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DEPARTMENT OF COMPUTER SCIENCE

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BONAFIDE CERTIFICATE

Certified to be the bonafide record of work done by Mitali Mathur
Of 6th semester 3rd year B.TECH degree course in SRM INSTITUTE OF SCIENCE & TECHNOLOGY, DELHI-NCR Campus for the Department of ***Computer Science & Engineering,*** *in Artificial Intelligence Laboratory during the academic year* ***2021-22.***

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Submitted for end semester examination held on __/____/___ at SRM INSTITUTE OF SCIENCE & TECHNOLOGY, DELHI-NCR Campus.

Internal Examiner-I ***Internal Examiner-II***

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Experiment 1

- **Aim –** Implementation of Toy problem
  Example-Implement water jug problem.
- **Algorithm –**

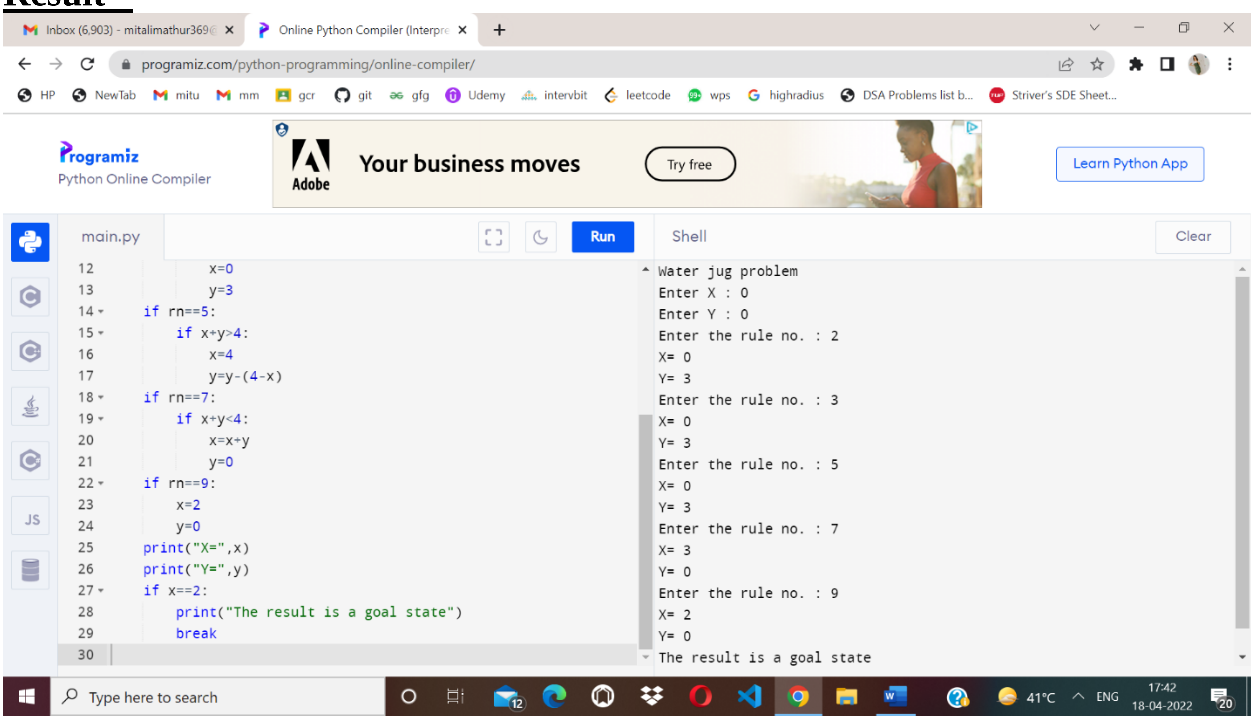
Rule	State	Process
1	(X,Y | X<4)	(4,Y) {Fill 4-gallon jug}
2	(X,Y |Y<3)	(X,3) {Fill 3-gallon jug}
3	(X,Y |X>0)	(0,Y) {Empty 4-gallon jug}
4	(X,Y | Y>0)	(X,0) {Empty 3-gallon jug}
5	(X,Y | X+Y>=4 ^ Y>0)	(4,Y-(4-X)) {Pour water from 3-gallon jug into 4-gallon jug until 4-gallon jug is full}
6	(X,Y | X+Y>=3 ^X>0)	(X-(3-Y),3) {Pour water from 4-gallon jug into 3-gallon jug until 3-gallon jug is full}
7	(X,Y | X+Y<=4 ^Y>0)	(X+Y,0) {Pour all water from 3-gallon jug into 4-gallon jug}
8	(X,Y | X+Y <=3^ X>0)	(0,X+Y) {Pour all water from 4-gallon jug into 3-gallon jug}
9	(0,2)	(2,0) {Pour 2 gallon water from 3 gallon jug into 4 gallon jug}

- **Code –**

```
print("Water jug problem")
x=int(input("Enter X : "))
y=int(input("Enter Y : "))
while True:
    rn=int(input("Enter the rule no. : "))
    if rn==2:
        if y<3:
            x=0
```

```
        y=3
if rn==3:
    if x>0:
        x=0
        y=3
if rn==5:
    if x+y>4:
        x=4
        y=y-(4-x)
if rn==7:
    if x+y<4:
        x=x+y
        y=0
if rn==9:
    x=2
    y=0
print("X=",x)
print("Y=",y)
if x==2:
    print("The result is a goal state")
    break
```

- **<u>Result –</u>**



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TIC TAC TOE

import random

class TicTacToe:

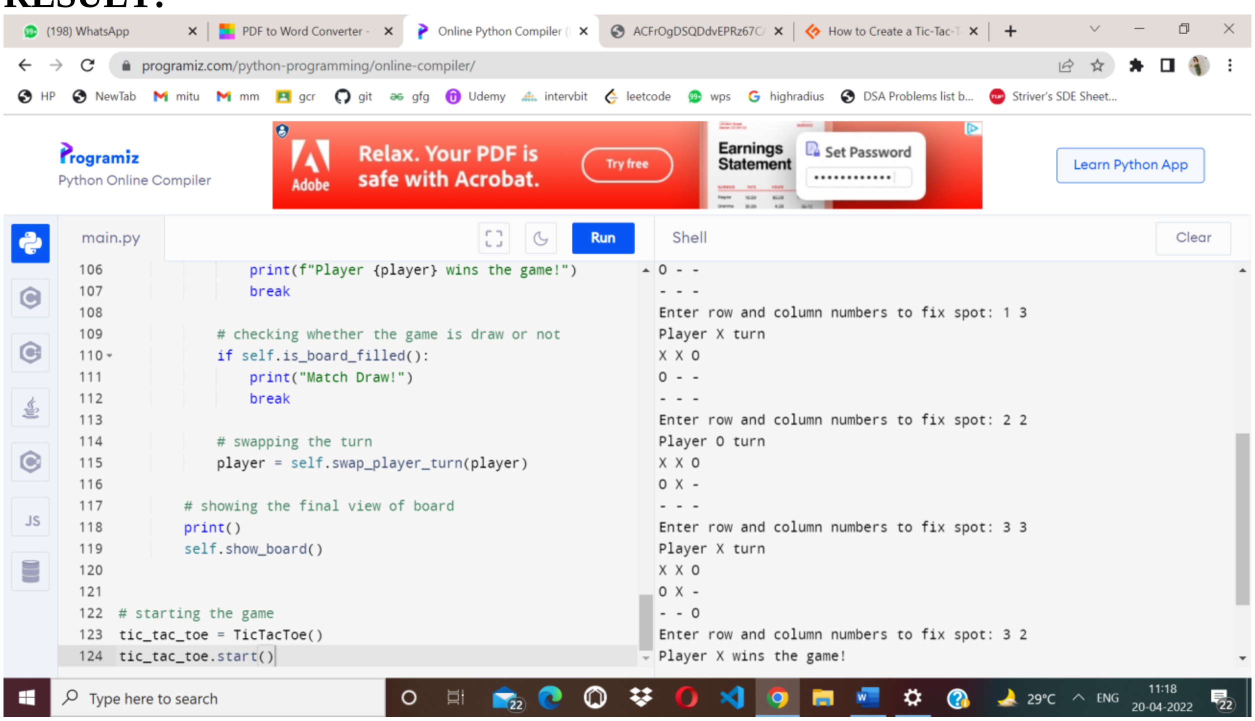
```
    def __init__(self):
        self.board = []
    def create_board(self):
        for i in range(3):
            row = []
            for j in range(3):
                row.append('-')
            self.board.append(row)
    def get_random_first_player(self):
        return random.randint(0, 1)
    def fix_spot(self, row, col, player):
        self.board[row][col] = player
    def is_player_win(self, player):
        win = None
        n = len(self.board)
        # checking rows
        for i in range(n):
            win = True
            for j in range(n):
                if self.board[i][j] != player:
                    win = False
                    break
            if win:
                return win
        # checking columns
        for i in range(n):
            win = True
```

```
    for j in range(n):
        if self.board[j][i] != player:
            win = False
            break
    if win:
        return win
# checking diagonals
win = True
for i in range(n):
    if self.board[i][i] != player:
        win = False
        break
if win:
    return win
win = True
for i in range(n):
    if self.board[i][n - 1 - i] != player:
        win = False
        break
if win:
    return win
return False
for row in self.board:
    for item in row:
        if item == '-':
            return False
return True
```

```
    def is_board_filled(self):
        for row in self.board:
            for item in row:
                if item == '-':
                    return False
        return True
    def swap_player_turn(self, player):
        return 'X' if player == 'O' else 'O
    def show_board(self):
        for row in self.board:
            for item in row:
                print(item, end=" ")
            print()

    def start(self):
        self.create_board()
        player = 'X' if self.get_random_first_player() == 1 else 'O'
        while True:
            print(f"Player {player} turn")
            self.show_board()
            # taking user input
            row, col = list(
                map(int, input("Enter row and column numbers to fix spot: ").split()))
            print()
            # fixing the spot
            self.fix_spot(row - 1, col - 1, player)
            # checking whether current player is won or not
```

```
            if self.is_player_win(player):
                print(f"Player {player} wins the game!")
                break
            # checking whether the game is draw or not
            if self.is_board_filled():
                print("Match Draw!")
                break
            # swapping the turn
            player = self.swap_player_turn(player)
        # showing the final view of board
        print()
        self.show_board()
# starting the game
tic_tac_toe = TicTacToe()
tic_tac_toe.start()
```

