Usman Institute of Technology

Department of Computer Science
Course Code: CS-321
Artificial Intelligence
Spring 2023

Lab 04

Instructor: Dr. Nasir Uddin
E-mail: nuddin@uit.edu

Objective

This experiment demonstrates implementation of an intelligent agent using Python. It guides students through the working of a two player tic tac toe agent. Such techniques can be used to implement similar agent programs.

Student Information

Student Name	
Student ID	
Date	

Assessment

Marks Obtained	
Remarks	
Signature	

Usman Institute of Technology
Department of Computer Science
Course Code: CS-321
Artificial Intelligence
Spring 2023

Objective

This experiment demonstrates implementation of an intelligent agent using Python. It guides students through the working of a two player tic tac toe agent. Such techniques can be used to implement similar agent programs.

Instructions

You have to perform the following tasks yourselves. Raise your hand if you face any difficulty in understanding and solving these tasks. **Plagiarism** is an abhorrent practice and you should not engage in it.

How to Submit

- Submit lab work using TEAMS.

1 Agents

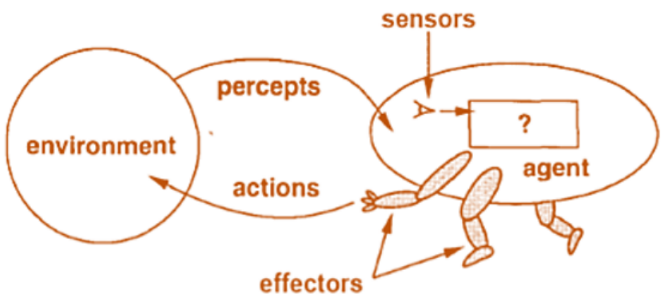
An agent is anything that can be viewed as perceiving its environment through **sensors** and acting upon that environment through **actuators**

1.1 Human agent

For human agent eyes, ears, and other organs work as **sensors** and hands, legs, mouth, and other body parts for **actuators**

1.2 Robotic agent

For a robotic agent cameras and infrared range finders are sensors; various motors represent actuators



1.3 Agent Types

Four basic types in order of increasing generality:

- Simple reflex agents
- Model-based reflex agents
- Goal-based agents
- Utility-based agents

1.4 Vacuum-Cleaner Agent

Percepts: location and contents, e.g., [A, Dirty]
Actions: Left, Right, Suck, No Op

```
function Reflex-Vacuum-Agent( [location,status]) returns an action
if status = Dirty then return Clean
else if location = A then return Right
else if location = B then return Left
```

1.5 Multi player Tic Tac Toe Agent

Two human players, play Tic Tac Toe with paper and pencil. One player is ‘X’ and the other player is ‘O’. Players take turns placing their ‘X’ or ‘O’. If a player gets three of their marks on the board in a row, column or one of the two diagonals, they win. When the board fills up with neither player winning, the game ends in a draw. Let’s get started by looking at a sample run of the program. The game is played between a human player and computer agent. The player makes their move by entering the number representing the desired location.

The following figure shows sample Run of Tic Tac Toe:

The computer will go first

O		

What is your next move (1-9):
8

O	X	O
O		X

What is your next move (1-9):
3

O		O
		X

What is your next move (1-9):
5

O	X	O
O	X	
O		X

The computer has beaten you! You lose.

Table 1 represent mapping of the location:

7	8	9
4	5	6
1	2	3

Table 1 Location Mapping

1.6 Flow of The Agent Program

Figure 1 displays the flow chart of Tic Tac Toe program. The computer agent goes first and uses the symbol ‘O’. The boxes on the left side of the flow chart are what happens during the player’s turn.

