TIC TAC TOE

Implementation Using Minimax Algorithm

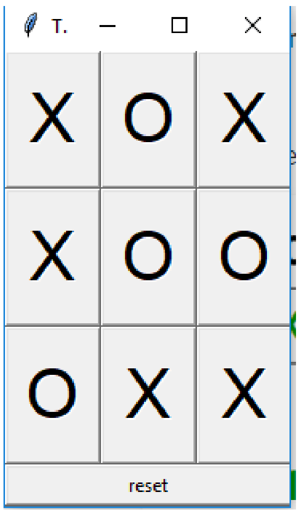
A. Introduction

Minimax is a kind of backtracking algorithm that is used in decision making and game theory to find the optimal move for a player, assuming that your opponent also plays optimally. In Minimax the two players are called maximizer and minimizer. The **maximizer** tries to get the highest score possible while the **minimizer** tries to do the opposite and get the lowest score possible. Basicly, minimax using BFS alghorithm on its implementation

Every board state has a value associated with it. In a given state if the maximizer has upper hand then, the score of the board will tend to be some positive value. If the minimizer has the upper hand in that board state then it will tend to be some negative value. The values of the board are calculated by some heuristics which are unique for every type of game.

B. Rules of the Game

- The game is to be played between two people (in this program between HUMAN and COMPUTER).
- One of the player chooses ‘O’ and the other ‘X’ to mark their respective cells.
- The game starts with one of the players and the game ends when one of the players has one whole row/ column/ diagonal filled with his/her respective character (‘O’ or ‘X’).
- If no one wins, then the game is said to be draw.



C. Analysis

If we represent our board as a 3×3 , then we have to check each row, each column and the diagonals to check if either of the players have gotten 3 in a row. The basic idea behind the evaluation function is to give a high value for a board if **maximizer**'s turn or a low value for the board if **minimizer**'s turn.

- If X wins on the board we give it a positive value of -1.
- If O wins on the board we give it a negative value of +1.
- If no one has won or the game results in a draw then we give a value of +0.

Finding the Best Move :

To check whether or not the current move is better than the best move we take the help of **minimax()** function which will consider all the possible ways the game can go and returns the best value for that move, assuming the opponent also plays optimally.

```
def __minimax(self, player):
  if self.won():
    if player:
      return (-1,None)
    else:
      return (+1,None)
  elif self.tied():
    return (0,None)
  elif player:
    best = (-2,None)
    for x,y in self.fields:
      if self.fields[x,y]==self.empty:
        value = self.move(x,y).__minimax(not player)[0]        #implementasi BFS player
        if value>best[0]:
          best = (value,(x,y))
    return best
  else:
    best = (+2,None)
    for x,y in self.fields:
      if self.fields[x,y]==self.empty:                     #implementasi BFS opponent
        value = self.move(x,y).__minimax(not player)[0]
        if value<best[0]:
          best = (value,(x,y))
    return best
```

Checking for GameOver state :

To check whether the game is over and to make sure there are no moves left we use **tied()** function. It is a simple straightforward function which checks whether a move is available or not and returns true or false respectively, it also indicate that the game end in tied state.

```
def tied(self):                        #kondisi tidak ada yang menang
  for (x,y) in self.fields:
    if self.fields[x,y]==self.empty:
      return False
  return True
```

Checking for Winning state :

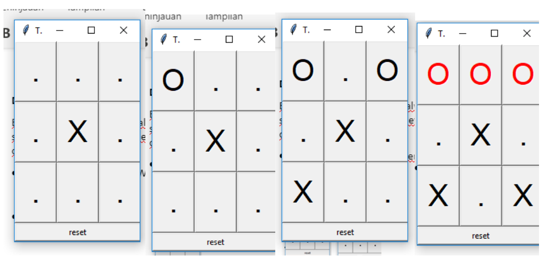
The otherways, the game should stop when one of the player reach winning condition (horizontally, vertically, or diagonally). So we need **won()** function to check it.

```python
def won(self):                                  #mengecek kemenangan setiap baris horizontal,vertical,horizontal
  # horizontal
  for y in range(self.size):
    winning = []
    for x in range(self.size):
      if self.fields[x,y] == self.opponent:
        winning.append((x,y))
    if len(winning) == self.size:
      return winning
  # vertical
  for x in range(self.size):
    winning = []
    for y in range(self.size):
      if self.fields[x,y] == self.opponent:
        winning.append((x,y))
    if len(winning) == self.size:
      return winning
  # diagonal
  winning = []
  for y in range(self.size):
    x = y
    if self.fields[x,y] == self.opponent:
      winning.append((x,y))
  if len(winning) == self.size:
    return winning
  # other diagonal
  winning = []
  for y in range(self.size):
    x = self.size-1-y
    if self.fields[x,y] == self.opponent:
      winning.append((x,y))
  if len(winning) == self.size:
    return winning
  # default
  return None
```

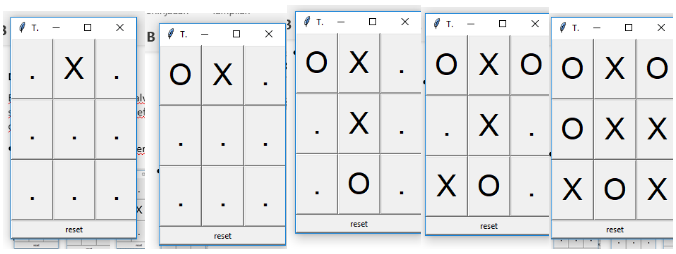
D. Demo

Because the computer side always find best solution to prevent the player won, so its almost impossible to defeat the AI. So, here the condition when the computer won or draw.