RESULT:

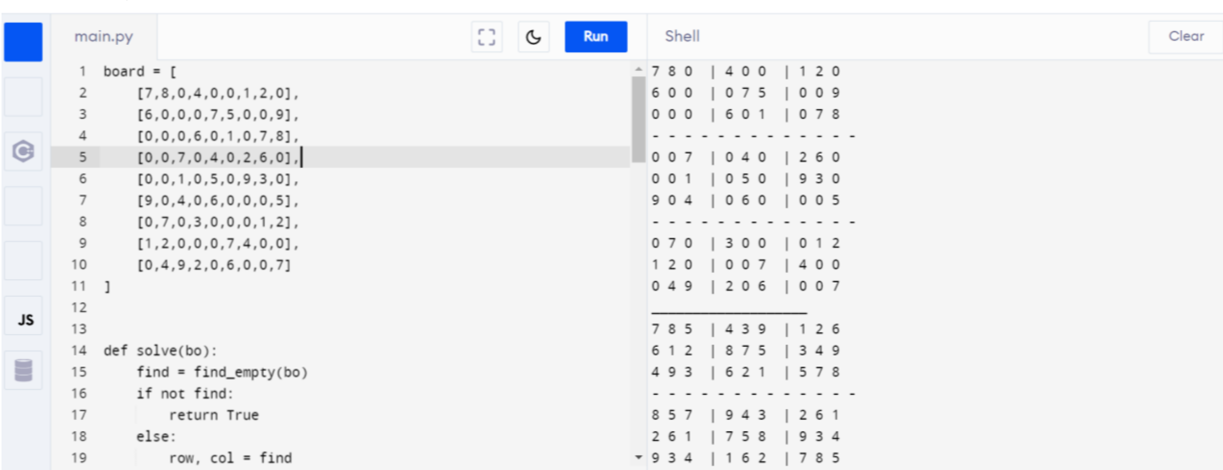


SUDUKO:

```
board = [
    [7,8,0,4,0,0,1,2,0],
    [6,0,0,0,7,5,0,0,9],
    [0,0,0,6,0,1,0,7,8],
    [0,0,7,0,4,0,2,6,0],
    [0,0,1,0,5,0,9,3,0],
    [9,0,4,0,6,0,0,0,5],
    [0,7,0,3,0,0,0,1,2],
    [1,2,0,0,0,7,4,0,0],
    [0,4,9,2,0,6,0,0,7]
]


def solve(bo):
    find = find_empty(bo)
    if not find:
        return True
    else:
        row, col = find
    for i in range(1,10):
        if valid(bo, i, (row, col)):
            bo[row][col] = i
            if solve(bo):
                return True

            bo[row][col] = 0
    return False
def valid(bo, num, pos):
    # Check row
    for i in range(len(bo[0])):
        if bo[pos[0]][i] == num and pos[1] != i:
            return False
    # Check column
    for i in range(len(bo)):
        if bo[i][pos[1]] == num and pos[0] != i:
            return False

    # Check box
    box_x = pos[1] // 3
    box_y = pos[0] // 3

    for i in range(box_y*3, box_y*3 + 3):
```

```
        for j in range(box_x * 3, box_x*3 + 3):
            if bo[i][j] == num and (i,j) != pos:
                return False
    return True
def print_board(bo):
    for i in range(len(bo)):
        if i % 3 == 0 and i != 0:
            print("- - - - - - - - - - - - - ")

        for j in range(len(bo[0])):
            if j % 3 == 0 and j != 0:
                print(" | ", end="")

            if j == 8:
                print(bo[i][j])
            else:
                print(str(bo[i][j]) + " ", end="")


def find_empty(bo):
    for i in range(len(bo)):
        for j in range(len(bo[0])):
            if bo[i][j] == 0:
                return (i, j)  # row, col

    return None

print_board(board)
solve(board)
print("___________________")
print_board(board)
```

RESULT:



Experiment 2

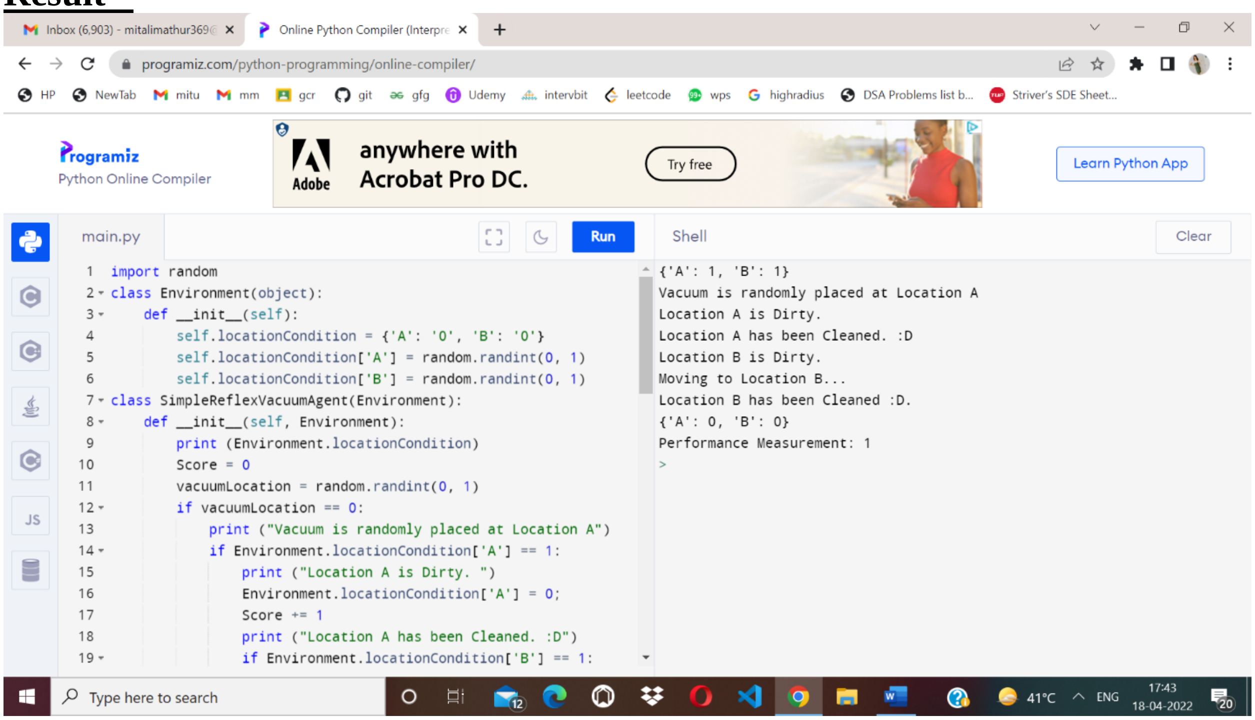
- **Aim –** Developing Agent Program for Real World Problem.

- **Code –**

```
import random
class Environment(object):
    def __init__(self):
        self.locationCondition = {'A': '0', 'B': '0'}
        self.locationCondition['A'] = random.randint(0, 1)
        self.locationCondition['B'] = random.randint(0, 1)
class SimpleReflexVacuumAgent(Environment):
    def __init__(self, Environment):
        print (Environment.locationCondition)
        Score = 0
        vacuumLocation = random.randint(0, 1)
        if vacuumLocation == 0:
            print ("Vacuum is randomly placed at Location A")
            if Environment.locationCondition['A'] == 1:
                print ("Location A is Dirty. ")
                Environment.locationCondition['A'] = 0;
                Score += 1
                print ("Location A has been Cleaned. :D")
                if Environment.locationCondition['B'] == 1:
                    print ("Location B is Dirty.")
                    print ("Moving to Location B...")
                    Score -= 1
                    Environment.locationCondition['B'] = 0;
                    Score += 1
                    print ("Location B has been Cleaned :D.")
            else:
                if Environment.locationCondition['B'] == 1:
                    print ("Location B is Dirty.")
                    Score -= 1
                    print ("Moving to Location B...")
                    Environment.locationCondition['B'] = 0;
                    Score += 1
                    print ("Location B has been Cleaned. :D")
        elif vacuumLocation == 1:
            print ("Vacuum is randomly placed at Location B. ")
            if Environment.locationCondition['B'] == 1:
                print ("Location B is Dirty")
                Environment.locationCondition['B'] = 0;
                Score += 1
```

```
            print ("Location B has been Cleaned")
            if Environment.locationCondition['A'] == 1:
                print ("Location A is Dirty")
                Score -= 1
                print ("Moving to Location A")
                Environment.locationCondition['A'] = 0;
                Score += 1
                print ("Location A has been Cleaned")
        else:
            if Environment.locationCondition['A'] == 1:
                print ("Location A is Dirty")
                print ("Moving to Location A")
                Score -= 1
                Environment.locationCondition['A'] = 0;
                Score += 1
                print ("Location A has been Cleaned")
    print (Environment.locationCondition)
    print ("Performance Measurement: " + str(Score))
theEnvironment = Environment()
theVacuum = SimpleReflexVacuumAgent(theEnvironment)
```