The right side shows what happens on the computer's turn. After the player or computer makes a move, the program checks if they won or caused a tie, and then the game switches turns. After the game is over, the program asks the player if they want to play again. The program can be further

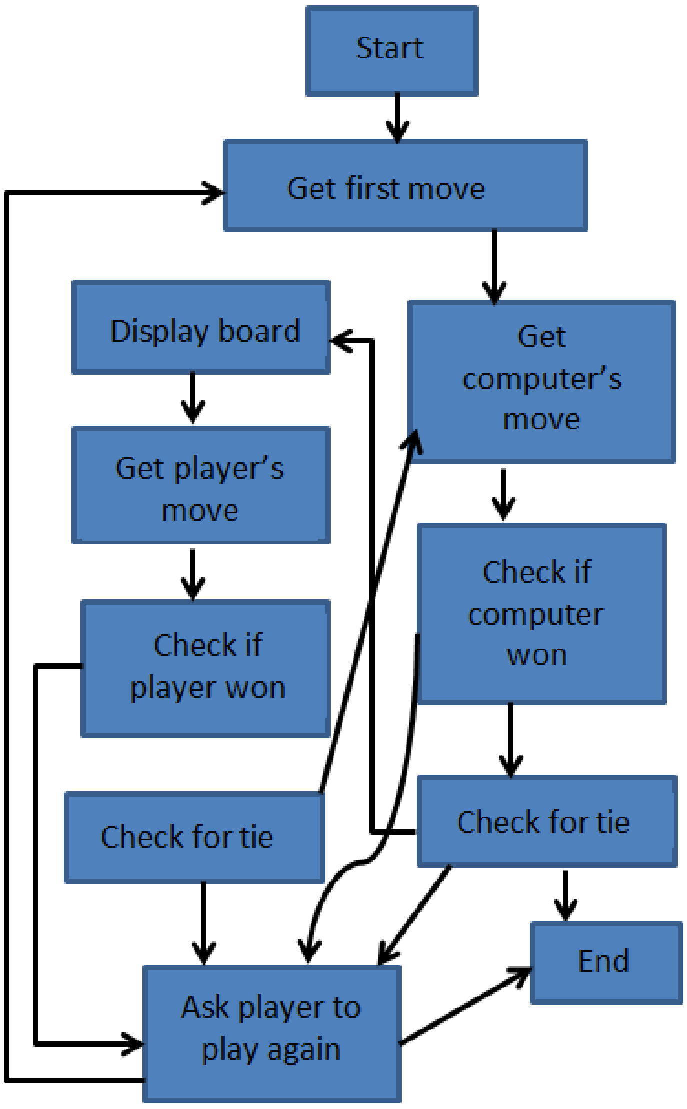


Figure 1: Flow Chart of Tic Tac Toe

modified to a less rigid approach to let the human player choose if they want to be 'X' or 'O'. Who takes the first turn is randomly chosen. Then the player and computer take turns making moves.

1.7 Representing the Board

First, you must figure out how to represent the board as a variable. On paper, the Tic Tac Toe board is drawn as a pair of horizontal lines and a pair of vertical lines, with either an X, O, or empty space in each of the nine spaces. In the program, the Tic Tac Toe board is represented as a list of strings. Each string will represent one of the nine spaces on the board. The strings will either be 'X' for the X player, 'O' for the O player, or a single space ' ' for a blank space. So if a list with ten strings was stored in a variable named board, then board[7] would be the top-left space on the board. board[5] would be the center. board[4] would be the left side space, and so on. The program will ignore the string at index 0 in the list. The player will enter a number from 1 to 9 to tell the game which space they want to move on.

1.8 Game AI

The AI needs to be able to look at a board and decide which types of spaces it will move on. To be clear, we will label three types of spaces on the Tic Tac Toe board: corners, sides, and the center. Figure 4 is a chart of what each space is.

Corner	Side	Corner
Side	Center	Side
Corner	Side	Corner

Table 2 Space Types

The AI's algorithm will have the following steps:

1. First, see if there's a move the computer can make that will win the game. If there is, take that move. Otherwise, go to step 2.
2. See if there's a move the player can make that will cause the computer to lose the game. If there is, move there to block the player. Otherwise, go to step 3.
3. Check if any of the corner spaces (spaces 1, 3, 7, or 9) are free. If so, move there. If no corner piece is free, then go to step
4. Check if the center is free. If so, move there. If it isn't, then go to step 5.
5. Move on any of the side pieces (spaces 2, 4, 6, or 8). There are no more steps, because if the execution reaches step 5 the side spaces are the only spaces left.

