toe game that will be used for this paper is from [6]. This

program is written in Java and it has simple AI algorithm that can make people

understand about how to implement AI in the game.

This AI program has two strategies based on Newell and Simon’s 1972 Tic-Tac-Toe

program:

a) Try to take the center pile if human player did not take it.

b) Block the opponent way, if there are two piles taken by opponent already

either in horizontal, vertical, or diagonal fork.

The main part of this algorithm is located at variable named pattern. This variable

controls the AI algorithm. For the initial value, this variable’s value is,

int pattern[][]={{10,1,2,3,11},

{10,1,4,7,11},

{10,1,5,9,11},

{10,2,5,8,11},

{10,3,5,7,11},

{10,3,6,9,11},

{10,4,5,6,11},

{10,7,8,9,11}};

This variable consists of:

1) Flag (10,…,…,…,11)

2) Fork conditions to beat the game (AI will check in this order):

a) 1,2,3

b) 1,4,7

c) 1,5,9

d) 2,5,8

e) 3,5,7

f) 3,6,9

g) 4,5,6

h) 7,8,9

There are three flags that represent three conditions:

1) Normal flag, opponent has not taken this fork yet (10,…,…,…,11).

2) Taken flag, the fork has been taken by opponent (11,…,…,…,10).

3) Pruning flag, this fork is unused (11,…,…,…,11).

The simple AI algorithm of Tic-Tac-Toe: [6]

1) Computer will check if the center pile had been taken or not. If no, he will take

it, otherwise he will find another pile.

if(b[4].getIcon()==null){

if(firstTurn) b[4].setIcon(ic2);

else b[4].setIcon(ic1);

this.compCheck(5);

}

2) Computer will search the pile based on the order of fork conditions. Each fork

has a flag.

{10,1,2,3,11},

{10,1,4,7,11},

{10,1,5,9,11},

{10,2,5,8,11},

{10,3,5,7,11},

{10,3,6,9,11},

{10,4,5,6,11},

{10,7,8,9,11}};

3) Every pile that was taken by human, fork flag will change to Taken Flag for

every fork that has particular pile number.

public void humanCheck(int num1){

for(i=0;i<=7;i++){

for(j=1;j<=3;j++){

if(pattern[i][j]==num1){

pattern[i][0]=11;

pattern[i][4]=10;

}

}

}

}

4) Every pile that was taken by AI, fork flag will change to Normal Flag (change

right flag only to be 11).

public void compCheck(int num1){

for(ii=0;ii<=7;ii++){

for(jj=1;jj<=3;jj++){

if(pattern[ii][jj]==num1){

pattern[ii][4]=11;

}

}

}

}

5) If the fork has Normal Flag, AI will take it without check if there is any human’s

trail or not. Because, Normal Flag means there is no human’s trail in particular

fork.

if(pattern[i][0]==10){

for(j=1;j<=3;j++){

if(b[(pattern[i][j]-1)].getIcon()==null){

if(firstTurn) b[(pattern[i][j]-1)].setIcon(ic2);

else b[(pattern[i][j]-1)].setIcon(ic1);

this.compCheck(pattern[i][j]);

set=false;

break;

}

}

}

6) If the fork has Taken Flag, AI will check if the two other piles in particular fork

had been taken or not. If yes, computer will the pile in order to block

human’s trail, otherwise computer will find another route.

if(pattern[i][4]==10){

int count=0;

for(j=1;j<=3;j++){

if(b[(pattern[i][j]-1)].getIcon()!=null){

count++;

}

else{

yesnull=pattern[i][j];

}

}

if(count==2){

if(firstTurn)b[yesnull-1].setIcon(ic2);

else b[yesnull-1].setIcon(ic1);

this.compCheck(yesnull);

set=false;

break;

}

}

**4. Summary**

Tic-Tac-Toe game is a traditional game that still being played until present day. All

algorithm that used in this game have the same purpose, to block the opponent’s way.

Each developer has his/her own style of algorithm. However, in order to be more

effective, the basic of algorithm should include all aspects based on Newell.

Simon’s 1972 Tic-Tac-Toe.

5**. Reference**

[1] P. Wensink, The History of Tic-Tac-Toe is Pretty Fascinating Stuff, [Online].

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[2] M. J. P. Wolf, Encyclopedia of Video Games: The Culture, Technology, and Art of

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[3] https://www.flaticon.com/free-icon/tic-tac-toe-game\_75468

[4] T. Bolon, How to never lose at Tic-Tac-Toe, BookCountry, 2013.

[5] A. Abdolsaheb, How to Make your Tic Tac Toe Game Unbeatable by using the

Minimax Algorithm, Feb. 2017. [Online]. Available:

https://medium.freecodecamp.org/how-to-make-your-tic-tac-toe-game-unbeatable-by-

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