- **<u>Result –</u>**



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GRAPH COLORING

```
# Python3 program to implement greedy
# algorithm for graph coloring
def addEdge(adj, v, w):
    adj[v].append(w)
```

```
        # Note: the graph is undirected
        adj[w].append(v)
        return adj
# Assigns colors (starting from 0) to all
# vertices and prints the assignment of colors
def greedyColoring(adj, V):
        result = [-1] * V
        # Assign the first color to first vertex
        result[0] = 0;
        # A temporary array to store the available colors.
        # True value of available[cr] would mean that the
        # color cr is assigned to one of its adjacent vertices
        available = [False] * V

        # Assign colors to remaining V-1 vertices
        for u in range(1, V):

                # Process all adjacent vertices and
                # flag their colors as unavailable
                for i in adj[u]:
                        if (result[i] != -1):
                                available[result[i]] = True

                # Find the first available color
                cr = 0
                while cr < V:
                        if (available[cr] == False):
                                break

                        cr += 1

                # Assign the found color
                result[u] = cr

                # Reset the values back to false
                # for the next iteration
                for i in adj[u]:
                        if (result[i] != -1):
                                available[result[i]] = False
        # Print the result
        for u in range(V):
                print("Vertex", u, " ---> Color", result[u])
```

```
# Driver Code
if __name__ == '__main__':

    g1 = [[] for i in range(5)]
    g1 = addEdge(g1, 0, 1)
    g1 = addEdge(g1, 0, 2)
    g1 = addEdge(g1, 1, 2)
    g1 = addEdge(g1, 1, 3)
    g1 = addEdge(g1, 2, 3)
    g1 = addEdge(g1, 3, 4)
    print("Coloring of graph 1 ")
    greedyColoring(g1, 5)

    g2 = [[] for i in range(5)]
    g2 = addEdge(g2, 0, 1)
    g2 = addEdge(g2, 0, 2)
    g2 = addEdge(g2, 1, 2)
    g2 = addEdge(g2, 1, 4)
    g2 = addEdge(g2, 2, 4)
    g2 = addEdge(g2, 4, 3)
    print("\nColoring of graph 2")
    greedyColoring(g2, 5)
```

<u>RESULT</u>:

Experiment 3

- **Aim –** Implementation of Constraint satisfaction problem
  Example: Implement N- queen Problem
- **Algorithm –**

```
while there are untried configurations
{
  generate the next configuration
  if queens don't attack in this configuration then
  {
    print this configuration;
  }
}
```

- **Code –**

```
global N
N=int(input("enter no of queens : "))
def printSolution(board):
    for i in range(N):
        for j in range(N):
            print(board[i][j],end=" ")
        print(" ")
def isSafe(board,row,col):
    for i in range(col):
        if board[row][i]=='Q':
            return False
    for i,j in zip(range(row,-1,-1), range(col,-1,-1)):
        if board[i][j]=='Q':
            return False
    for i,j in zip(range(row,N,1), range(col,-1,-1)):
        if board[i][j]=='Q':
            return False

    return True
def solveNQUtil(board,col):
    if col>=N:
        return True
    for i in range(N):
        if isSafe(board,i,col):
            board[i][col]='Q'
            if solveNQUtil(board,col+1) == True:
                return True
            board[i][col]=0
    return False
def solveNQ():
    board = [[0 for i in range(N)] for j in range(N)]
    if solveNQUtil(board,0)==False:
```

```
            print("Solution does not exist")
            return False
        printSolution(board)
        return True
solveNQ()
```

- **<u>RESULT</u>**:

Experiment 4

- **Aim –** To Implementation and Analysis of BFS and DFS for Application.
- **Algorithm –**

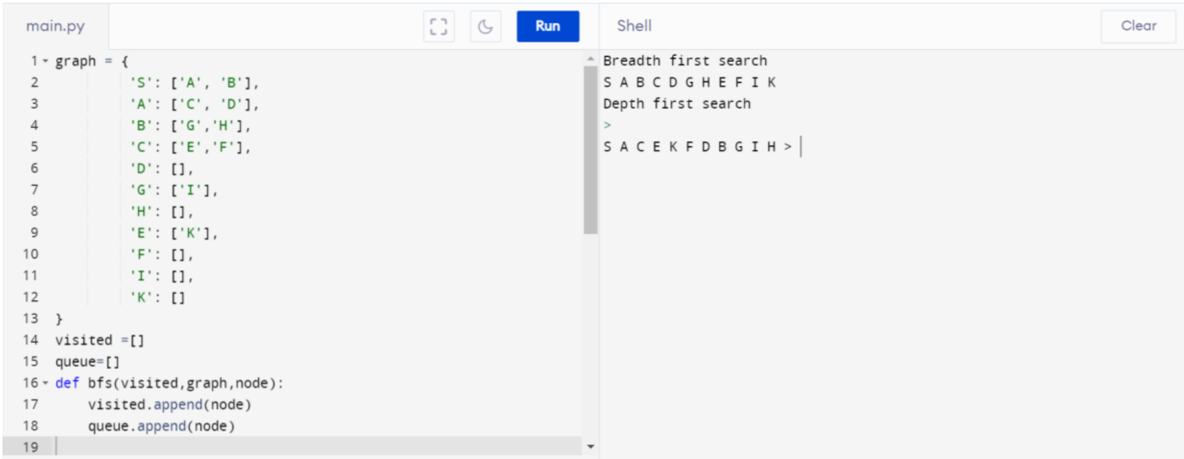
1. Create a node list (Queue) that initially contains the first node N and mark it as visited.
2. Visit the adjacent unvisited vertex of N and insert it in a queue.
3. If there are no remaining adjacent vertices left, remove the first vertex from the queue mark it as visited, display it.
4. Repeat step 1 and step 2 until the queue is empty or the desired node is found.

- **Code –**

```
graph = {
        'S': ['A', 'B'],
        'A': ['C', 'D'],
        'B': ['G','H'],
        'C': ['E','F'],
        'D': [],
        'G': ['I'],
        'H': [],
        'E': ['K'],
        'F': [],
        'I': [],
        'K': []
}
visited =[]
queue=[]
def bfs(visited,graph,node):
    visited.append(node)
    queue.append(node)

    while queue:
        P=queue.pop(0)
        print(P,end=" ")
        for neighbour in graph[P]:
            if neighbour not in visited:
                visited.append(neighbour)
                queue.append(neighbour)
avisit=set()
def dfs(avisit,graph,node):
    if node not in avisit:
        print(node,end=" ")
        avisit.add(node)
        for neighbour in graph[node]:
```

```
        dfs(avisit,graph,neighbour)
print("Breadth first search")
bfs(visited,graph,'S')
print("\nDepth first search")
dfs(avisit,graph,'S')
```

- **<u>RESULT</u>**:



Experiment 5

- **Aim-** To implement Best First Search and A* algorithm.
- **Algorithm-**

1. **Best First Search-**

   Step 1: Place the starting node into the OPEN list.
   Step 2: If the OPEN list is empty, Stop and return failure.
   Step 3: Remove the node n, from the OPEN list which has the lowest value of h(n), and places it in the CLOSED list.
   If node n is goal then return
   else
   Step 4: Expand the node n, and generate and check the successors of node n. and find whether any node is a goal node or not. If any successor node is goal node, then return success and terminate the search, else proceed to Step 5.
   Step 5: For each successor node, algorithm checks for evaluation function f(n), and then check if the node has been in either OPEN or CLOSED list. If the node has not been in both list, then add it to the OPEN list.
   Step 6: Return to Step 2.

2. **A*-**

   Step1: Place the starting node in the OPEN list.
   Step 2: Check if the OPEN list is empty or not, if the list is empty then return failure and stops.
   Step 3: Select the node from the OPEN list which has the smallest value of evaluation function (g+h), if node n is goal node then return success and stop, otherwise
   Step 4:Expand node n and generate all of its successors, and put n into the closed list. For each successor n', check whether n' is already in the OPEN or CLOSED list, if not then compute evaluation function for n' and place into Open list.
   Step 5: Else if node n' is already in OPEN and CLOSED, then it should be attached to the back pointer which reflects the lowest g(n') value.
   Step 6: Return to Step 2.

