Open Ended

Artificial Intelligence

[CSE401**]**

DEPARTMENT

OF

COMPUTER SCIENCE AND ENGINEERING

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING



**Submitted To: Submitted By:**

Dr. S. K. Dubey Shubham Periwal

Associate Professor A2305218241

CSE Department, ASET B. Tech (CSE)

7CSE4Y

AMITY SCHOOL OF ENGINEERING AND TECHNOLOGY

AMITY UNIVERSITY UTTAR PRADESH

NOIDA-201301

**Open-Ended Program**

**Name: Shubham Periwal**

**Enrollment No.: A2305218241**

**Subjec*t*: Artificial Intelligence**

**Section:** **7CSE4-Y**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Category**  **of Assignment** | **Code** | **Name of Experiment** | **Date of Allotment of experiment** | **Date of Evaluation** | **Max.**  **Marks** | **Marks obtained** | **Sign.**  **of Faculty** |
| **Design Based Open Ended experiment** | **PR (10)** | Implementation of Ultimate Tic Tac Toe | 22/10/21 | 29/10/21 | **10** |  |  |

**OPEN ENDED EXPERIMENT**

**Date: - 22/10/21**

**Objective: -** Implementation of Ultimate Tic Tac Toe.

**Software Used: -** Python

**Theory: -** Ultimate tic-tac-toe is a board game composed of nine tic-tac-toe boards arranged in a 3 × 3 grid. Players take turns playing in the smaller tic-tac-toe boards until one of them wins in the larger tic-tac-toe board. Compared to traditional tic-tac-toe, strategy in this game is conceptually more difficult and has proven more challenging for computers.

Rules of the ultimate tic tac toe

* Each small 3-by-3 tic-tac-toe board is referred to as a local board, and the larger 3-by-3 board is referred to as the global board.
* The game starts with X playing wherever they want in any of the 81 empty spots. This move 'sends' their opponent to its relative location. For example, if X played in the top right square of their local board, then O needs to play next in the local board at the top right of the global board. O can then play in any one of the nine available spots in that local board, each move sending X to a different local board.
* If a move is played so that it is to win a local board by the rules of normal tic-tac-toe, then the entire local board is marked as a victory for the player in the global board.
* Once a local board is won by a player or it is filled completely, no more moves may be played in that board. If a player is sent to such a board, then that player may play in any other board.

Game play ends when either a player wins the global board or there are no legal moves remaining, in which case the game is a draw

**Code: -**

print ("Shubham Periwal A2305218241 7CSE4-Y")

from math import inf

from collections import Counter

import itertools

from time import time

TIME\_LIMIT = 5

def index(x, y):

    x -= 1

    y -= 1

    return ((x//3)\*27) + ((x % 3)\*3) + ((y//3)\*9) + (y % 3)

def box(x, y):

    return index(x, y) // 9

def next\_box(i):

    return i % 9

def indices\_of\_box(b):

    return list(range(b\*9, b\*9 + 9))

def print\_board(state):

    for row in range(1, 10):

        row\_str = ["|"]

        for col in range(1, 10):

            row\_str += [state[index(row, col)]]

            if (col) % 3 == 0:

                row\_str += ["|"]

        if (row-1) % 3 == 0:

            print("-"\*(len(row\_str)\*2-1))

        print(" ".join(row\_str))

    print("-"\*(len(row\_str)\*2-1))

def add\_piece(state, move, player):

    if not isinstance(move, int):

        move = index(move[0], move[1])

    return state[: move] + player + state[move+1:]

def update\_box\_won(state):

    temp\_box\_win = ["."] \* 9

    for b in range(9):

        idxs\_box = indices\_of\_box(b)

        box\_str = state[idxs\_box[0]: idxs\_box[-1]+1]

        temp\_box\_win[b] = check\_small\_box(box\_str)

    return temp\_box\_win

def check\_small\_box(box\_str):

    global possible\_goals

    for idxs in possible\_goals:

        (x, y, z) = idxs

        if (box\_str[x] == box\_str[y] == box\_str[z]) and box\_str[x] != ".":

            return box\_str[x]

    return "."

def possible\_moves(last\_move):

    global box\_won

    if not isinstance(last\_move, int):

        last\_move = index(last\_move[0], last\_move[1])

    box\_to\_play = next\_box(last\_move)

    idxs = indices\_of\_box(box\_to\_play)

    if box\_won[box\_to\_play] != ".":

        pi\_2d = [indices\_of\_box(b) for b in range(9) if box\_won[b] == "."]