This all takes place in the "Get computer's move" function shown in the following code:

```python
import random
def drawBoard(board):
    #This function prints out the board that is passed to it.
    #"board" is a list of 10 strings representing the board (ignore index 0)
    print()
    print('   |   |')
    print(' '+board[7]+' | ' +board[8]+' | '+board[9])
    print('   |   |')
    print('-----------')
    print(' '+board[4]+' | ' +board[5]+' | '+board[6])
    print('   |   |')
    print('-----------')
    print('   |   |')
    print(' '+board[1]+' | ' +board[2]+' | '+board[3])
    print('   |   |')
def inputPlayerLetter():
    #Lets the player type which letter they want to be their mark
    #Returns a list with the player's letter as the first item, and the computer's letter as the second.
    #For simplification, keeping X as the player's letter and O as the computer's letter
    return['X','O']
def whoGoesFirst():
    #for simplification letting the computer go first
    return 'computer'
def playAgain():
    #This function returns True if the player wants to play again, otherwise it returns False.
    print('Do you want to play again? (yes or no)')
    return input().lower().startswith('y')
def makeMove(board,letter,move):
    #This function simply marks the planned move (Location of the board with the player's letter.
    board[move]=letter
    def isWinner(bo, le):
    #Given a board and a player's letter, this function returns True if that player has won.
    #We use bo instead of board and le instead of letter so we don't have to type as much.
    return ((bo[7]==le and bo[8]==le and bo[9]==le) or # across the top
    (bo[4]==le and bo[5]==le and bo[6]==le) or # across the middle
    (bo[1]==le and bo[2]==le and bo[3]==le) or # across the bottom
    (bo[7]==le and bo[4]==le and bo[1]==le) or #down the left side
    (bo[8]==le and bo[5]==le and bo[2]==le) or #down the middle
    (bo[9]==le and bo[6]==le and bo[3]==le) or #down the right side
    (bo[7]==le and bo[5]==le and bo[3]==le) or #diagonal
    (bo[9]==le and bo[5]==le and bo[1]==le)) #diagonal
def getBoardCopy(board):
    #Make a duplicate of the board list and return it the duplicate
    dupeBoard=[]
    for i in board:
        dupeBoard.append(i)
    return dupeBoard
def isSpaceFree(board, move):
    # Return true if the passed move is free on the passed board.
    return board[move]==''
def getPlayerMove(board):
    #Let the player type in his move
    move=''
    while move not in '1 2 3 4 5 6 7 8 9'.split() or not isSpaceFree(board, int(move)):
        print('What is your next move? (1-9)')
        move=input()
    return int(move)
def chooseRandomMoveFromList(board, movesList):
    #Returns a valid move from the passed list on the passed board.
    #Returns None if there is no valid move.
    possibleMoves=[]
    for i in movesList:
        if isSpaceFree(board, i):
            possibleMoves.append(i)
    if len(possibleMoves)!=0:
        return random.choice(possibleMoves)
    else:
        return None
def getComputerMove(board, computerLetter):
    #Given a board and the computer's letter, determine where to move and return that move.
    if computerLetter=='X':
        playerLetter='O'
    else:
        playerLetter='X'

    # Here is our algorithm for our tic toc toe AI:
    # First, check if we can win in the next move
    for i in range(1,10):
        copy= getBoardCopy(board)
        if isSpaceFree(copy,i):
            makeMove(copy, computerLetter,i)
            return i
        # Check if the player could win on his next move, and block them.
    for i in range(1,10):
        copy=getBoardCopy(board)
        if isSpaceFree(copy,i):
            makeMove(copy, playerLetter, i)
            if isWinner(copy, playerLetter):
                return i
```

```python
  # Try to take one of the corners, if they are free
  move = chooseRandomMoveFromList(board, [1,3,7,9])
  if move !=None:
    return move
  #Try to take the center, if it is free.
  if isSpaceFree(board,5):
    return 5
  # Move on one of the sides
  return chooseRandomMoveFromList(board,[2,4,6,8])
def isBoardFull(board):
# Return True if every space on the board has been taken. Otherwise returns False.
  for i in range(1,10):
    if isSpaceFree(board,i):
      return False
  return True

def main():
  print('Welcome to a game of Tic Tac Toe!')
  while True:
    print('Entered first while')
    #Reset the board
    theBoard=[' ']*10
    playerLetter, computerLetter=inputPlayerLetter()
    turn=whoGoesFirst()
    print('The '+turn + ' will go first.')
    gameIsPlaying=True
    while gameIsPlaying:
      print('First statment of the 2nd while loop')
      if turn=='player':
        drawBoard(theBoard)
        move=getPlayerMove(theBoard)
        makeMove(theBoard,playerLetter,move)

        if isWinner(theBoard, playerLetter):
          drawBoard(theBoard)
          print('Hooray! You have won the game!')
          gameIsPlaying=False
        else:
          if isBoardFull(theBoard):
            drawBoard(theBoard)
            print('The game is tie!')
            break
        else:
          turn = 'computer'
      else:
        #computer's turn.
        move =getComputerMove(theBoard, computerLetter)
        makeMove(theBoard, computerLetter, move)
        if isWinner(theBoard,computerLetter):
          drawBoard(theBoard)
          print('The computer has beaten you! You lose.')
          gameisPlaying=False
          break
        else:
          if isBoardFull(theBoard):
            drawBoard(theBoard)
            print('The game is a tie!')
            break
          else:
            turn ='player'
    if not playAgain():
    break;