- **Code-**

1. **Best First Search-**

```
# This class represent a graph
class Graph:
    # Initialize the class
    def __init__(self, graph_dict=None, directed=True):
        self.graph_dict = graph_dict or {}
        self.directed = directed
        if not directed:
            self.make_undirected()
```

```
    # Create an undirected graph by adding symmetric edges
    def make_undirected(self):
        for a in list(self.graph_dict.keys()):
            for (b, dist) in self.graph_dict[a].items():
                self.graph_dict.setdefault(b, {})[a] = dist
    # Add a link from A and B of given distance, and also add the inverse link if the
graph is undirected
    def connect(self, A, B, distance=1):
        self.graph_dict.setdefault(A, {})[B] = distance
        if not self.directed:
            self.graph_dict.setdefault(B, {})[A] = distance
    # Get neighbors or a neighbor
    def get(self, a, b=None):
        links = self.graph_dict.setdefault(a, {})
        if b is None:
            return links
        else:
            return links.get(b)
    # Return a list of nodes in the graph
    def nodes(self):
        s1 = set([k for k in self.graph_dict.keys()])
        s2 = set([k2 for v in self.graph_dict.values() for k2, v2 in v.items()])
        nodes = s1.union(s2)
        return list(nodes)
# This class represent a node
class Node:
    # Initialize the class
    def __init__(self, name:str, parent:str):
        self.name = name
        self.parent = parent
        self.g = 0 # Distance to start node
        self.h = 0 # Distance to goal node
        self.f = 0 # Total cost
    # Compare nodes
    def __eq__(self, other):
        return self.name == other.name
    # Sort nodes
    def __lt__(self, other):
         return self.f < other.f
    # Print node
    def __repr__(self):
        return ('({0},{1})'.format(self.position, self.f))
# Best-first search
```

```
def best_first_search(graph, heuristics, start, end):

    # Create lists for open nodes and closed nodes
    open = []
    closed = []
    # Create a start node and an goal node
    start_node = Node(start, None)
    goal_node = Node(end, None)
    # Add the start node
    open.append(start_node)

    # Loop until the open list is empty
    while len(open) > 0:
        # Sort the open list to get the node with the lowest cost first
        open.sort()
        # Get the node with the lowest cost
        current_node = open.pop(0)
        # Add the current node to the closed list
        closed.append(current_node)

        # Check if we have reached the goal, return the path
        if current_node == goal_node:
            path = []
            while current_node != start_node:
                path.append(current_node.name + ': ' + str(current_node.g))
                current_node = current_node.parent
            path.append(start_node.name + ': ' + str(start_node.g))
            # Return reversed path
            return path[::-1]
        # Get neighbours
        neighbors = graph.get(current_node.name)
        # Loop neighbors
        for key, value in neighbors.items():
            # Create a neighbor node
            neighbor = Node(key, current_node)
            # Check if the neighbor is in the closed list
            if(neighbor in closed):
                continue
            # Calculate cost to goal
            neighbor.g = current_node.g + graph.get(current_node.name, neighbor.name)
            neighbor.h = heuristics.get(neighbor.name)
            neighbor.f = neighbor.h
            # Check if neighbor is in open list and if it has a lower f value
```

```
            if(add_to_open(open, neighbor) == True):
                # Everything is green, add neighbor to open list
                open.append(neighbor)
    # Return None, no path is found
    return None
# Check if a neighbor should be added to open list
def add_to_open(open, neighbor):
    for node in open:
        if (neighbor == node and neighbor.f >= node.f):
            return False
    return True
# The main entry point for this module
def main():
    # Create a graph
    graph = Graph()
    # Create graph connections (Actual distance)
    graph.connect('Jaipur', 'Gurugram', 111)
    graph.connect('Jaipur', 'Mumbai', 85)
    graph.connect('Gurugram', 'Noida', 104)
    graph.connect('Gurugram', 'Sitapur', 140)
    graph.connect('Gurugram', 'Delhi', 183)
    graph.connect('Mumbai', 'Noida', 230)
    graph.connect('Mumbai', 'Kolkata', 67)
    graph.connect('Kolkata', 'Bilaspur', 191)
    graph.connect('Kolkata', 'Sitapur', 64)
    graph.connect('Noida', 'Delhi', 171)
    graph.connect('Noida', 'Madurai', 170)
    graph.connect('Noida', 'Pondicherry', 220)
    graph.connect('Sitapur', 'Delhi', 107)
    graph.connect('Bilaspur', 'Bern', 91)
    graph.connect('Bilaspur', 'Zurich', 85)
    graph.connect('Bern', 'Zurich', 120)
    graph.connect('Zurich', 'Memmingen', 184)
    graph.connect('Memmingen', 'Delhi', 55)
    graph.connect('Memmingen', 'Madurai', 115)
    graph.connect('Madurai', 'Delhi', 123)
    graph.connect('Madurai', 'Pondicherry', 189)
    graph.connect('Madurai', 'Raipur', 59)
    graph.connect('Raipur', 'Shimla', 81)
    graph.connect('Pondicherry', 'Lucknow', 102)
    graph.connect('Shimla', 'Lucknow', 126)
    # Make graph undirected, create symmetric connections
    graph.make_undirected()
```

```python
    # Create heuristics (straight-line distance, air-travel distance)
    heuristics = {}
    heuristics['Bilaspur'] = 204
    heuristics['Bern'] = 247
    heuristics['Jaipur'] = 215
    heuristics['Kolkata'] = 137
    heuristics['Lucknow'] = 318
    heuristics['Mumbai'] = 164
    heuristics['Madurai'] = 120
    heuristics['Memmingen'] = 47
    heuristics['Noida'] = 132
    heuristics['Pondicherry'] = 257
    heuristics['Raipur'] = 168
    heuristics['Sitapur'] = 75
    heuristics['Shimla'] = 236
    heuristics['Gurugram'] = 153
    heuristics['Zurich'] = 157
    heuristics['Delhi'] = 0
    # Run search algorithm
    path = best_first_search(graph, heuristics, 'Jaipur', 'Delhi')
    print(path)
    print()
# Tell python to run main method
if __name__ == "__main__": main()
```

2. **A*-**

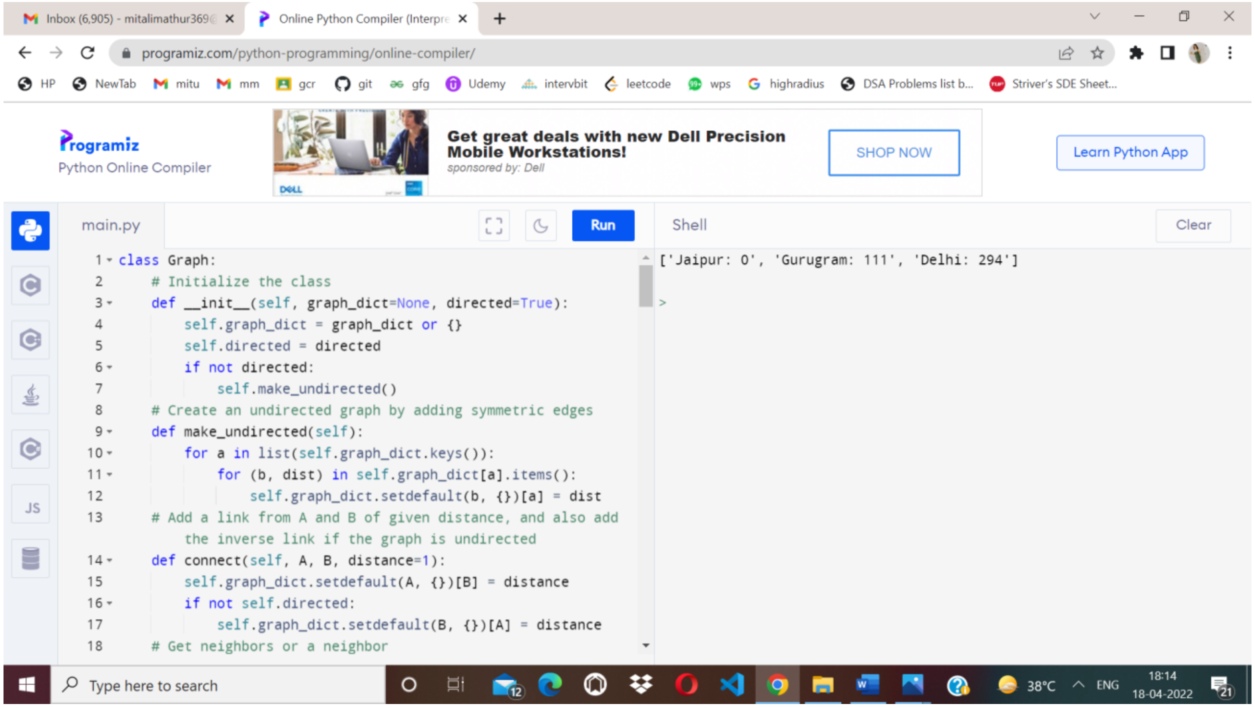
```python
from queue import PriorityQueue

#Creating Base Class
class State(object):
    def __init__(self, value, parent, start = 0, goal = 0):
        self.children = []
        self.parent = parent
        self.value = value
        self.dist = 0
        if parent:
            self.start = parent.start
            self.goal = parent.goal
            self.path = parent.path[:]
            self.path.append(value)

        else:
            self.path = [value]
```

```
        self.start = start
        self.goal = goal

    def GetDistance(self):
        pass
    def CreateChildren(self):
        pass


# Creating subclass
class State_String(State):
    def __init__(self, value, parent, start = 0, goal = 0 ):
        super(State_String, self).__init__(value, parent, start, goal)
        self.dist = self.GetDistance()

    def GetDistance(self):
            if self.value == self.goal:
                return 0
            dist = 0
            for i in range(len(self.goal)):
                letter = self.goal[i]
                dist += abs(i - self.value.index(letter))
            return dist

    def CreateChildren(self):
            if not self.children:
                for i in range(len(self.goal)-1):
                    val = self.value
                    val = val[:i] + val[i+1] + val[i] + val[i+2:]
                    child = State_String(val, self)
                    self.children.append(child)

# Creating a class that hold the final magic
class A_Star_Solver:
    def __init__(self, start, goal):
        self.path = []
        self.vistedQueue =[]
        self.priorityQueue = PriorityQueue()
        self.start = start
        self.goal = goal

    def Solve(self):
        startState = State_String(self.start,0,self.start,self.goal)
```