        possible\_indices = list(itertools.chain.from\_iterable(pi\_2d))

    else:

        possible\_indices = idxs

    return possible\_indices

def successors(state, player, last\_move):

    succ = []

    moves\_idx = []

    possible\_indexes = possible\_moves(last\_move)

    for idx in possible\_indexes:

        if state[idx] == ".":

            moves\_idx.append(idx)

            succ.append(add\_piece(state, idx, player))

    return zip(succ, moves\_idx)

def print\_successors(state, player, last\_move):

    for st in successors(state, player, last\_move):

        print\_board(st[0])

def opponent(p):

    return "O" if p == "X" else "X"

def evaluate\_small\_box(box\_str, player):

    global possible\_goals

    score = 0

    three = Counter(player \* 3)

    two = Counter(player \* 2 + ".")

    one = Counter(player \* 1 + "." \* 2)

    three\_opponent = Counter(opponent(player) \* 3)

    two\_opponent = Counter(opponent(player) \* 2 + ".")

    one\_opponent = Counter(opponent(player) \* 1 + "." \* 2)

    for idxs in possible\_goals:

        (x, y, z) = idxs

        current = Counter([box\_str[x], box\_str[y], box\_str[z]])

        if current == three:

            score += 100

        elif current == two:

            score += 10

        elif current == one:

            score += 1

        elif current == three\_opponent:

            score -= 100

            return score

        elif current == two\_opponent:

            score -= 10

        elif current == one\_opponent:

            score -= 1

    return score

def evaluate(state, last\_move, player):

    global box\_won

    score = 0

    score += evaluate\_small\_box(box\_won, player) \* 200

    for b in range(9):

        idxs = indices\_of\_box(b)

        box\_str = state[idxs[0]: idxs[-1]+1]

        score += evaluate\_small\_box(box\_str, player)

    return score

def minimax(state, last\_move, player, depth, s\_time):

    succ = successors(state, player, last\_move)

    best\_move = (-inf, None)

    for s in succ:

        val = min\_turn(s[0], s[1], opponent(player), depth-1, s\_time,

                       -inf, inf)

        if val > best\_move[0]:

            best\_move = (val, s)

#        print("val = ", val)

#        print\_board(s[0])

    return best\_move[1]

def min\_turn(state, last\_move, player, depth, s\_time, alpha, beta):

    global box\_won

    if depth <= 0 or check\_small\_box(box\_won) != ".":# or time() - s\_time >= 10:

        return evaluate(state, last\_move, opponent(player))

    succ = successors(state, player, last\_move)

    for s in succ:

        val = max\_turn(s[0], s[1], opponent(player), depth-1, s\_time,

                       alpha, beta)

        if val < beta:

            beta = val

        if alpha >= beta:

            break

    return beta

def max\_turn(state, last\_move, player, depth, s\_time, alpha, beta):

    global box\_won

    if depth <= 0 or check\_small\_box(box\_won) != ".":# or time() - s\_time >= 20:

        return evaluate(state, last\_move, player)

    succ = successors(state, player, last\_move)

    for s in succ:

        val = min\_turn(s[0], s[1], opponent(player), depth-1, s\_time,

                       alpha, beta)

        if alpha < val:

            alpha = val

        if alpha >= beta:

            break

    return alpha

def valid\_input(state, move):

    global box\_won

    if not (0 < move[0] < 10 and 0 < move[1] < 10):

        return False

    if box\_won[box(move[0], move[1])] != ".":

        return False

    if state[index(move[0], move[1])] != ".":

        return False

    return True

def take\_input(state, bot\_move):

    all\_open\_flag = False

    if bot\_move == -1 or len(possible\_moves(bot\_move)) > 9:

        all\_open\_flag = True

    if all\_open\_flag:

        print("Play anywhere you want!")

    else:

        box\_dict = {0: "Upper Left", 1: "Upper Center", 2: "Upper Right",

                    3: "Center Left", 4: "Center", 5: "Center Right",

                    6: "Bottom Left", 7: "Bottom Center", 8: "Bottom Right"}

        print("Where would you like to place 'X' in ~"

              + box\_dict[next\_box(bot\_move)] + "~ box?")