- Player Lose (X) (Computer Won (O))



- Draw



E. Source Code

```
import sys
if sys.version_info >= (3, 0): #untuk interface (GUI)
from tkinter import Tk, Button
from tkinter.font import Font
else:
from Tkinter import Tk, Button
from tkFont import Font
from copy import deepcopy


class Board:
def __init__(self,other=None): #menginisialisasi komponen dari board
self.player = 'X'
self.opponent = 'O'
self.empty = '.'
self.size = 3
self.fields = {}
for y in range(self.size):
for x in range(self.size):
self.fields[x,y] = self.empty
# copy constructor
if other:
self.__dict__ = deepcopy(other.__dict__) #mengcopy self dan semua isinya ke
other._dict_
def move(self,x,y):
board = Board(self) #mereturn status terbaru dari setiap state
board.fields[x,y] = board.player
(board.player,board.opponent) = (board.opponent,board.player)
```

```
return board
def __minimax(self, player):
if self.won():
if player:
return (-1,None)
else:
return (+1,None)
elif self.tied():
return (0,None)
elif player:
best = (-2,None)
for x,y in self.fields:
if self.fields[x,y]==self.empty:
value = self.move(x,y).__minimax(not player)[0] #implementasi BFS player
if value>best[0]:
best = (value,(x,y))
return best
else:
best = (+2,None)
for x,y in self.fields:
if self.fields[x,y]==self.empty: #implementasi BFS opponent
value = self.move(x,y).__minimax(not player)[0]
if value<best[0]:
best = (value,(x,y))
return best
def best(self): #melooping minimax
return self.__minimax(True)[1]
def tied(self): #kondisi tidak ada yang menang
for (x,y) in self.fields:
if self.fields[x,y]==self.empty:
return False
```

```
return True

def won(self): #mengecek kemenangan setiap baris
horizontal,vertical,horizontal

# horizontal

for y in range(self.size):

winning = []

for x in range(self.size):

if self.fields[x,y] == self.opponent:

winning.append((x,y))

if len(winning) == self.size:

return winning

# vertical

for x in range(self.size):

winning = []

for y in range(self.size):

if self.fields[x,y] == self.opponent:

winning.append((x,y))

if len(winning) == self.size:

return winning

# diagonal

winning = []

for y in range(self.size):

x = y

if self.fields[x,y] == self.opponent:

winning.append((x,y))

if len(winning) == self.size:

return winning

# other diagonal

winning = []

for y in range(self.size):

x = self.size-1-y

if self.fields[x,y] == self.opponent:
```

```
winning.append((x,y))
if len(winning) == self.size:
return winning
# default
return None
class GUI:


def __init__(self):
self.app = Tk()
self.app.title('TicTacToe')
self.app.resizable(width=True, height=True)
self.board = Board()
self.font = Font(family="Helvetica", size=32)
self.buttons = {}
for x,y in self.board.fields:
handler = lambda x=x,y=y: self.move(x,y)
button = Button(self.app, command=handler, font=self.font, width=2, height=1)
button.grid(row=y, column=x)
self.buttons[x,y] = button
handler = lambda: self.reset()
button = Button(self.app, text='reset', command=handler)
button.grid(row=self.board.size+1, column=0, columnspan=self.board.size,
sticky="WE")
self.update()
def reset(self):
self.board = Board()
self.update()
def move(self,x,y):
self.app.config(cursor="watch")
self.app.update()
self.board = self.board.move(x,y)
```

```
self.update()
move = self.board.best()
if move:
self.board = self.board.move(*move)
self.update()
self.app.config(cursor="")
def update(self):
for (x,y) in self.board.fields:
text = self.board.fields[x,y]
self.buttons[x,y]['text'] = text
self.buttons[x,y]['disabledforeground'] = 'black'
if text==self.board.empty:
self.buttons[x,y]['state'] = 'normal'
else:
self.buttons[x,y]['state'] = 'disabled'
winning = self.board.won()
if winning:
for x,y in winning:
self.buttons[x,y]['disabledforeground'] = 'red'
for x,y in self.buttons:
self.buttons[x,y]['state'] = 'disabled'
for (x,y) in self.board.fields:
self.buttons[x,y].update()


def mainloop(self):
self.app.mainloop()


if __name__ == '__main__':
GUI().mainloop()
```