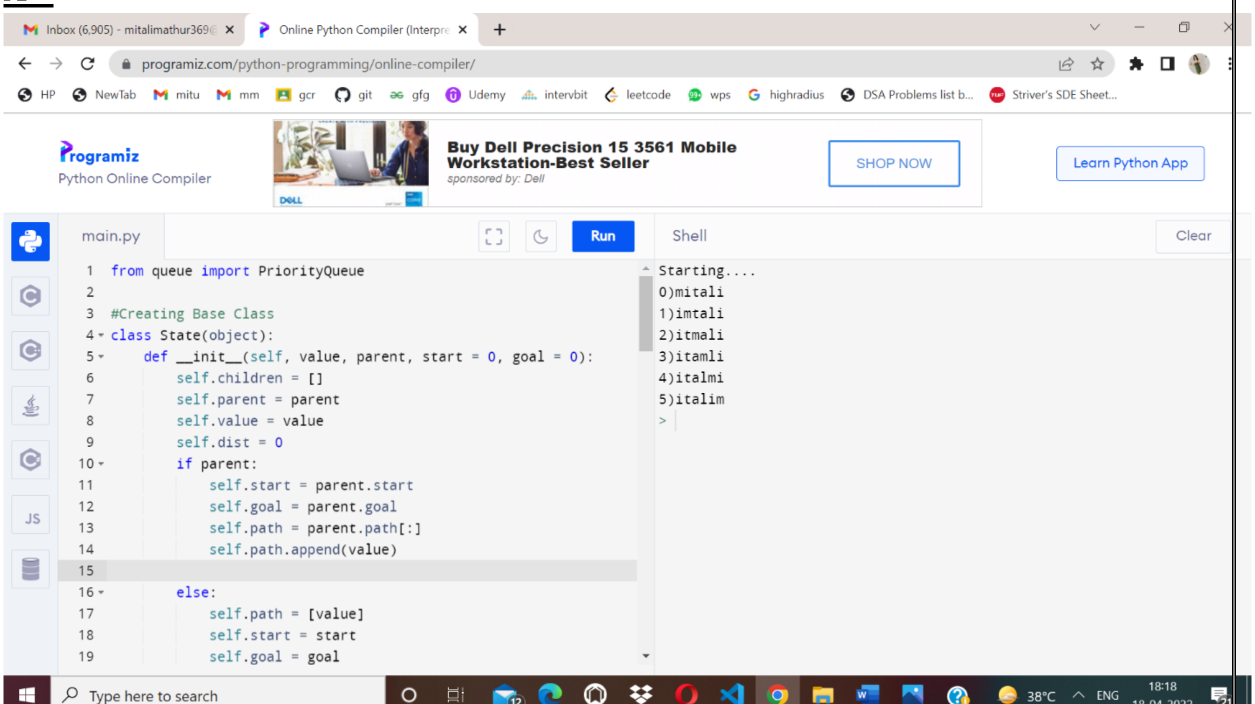
```
        count = 0
        self.priorityQueue.put((0,count, startState))
        while(not self.path and self.priorityQueue.qsize()):
            closesetChild = self.priorityQueue.get()[2]
            closesetChild.CreateChildren()
            self.vistedQueue.append(closesetChild.value)
            for child in closesetChild.children:
                if child.value not in self.vistedQueue:
                    count += 1
                    if not child.dist:
                        self.path = child.path
                        break
                    self.priorityQueue.put((child.dist,count,child))
        if not self.path:
            print("Goal Of  is not possible !" + self.goal )
        return self.path

# Calling all the existing stuffs
if __name__ == "__main__":
    start1 = "mitali"
    goal1 = "italim"
    print("Starting....")
    a = A_Star_Solver(start1,goal1)
    a.Solve()
    for i in range(len(a.path)):
        print("{0}){1}".format(i,a.path[i]))
```

RESULT:

1. Best First Search-



2. A*-



Experiment 6

- **Aim –** To implement Minimax Algorithm.

- **Algorithm –**

    function minimax(node, depth, Player)

    1.if depth ==0 or node is a terminal node then

    return value(node)

    2.If Player =‘Max’ // for **Maximizer Player**

    set **α = -∞** //**worst case value for MAX**

    for each child of node do

    value= minimax(child, depth-1, ’MIN’)

    α= max(α, Value) //gives Maximum of the values

    return (α)

    else // for **Minimizer player**

    set **α = +∞** //**worst case value for MIN**

    for each child of node do

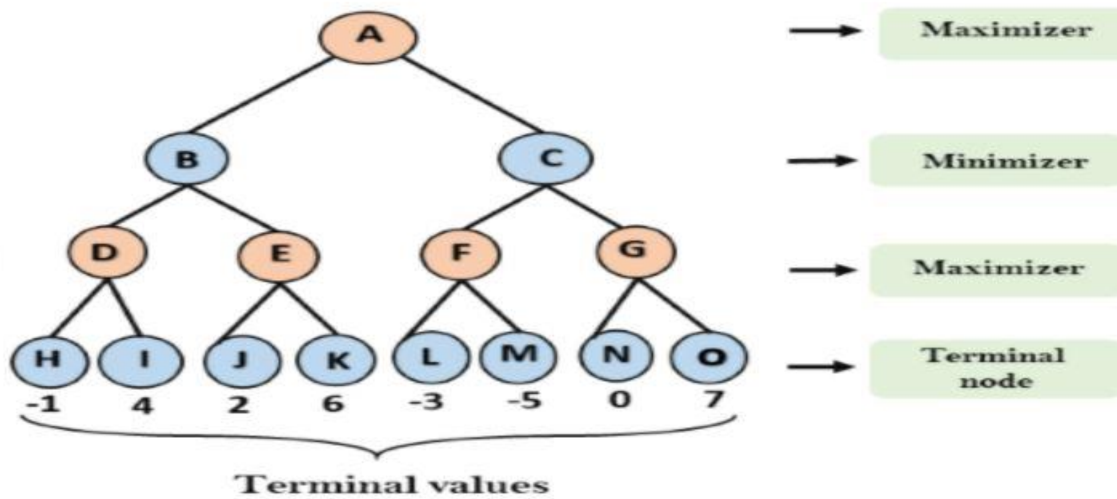
    value= minimax(child, depth-1, ’MAX’)

    α = min(α, Value) //gives minimum of the values

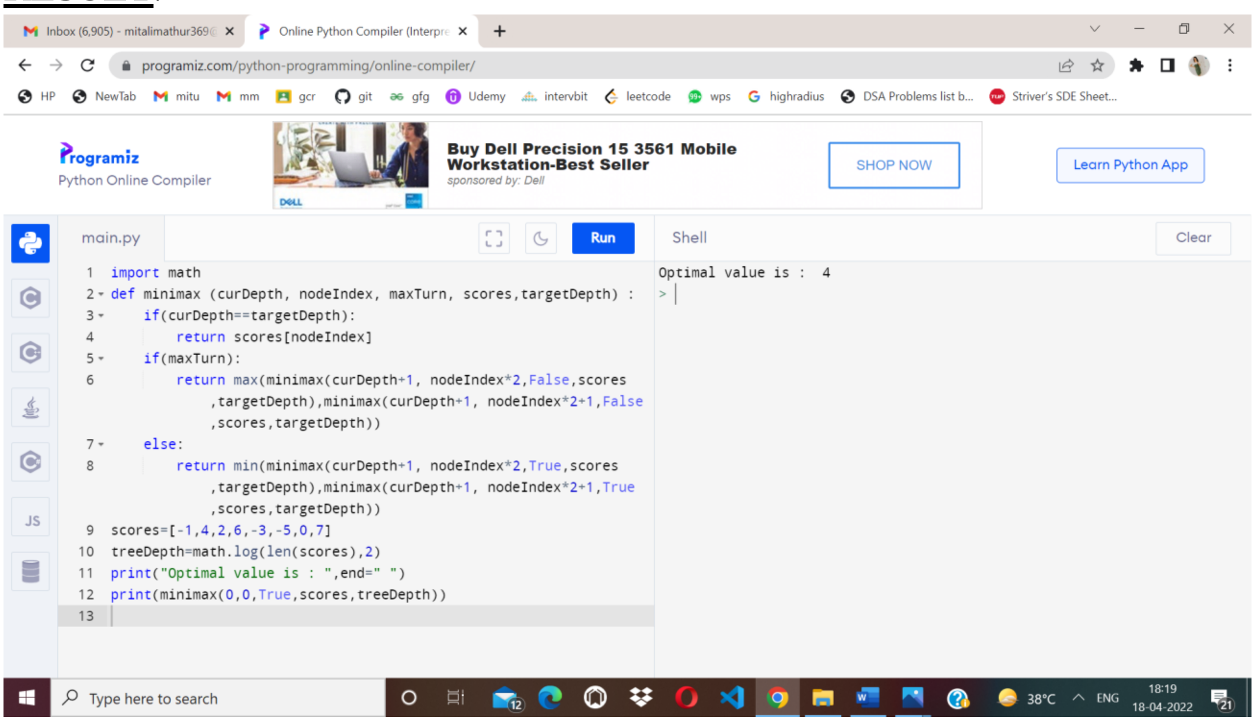
    return (α)

- **Code –**

```
import math
def minimax (curDepth, nodeIndex, maxTurn, scores,targetDepth) :
    if(curDepth==targetDepth):
        return scores[nodeIndex]
    if(maxTurn):
        return max(minimax(curDepth+1,
nodeIndex*2,False,scores,targetDepth),minimax(curDepth+1,
nodeIndex*2+1,False,scores,targetDepth))
    else:
        return min(minimax(curDepth+1,
nodeIndex*2,True,scores,targetDepth),minimax(curDepth+1,
nodeIndex*2+1,True,scores,targetDepth))
scores=[-1,4,2,6,-3,-5,0,7]
treeDepth=math.log(len(scores),2)
print("Optimal value is : ",end=" ")
print(minimax(0,0,True,scores,treeDepth))
```


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
-1
4
2
6
-3
-5
0
7
Terminal values
Maximizer
Minimizer
Maximizer
Terminal node

- **<u>RESULT</u>**:


Inbox (6,905) - mitalimathur369
Online Python Compiler (Interpre
programiz.com/python-programming/online-compiler/
HP
NewTab
mitu
mm
gcr
git
gfg
Udemy
intervbit
leetcode
wps
highradius
DSA Problems list b...
Striver's SDE Sheet...
Programiz
Python Online Compiler
Buy Dell Precision 15 3561 Mobile Workstation-Best Seller
sponsored by: Dell
SHOP NOW
Learn Python App
main.py
Run
Shell
Clear
import math
def minimax (curDepth, nodeIndex, maxTurn, scores,targetDepth) :
if(curDepth==targetDepth):
return scores[nodeIndex]
if(maxTurn):
return max(minimax(curDepth+1, nodeIndex*2,False,scores ,targetDepth),minimax(curDepth+1, nodeIndex*2+1,False ,scores,targetDepth))
else:
return min(minimax(curDepth+1, nodeIndex*2,True,scores ,targetDepth),minimax(curDepth+1, nodeIndex*2+1,True ,scores,targetDepth))
scores=[-1,4,2,6,-3,-5,0,7]
treeDepth=math.log(len(scores),2)
print("Optimal value is : ",end=" ")
print(minimax(0,0,True,scores,treeDepth))
Optimal value is : 4
Type here to search
38°C
ENG
18:19
18-04-2022

-

Experiment 7

- **Aim –** Implementation of unification and resolution for real world problems.
- **Algorithm–**

Prolog unification

When programming in Prolog, we spend a lot of time thinking about how variables and rules "match" or "are assigned." There are actually two aspects to this. The first, "unification," regards how terms are matched and variables assigned to make terms match. The second, "resolution," is described in separate notes. Resolution is only used if rules are involved. You may notice in these notes that no rules are involved since we are only talking about unification.