    x = int(input("Row = "))

    if x == -1:

        raise SystemExit

    y = int(input("Col = "))

    print("")

    if bot\_move != -1 and index(x, y) not in possible\_moves(bot\_move):

        raise ValueError

    if not valid\_input(state, (x, y)):

        raise ValueError

    return (x, y)

def game(state="." \* 81, depth=20):

    global box\_won, possible\_goals

    possible\_goals = [(0, 4, 8), (2, 4, 6)]

    possible\_goals += [(i, i+3, i+6) for i in range(3)]

    possible\_goals += [(3\*i, 3\*i+1, 3\*i+2) for i in range(3)]

    box\_won = update\_box\_won(state)

    print\_board(state)

    bot\_move = -1

    while True:

        try:

            user\_move = take\_input(state, bot\_move)

        except ValueError:

            print("Invalid input or move not possible!")

            print\_board(state)

            continue

        except SystemError:

            print("Game Stopped!")

            break

        user\_state = add\_piece(state, user\_move, "X")

        print\_board(user\_state)

        box\_won = update\_box\_won(user\_state)

        game\_won = check\_small\_box(box\_won)

        if game\_won != ".":

            state = user\_state

            break

        s\_time = time()

        bot\_state, bot\_move = minimax(user\_state, user\_move, "O", depth,

                                      s\_time)

        print("Bot placed 'O' on", bot\_move, "\n")

        print\_board(bot\_state)

        state = bot\_state

        box\_won = update\_box\_won(bot\_state)

        game\_won = check\_small\_box(box\_won)

        if game\_won != ".":

            break

    if game\_won == "X":

        print("$$$$$ Congratulations YOU WIN! $$$$$")

    else:

        print("~~~~~ YOU LOSE! ~~~~~")

    return state

if \_\_name\_\_ == "\_\_main\_\_":

    INITIAL\_STATE = "." \* 81

    final\_state = game(INITIAL\_STATE, depth=5)

**Output:**

**Shubham Periwal A2305218241 7CSE4-Y**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Play anywhere you want!**

**Row = 1**

**Col = 1**

**-------------------------**

**| X . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 4**

**-------------------------**

**| X . . | . . . | . . . |**

**| . O . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Where would you like to place 'X' in ~Center~ box?**

**Row = 5**

**Col = 5**

**-------------------------**

**| X . . | . . . | . . . |**

**| . O . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . X . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 38**

**-------------------------**

**| X . . | . . . | . . . |**

**| . O . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Where would you like to place 'X' in ~Upper Right~ box?**

**Row = 2**

**Col = 8**

**-------------------------**

**| X . . | . . . | . . . |**

**| . O . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 44**

**-------------------------**

**| X . . | . . . | . . . |**

**| . O . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X . | . . . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Where would you like to place 'X' in ~Bottom Right~ box?**

**Row = 8**

**Col = 8**

**-------------------------**

**| X . . | . . . | . . . |**

**| . O . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X . | . . . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 41**

**-------------------------**

**| X . . | . . . | . . . |**

**| . O . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X O | . . . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Where would you like to place 'X' in ~Center Right~ box?**

**Row = 5**

**Col = 8**

**-------------------------**

**| X . . | . . . | . . . |**

**| . O . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 1**

**-------------------------**

**| X O . | . . . | . . . |**

**| . O . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Where would you like to place 'X' in ~Upper Center~ box?**

**Row = 2**

**Col = 5**

**-------------------------**

**| X O . | . . . | . . . |**

**| . O . | . X . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 7**

**-------------------------**

**| X O . | . . . | . . . |**

**| . O . | . X . | . X . |**

**| . O . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . . . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Where would you like to place 'X' in ~Bottom Center~ box?**

**Row = 8**

**Col = 5**

**-------------------------**

**| X O . | . . . | . . . |**

**| . O . | . X . | . X . |**

**| . O . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . X . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 12**

**-------------------------**

**| X O . | . . . | . . . |**

**| . O . | O X . | . X . |**

**| . O . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . . . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . X . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Where would you like to place 'X' in ~Center Left~ box?**

**Row = 5**

**Col = 2**

**-------------------------**

**| X O . | . . . | . . . |**

**| . O . | O X . | . X . |**

**| . O . | . . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . X . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 15**

**-------------------------**

**| X O . | . . . | . . . |**

**| . O . | O X . | . X . |**

**| . O . | O . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . . . | . X . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Where would you like to place 'X' in ~Bottom Left~ box?**