```

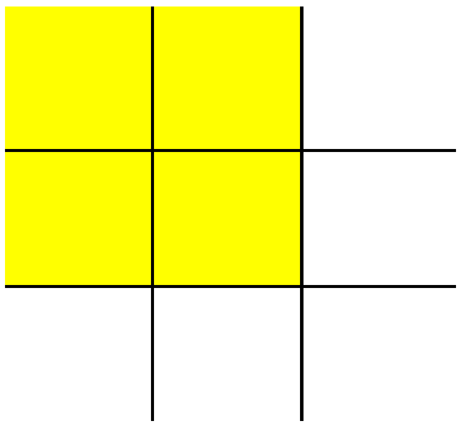
Usman Institute of Technology
Department of Computer Science
Course Code: CS-321
Artificial Intelligence
Spring 2023

Exercise 1

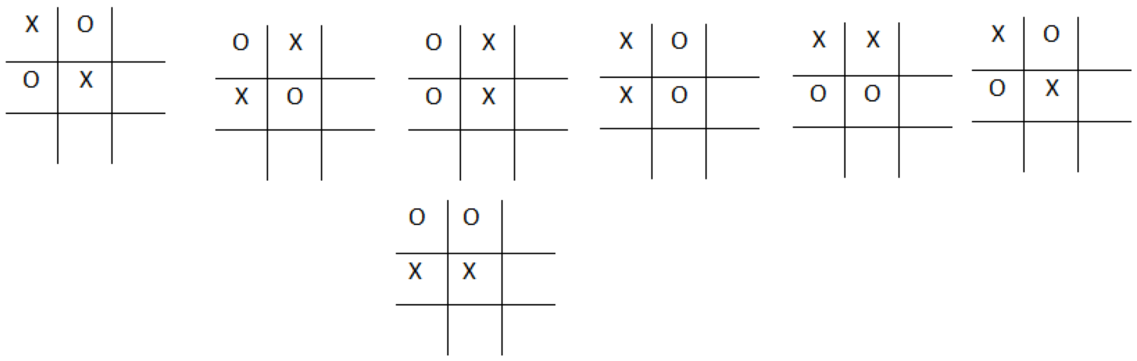
Consider the given Tic Tac Toe program designed for a match between Human and Agent. Convert it in to a program that demonstrates a play between Agent vs Agent, using two approaches:

1. Simple Reflex Agent:
   (a) Am I winning the game?
   (b) Am I losing the game?
   (c) Go for a random move.
2. Lookup Table: To reduce the number of possibilities your lookup table should hold, start by identifying 4 boxes that will always be filled at the start of you game. Then plan for the remaining game accordingly. For example:

   Your game always starts with any four boxes (of your choice) already filled in any specific order, again of your choice.



Now develop the reflex and lookup agents that can take the game forward from all possible configurations of these 4 boxes. In the sequence you are always playing 'X' and its always your turn next.



Exercise 2

Alter the agent you have written so that it can handle the scenario when the computer goes first or the player/agent goes first.

Usman Institute of Technology
Department of Computer Science
Course Code: CS-321
Artificial Intelligence
Spring 2023

Exercise 3

Alter the agent you have written so that it can handle all the combinations that can be formulated for the 4 cells you have selected.