Terms

Prolog has three kinds of **terms**:

1. Constants like 42 (numbers) and franklin (atoms, i.e., lower-case words).
2. Variables like X and Person (words that start with upper-case).
3. Complex terms like parent(franklin, bo) and baz(X, quux(Y))

Two terms **unify** if they can be matched. Two terms can be matched if:

- they are the same term (obviously), or
- they contain variables that can be unified so that the two terms without variables are the same.

For example, suppose our knowledge base is:

```
woman(mia).
loves(vincent, angela).
loves(franklin, mia).
```

- mia and mia unify because they are the same.
- mia and X unify because X can be given the value mia so that the two terms (without variables) are the same.
- woman(mia) and woman(X) unify because X can be set to mia which results in identical terms.
- loves(X, mia) and loves(vincent, X) **cannot** unify because there is no assignment for X (given our knowledge base) that makes the two terms identical.
- loves(X, mia) and loves(franklin, X) also cannot unify (can you see why?).

We saw in the Prolog notes that we can "query" the knowledge base and get, say, all the people who love mia. When we query with loves(X, mia). we are asking Prolog to give us all the values for X that unify. These values are, essentially, the people who love mia.

Rule :

term1 and term2 unify whenever:

1. If term1 and term2 are **constants**, then term1 and term2 unify if and only if they are the same atom, or the same number.
2. If term1 is a **variable** and term2 is any type of term, then term1 and term2 unify, and term1 is instantiated to term2. (And vice versa.) (If they are both variables, they're both instantiated to each other, and we say that they share values.)
3. If term1 and term2 are **complex terms**, they unify if and only if:

   a. They have the same **functor** and **arity**. The functor is the "function" name (this functor is foo: foo(X, bar)). The arity is the number of arguments for the functor (the arity for foo(X, bar) is 2).

   b. All of their corresponding arguments unify. **Recursion!**

   c. The variable instantiations are compatible (i.e., the same variable is not given two different unifications/values).

4. Two terms unify if and only if they unify for one of the above three reasons (there are no reasons left unstated).

Example
We'll use the = predicate to test if two terms unify. Prolog will answer "Yes" if they do, as well as any sufficient variable assignments to make the unification work.
Do these two terms unify?
1.

```
?- mia = mia.
```

o/p Ans:- Yes from Rule 1
2.

```
?- mia = X.
```

o/p Ans:- Yes, from rule 2.
3.

```
?- X = Y.
```

o/p Yes, from rule 2.
4.

```
?- k(s(g), Y) = k(s(g, X), Y).
```

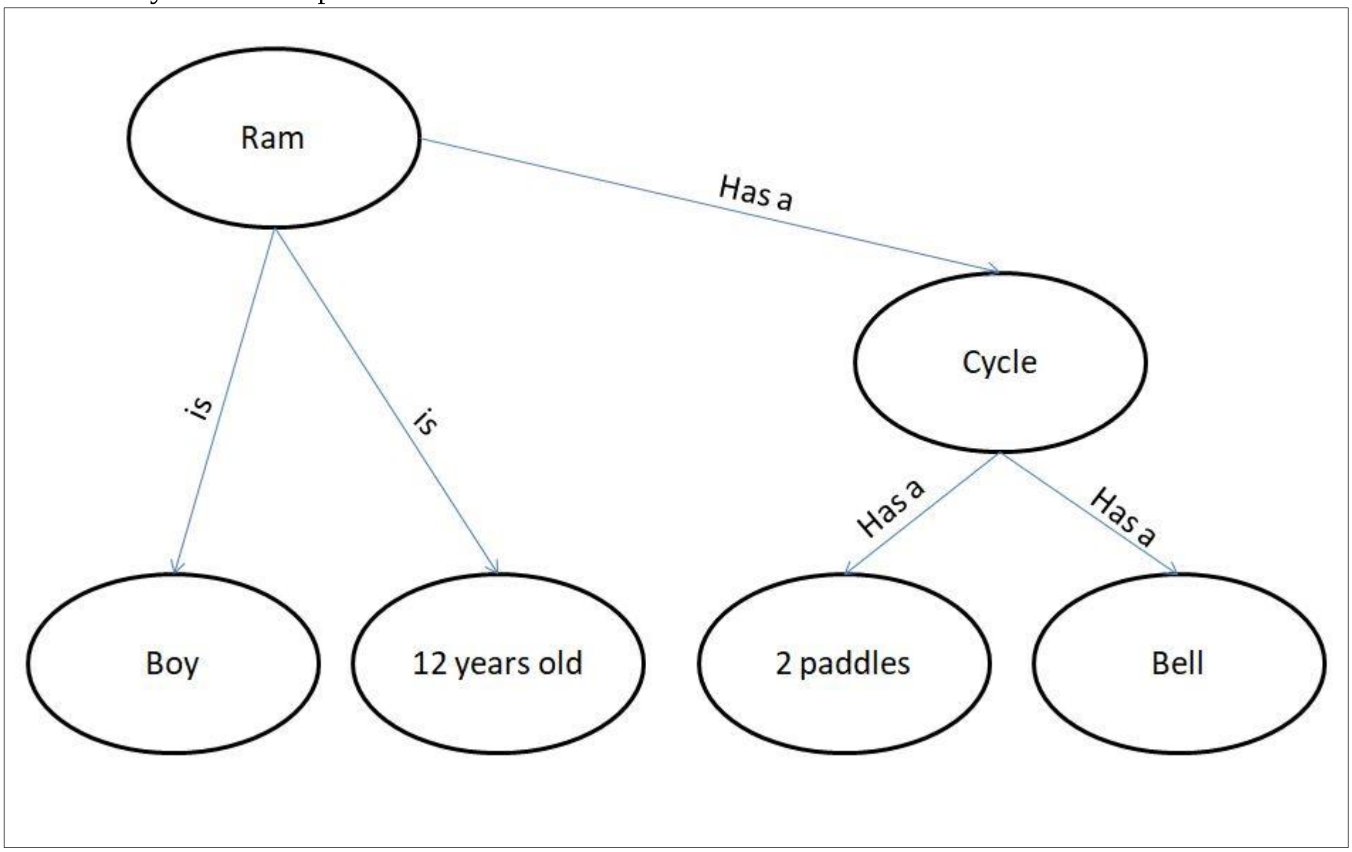
o/p

No, these two terms do not unify because arity of s(g) do not match with the arity of s(g,X) due to which rule 3 fails in recursion.

Experiment 8

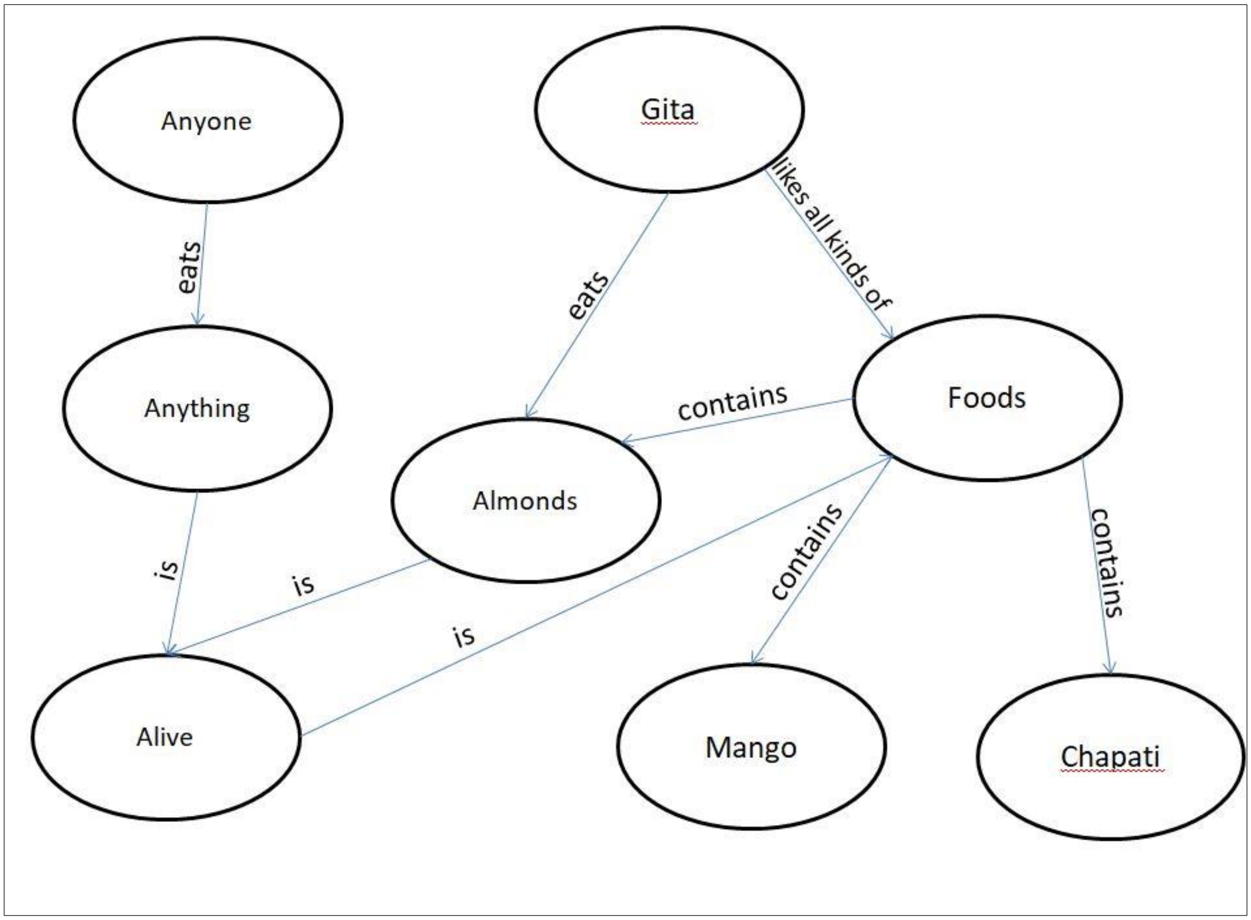
- **Aim –** Implementation of knowledge representation schemes – use cases.
- **Semantic relations –**

a. 1. Ram has a cycle.
   2. Ram is a boy.
   3. Cycle has a bell.
   4. Ram is 12 years old.
   5. Cycle has two paddles.