**Row = 8**

**Col = 2**

**-------------------------**

**| X O . | . . . | . . . |**

**| . O . | O X . | . X . |**

**| . O . | O . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 9**

**-------------------------**

**| X O . | O . . | . . . |**

**| . O . | O X . | . X . |**

**| . O . | O . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Play anywhere you want!**

**Row = 1**

**Col = 9**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | . . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 24**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X . |**

**| . . . | . . . | . . . |**

**-------------------------**

**Where would you like to place 'X' in ~Bottom Left~ box?**

**Row = 9**

**Col = 3**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X . |**

**| . . X | . . . | . . . |**

**-------------------------**

**Bot placed 'O' on 80**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X . |**

**| . . X | . . . | . . O |**

**-------------------------**

**Where would you like to place 'X' in ~Bottom Right~ box?**

**Row = 8**

**Col = 9**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | . X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X X |**

**| . . X | . . . | . . O |**

**-------------------------**

**Bot placed 'O' on 48**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O . . |**

**-------------------------**

**| . . . | . . O | . . . |**

**| . X . | . X O | O X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X X |**

**| . . X | . . . | . . O |**

**-------------------------**

**Where would you like to place 'X' in ~Center Left~ box?**

**Row = 4**

**Col = 1**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O . . |**

**-------------------------**

**| X . . | . . O | . . . |**

**| . X . | . X O | O X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X X |**

**| . . X | . . . | . . O |**

**-------------------------**

**Bot placed 'O' on 25**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O O . |**

**-------------------------**

**| X . . | . . O | . . . |**

**| . X . | . X O | O X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X X |**

**| . . X | . . . | . . O |**

**-------------------------**

**Where would you like to place 'X' in ~Bottom Center~ box?**

**Row = 9**

**Col = 5**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O O . |**

**-------------------------**

**| X . . | . . O | . . . |**

**| . X . | . X O | O X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X . | . X X |**

**| . . X | . X . | . . O |**

**-------------------------**

**Bot placed 'O' on 68**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O O . |**

**-------------------------**

**| X . . | . . O | . . . |**

**| . X . | . X O | O X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X O | . X X |**

**| . . X | . X . | . . O |**

**-------------------------**

**Where would you like to place 'X' in ~Center Right~ box?**

**Row = 4**

**Col = 7**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O O . |**

**-------------------------**

**| X . . | . . O | X . . |**

**| . X . | . X O | O X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X O | . X X |**

**| . . X | . X . | . . O |**

**-------------------------**

**Bot placed 'O' on 26**

**-------------------------**

**| X O . | O . . | . . X |**

**| . O . | O X . | . X . |**

**| . O . | O . . | O O O |**

**-------------------------**

**| X . . | . . O | X . . |**

**| . X . | . X O | O X . |**

**| . . . | . . O | . . . |**

**-------------------------**

**| . . . | . . . | . . . |**

**| . X . | . X O | . X X |**

**| . . X | . X . | . . O |**

**-------------------------**

**~~~~~ YOU LOSE! ~~~~~**

**Learning Outcome:**

Reinforcement learning is an area of Machine Learning. It is about taking suitable action to maximize reward in a particular situation. Reinforcement learning is all about making decisions sequentially. In simple words we can say that the output depends on the state of the current input and the next input depends on the output of the previous input.

E.g.- Chess Game

Various Practical applications of Reinforcement Learning –

* RL can be used in robotics for industrial automation.
* RL can be used in machine learning and data processing
* RL can be used to create training systems that provide custom instruction and materials according to the requirement

|  |  |  |  |
| --- | --- | --- | --- |
| **Internal Assessment (Design Based Experiment) sheet for Lab Experiment Department of Computer Science & Engineering Amity University, Noida (UP)** | | | |
| Programme | B. Tech CSE | Course Name | Artificial Intelligence |
| Course Code | [CSE401] | Semester | 7 |
| Student Name | **Shubham Periwal** | Enrollment No. | **A2305218241** |
| **Marking Criteria** | | | |
| **Criteria** | **Total Marks** | **Marks Obtained** | **Comments** |
| Designing Concept (D) | 3 |  |  |
| Application of Knowledge (E) | 2 |  |  |
| Performance (F) | 3 |  |  |
| Result (G) | 2 |  |  |
| Total | 10 |  |  |