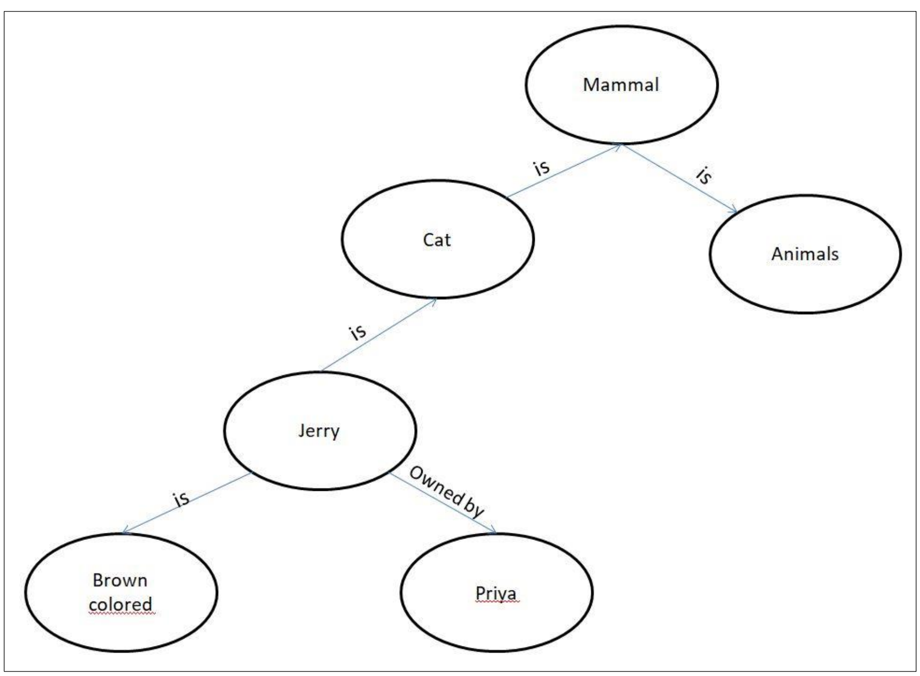


B.

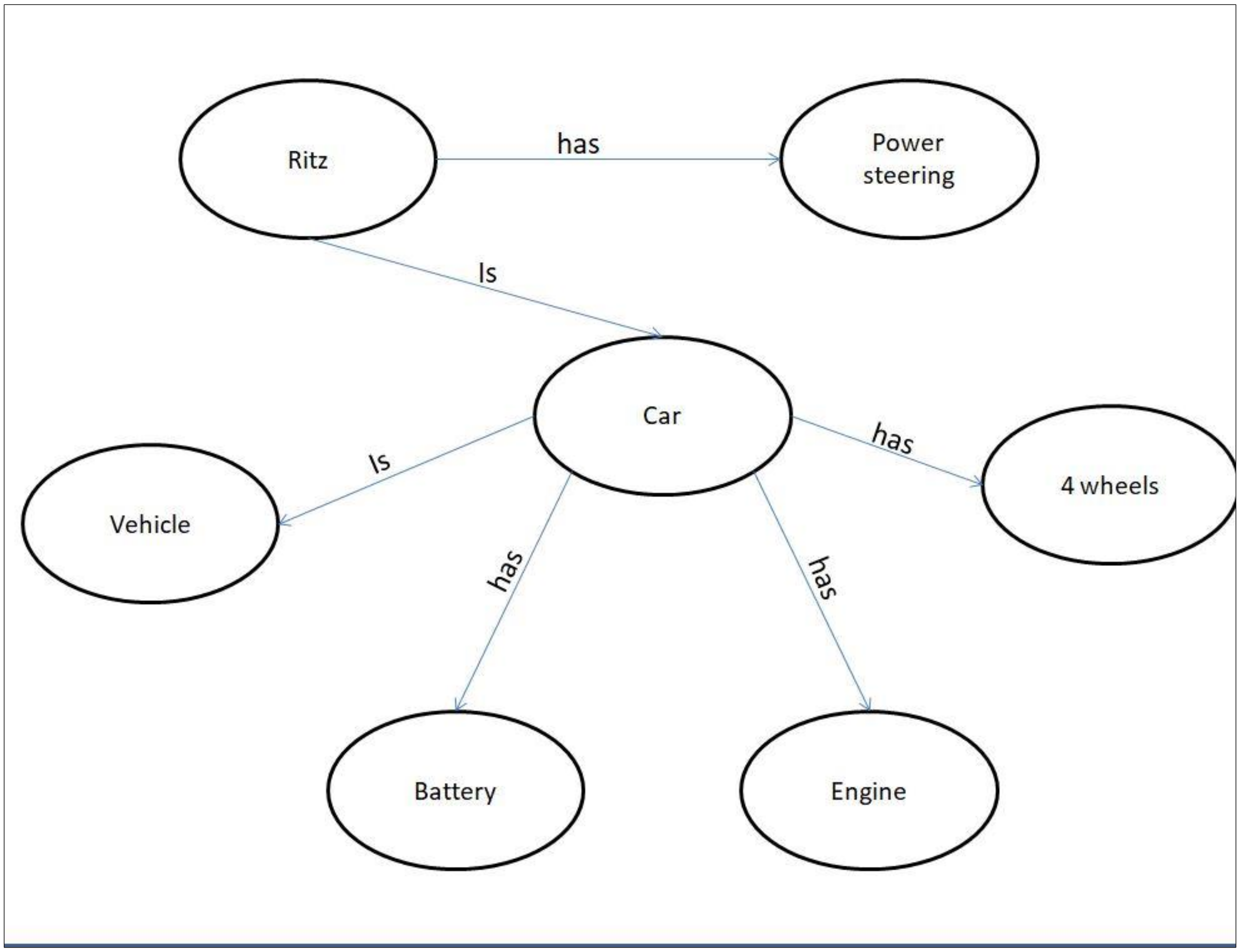
1. Gita likes all kinds of food.
2. Mango and chapati are food.
3. Gita eats almond and is still alive.
4. Anything eaten by anyone and is still alive is food.



b. 1. Jerry is a cat.
   2. Jerry is a mammal
   3. Jerry is owned by Priya.
   4. Jerry is brown colored.
   5. All Mammals are animal.



C. 1. Ritz is a car.
2. Car has 4 wheels.
3. Car is a vehicle.
4. Car has engine.
5. Car has battery.
6. Ritz has power steering.



Experiment 9

- **Aim –** Implementation of uncertain methods for an application.
- **Algorithm–**

$$\textbf{Probability of occurrence} = \frac{\text{Number of desired outcomes}}{\text{Total number of outcomes}}$$

we can find the probability of an uncertain event by using the above formula.

- **Code –**

Problem1:-

Calculate the Probability of finding how many students got the 60 marks for given data set .

```
import numpy as np
import collections
npArray= np.array([60, 70, 70, 70, 80,90,60])
c=collections.Counter(npArray) # Generate a dictionary {"value":"nbOfOccurrences"}
arraySize=npArray.size
nbOfOccurrences=c[60] #assuming you want the proba to get 10
proba=(nbOfOccurrences/arraySize)*100
print(proba) #print 60.0
```

output:- 28.57

Problem2:-

If In class 80 students and 60 students got 60 % marks then Calculate the Probability of finding how many students got the 60 marks for given data set .

```
#!/usr/bin/env python3
import sys
Marksprob = {}
for line in sys.stdin:
    line = line.strip()
    ClassA, Marks = line.split('\t', 1)
def event_probability(event_outcomes, sample_space):
    probability = (event_outcomes / sample_space) * 100
    return round(probability, 1)
ClassA = 30
Marks = 15
grade_probability = event_probability(Marks, ClassA)
print(str(grade_probability) + '%')
output:48%
```

RESULT:

The program has been executed successfully.

Experiment 10

- **Aim –** Implementation of block world problem.
- **Algorithm –**

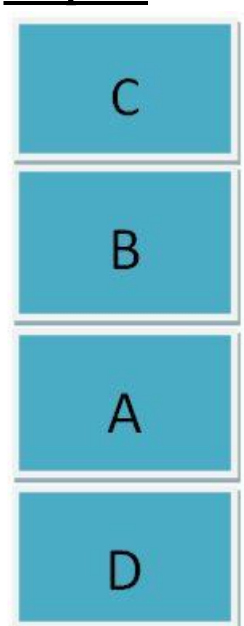
1. MOVE(B,A)- To lift block from B to A.
2. ON(B,A)- To place block B on A.
3. CLEAR(B)- To lift block B from the table.
4. PLACE(B)- To put the block B on table.

- **Code –**

```
class Strips(object):
 def __init__(self, name, preconds, effects, cost=1):
    self.name = name
    self.preconds = preconds
    self.effects = effects
    self.cost = cost
def __repr__(self):
    return self.name
class STRIPS_domain(object):
 def __init__(self, feats_vals, actions):
     self.feats_vals = feats_vals
     self.actions = actions
class Planning_problem(object):
 def __init__(self, prob_domain, initial_state, goal):
     self.prob_domain = prob_domain
     self.initial_state = initial_state
     self.goal = goal
boolean = {True, False}
### blocks world
def move(x,y,z):
    """string for the 'move' action"""
    return 'move_'+x+'_from_'+y+'_to_'+z
def on(x):
    """string for the 'on' feature"""
    return x+'_is_on'
def clear(x):
    """string for the 'clear' feature"""
    return 'clear_'+x
def create_blocks_world(blocks = {'a','b','c','d'}):
    blocks_and_table = blocks | {'table'}
    stmap = {Strips(move(x,y,z),{on(x):y, clear(x):True, clear(z):True},
    {on(x):z, clear(y):True, clear(z):False})}
    for x in blocks:
        for y in blocks_and_table:
```

```
            for z in blocks:
                if x!=y and y!=z and z!=x:
                    stmap.update({Strips(move(x,y,'table'), {on(x):y, clear(x):True},
                    {on(x):'table', clear(y):True})})
    for x in blocks:
        for y in blocks:
            for z in blocks:
                if x!=y:
                    feats_vals = {on(x):blocks_and_table-{x} for x in blocks}
                    feats_vals.update({clear(x):boolean for x in blocks_and_table})

    return STRIPS_domain(feats_vals, stmap)
    blocks1dom = create_blocks_world({'a','b','c'})
    blocks1 = Planning_problem(blocks1dom,
    {on('a'):'table', clear('a'):True,
    on('b'):'c', clear('b'):True,
    on('c'):'table', clear('c'):False}, # initial state
    {on('a'):'b', on('c'):'a'}) #goal
    blocks2dom = create_blocks_world({'a','b','c','d'})
    tower4 = {clear('a'):True, on('a'):'b',
    clear('b'):False, on('b'):'c',
    clear('c'):False, on('c'):'d',
    clear('d'):False, on('d'):'table'}
    blocks2 = Planning_problem(blocks2dom,
    tower4, # initial state
    {on('d'):'c',on('c'):'b',on('b'):'a'}) #goal
    blocks3 = Planning_problem(blocks2dom,
    tower4, # initial state
    {on('d'):'a', on('a'):'b', on('b'):'c'}) #goal
```

- **RESULT**: Goal achieved.
- **Output –**



Experiment 11

- **Aim –** Implementation of Learning algorithm.
- **Code –**

List of Common Machine Learning Algorithms

- Linear Regression
- Logistic Regression
- Decision Tree
- SVM
- Naive Bayes
- KNN
- K-Means
- Random Forest

1. KNN (K-Nearest Neighbours)

K-Nearest Neighbors, KNN for short, is a supervised learning algorithm specialized in classification. It is a simple algorithm that stores all available cases and classifies new cases by a majority vote of its k neighbors.

```
from scipy.spatial import distance



class KNN():

    def fit(self, X_train, Y_train):

        self.X_train = X_train

        self.Y_train = Y_train

    def predict(self, X_test):

        predictions = []

        for row in X_test:

            label = self.closest(row)

            predictions.append(label)

        return predictions
```

```
    def closest(self, row):
        best_dist = distance.euclidean(row, self.X_train[0])
        best_index = 0
        for i in range(1, len(self.X_train)):
            dist = distance.euclidean(row, self.X_train[i])
            if dist < best_dist:
                best_dist = dist
                best_index = i
        return self.Y_train[best_index]


from sklearn import datasets
iris = datasets.load_iris()


X = iris.data
Y = iris.target
from sklearn.cross_validation import train_test_split
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size = .75)


from sklearn.neighbors import KNeighborsClassifier
classifier = KNN()


classifier.fit(X_train, Y_train)
predictions = classifier.predict(X_test)


from sklearn.metrics import accuracy_score
```

print accuracy_score(Y_test, predictions)

OUTPUT::

```
0.9380530973451328
```

2. Linear Regression

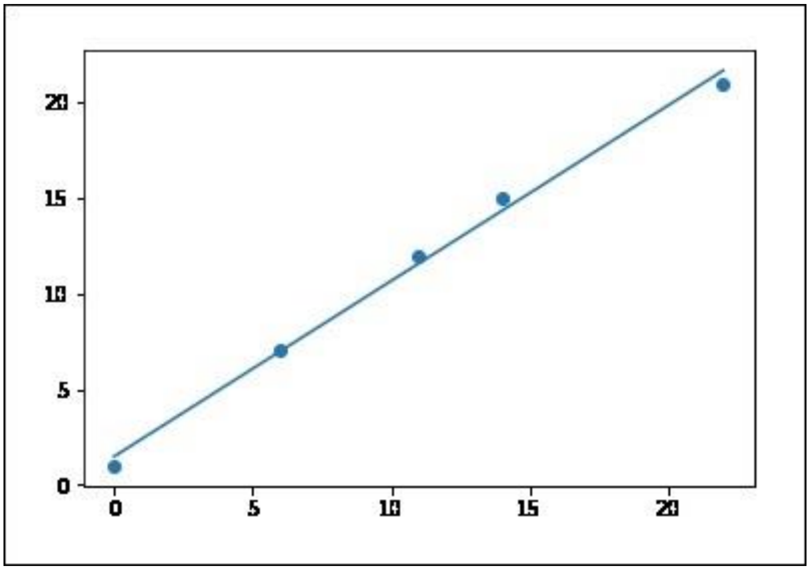
Linear regression is used to estimate real world values like cost of houses, number of calls, total sales etc.

Example

The best way to understand linear regression is by considering an example. Suppose we are asked to arrange students in a class in the increasing order of their weights.

```
# sample points
X = [0, 6, 11, 14, 22]
Y = [1, 7, 12, 15, 21]

# solve for a and b
def best_fit(X, Y):
   xbar = sum(X)/len(X)
   ybar = sum(Y)/len(Y)
   n = len(X) # or len(Y)

   numer = sum([xi*yi for xi,yi in zip(X, Y)]) - n * xbar * ybar
   denum = sum([xi**2 for xi in X]) - n * xbar**2

   b = numer / denum
   a = ybar - b * xbar

   print('best fit line:\ny = {:.2f} + {:.2f}x'.format(a, b))

   return a, b

# solution
a, b = best_fit(X, Y)
#best fit line:
#y = 0.80 + 0.92x

# plot points and fit line
import matplotlib.pyplot as plt
plt.scatter(X, Y)
yfit = [a + b * xi for xi in X]
plt.plot(X, yfit)
plt.show()
best fit line:
y = 1.48 + 0.92x
```

- **Output:-**



20
15
10
5
0
0
5
10
15
20

Experiment 12

- **Aim –** Development of ensemble model.
- **Code –**

An Ensemble method creates multiple models and combines them to solve it. Ensemble methods help to improve the robustness of the model.

Basic Ensemble Techniques

1 Max Voting
2 Averaging
3 Weighted Average

Problem: Development of ensemble model using Averaging Technique.

Averaging method: It is mainly used for regression problems. The method consists of build multiple models independently and returns the average of the prediction of all the models. In general, the combined output is better than an individual output because variance is reduced.

In the below example, three regression models (linear regression, xgboost, and random forest) are trained and their predictions are averaged. The final prediction output is pred_final.

```
# importing utility modules
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error

# importing machine learning models for prediction
from sklearn.ensemble import RandomForestRegressor
import xgboost as xgb
from sklearn.linear_model import LinearRegression

# loading train data set in dataframe from train_data.csv file
df = pd.read_csv("train_data.csv")

# getting target data from the dataframe
target = df["target"]

# getting train data from the dataframe
train = df.drop("target")

# Splitting between train data into training and validation dataset
X_train, X_test, y_train, y_test = train_test_split(
train, target, test_size=0.20)

# initializing all the model objects with default parameters
model_1 = LinearRegression()
model_2 = xgb.XGBRegressor()
model_3 = RandomForestRegressor()

# training all the model on the training dataset
model_1.fit(X_train, y_target)
model_2.fit(X_train, y_target)
```

```
model_3.fit(X_train, y_target)

# predicting the output on the validation dataset
pred_1 = model_1.predict(X_test)
pred_2 = model_2.predict(X_test)
pred_3 = model_3.predict(X_test)

# final prediction after averaging on the prediction of all 3 models
pred_final = (pred_1+pred_2+pred_3)/3.0

# printing the root mean squared error between real value and predicted value
print(mean_squared_error(y_test, pred_final))
```

Input:-

	Colleague 1	Colleague 2	Colleague 3	Colleague 4	Colleague 5	Final rating
Rating	5	4	5	4	4	4.4

Output: - final rating will be 4.4

RESULT:Program compiled successfully.

Experiment 13

- **Aim –** Implementation of NLP problem.
- **Code –**

  Problem:-

  Count total number of adjective and noun

```
# Import data and tagger
from nltk.corpus import twitter_samples
from nltk.tag import pos_tag_sents

# Load tokenized tweets
tweets_tokens = twitter_samples.tokenized('positive_tweets.json')

# Tag tagged tweets
tweets_tagged = pos_tag_sents(tweets_tokens)

# Set accumulators
JJ_count = 0
NN_count = 0

# Loop through list of tweets
for tweet in tweets_tagged:
    for pair in tweet:
        tag = pair[1]
        if tag == 'JJ':
            JJ_count += 1
        elif tag == 'NN':
            NN_count += 1

# Print total numbers for each adjectives and nouns
print('Total number of adjectives = ', JJ_count)
print('Total number of nouns = ', NN_count)
```

- **Result –**

```
- Output
Total number of adjectives =  6094
Total number of nouns =  13180
```

Experiment 14

Aim –Deep learning Project in Python

Code-

```
# Import pandas

import pandas as pd

# Read in white wine data

white = pd.read_csv("http://archive.ics.uci.edu/ml/machine-learning-databases/wine-quality/winequality-white.csv", sep=';')

# Read in red wine data

red = pd.read_csv("http://archive.ics.uci.edu/ml/machine-learning-databases/wine-quality/winequality-red.csv", sep=';')


import matplotlib.pyplot as plt

fig, ax = plt.subplots(1, 2)

ax[0].hist(red.alcohol, 10, facecolor='red', alpha=0.5, label="Red wine")

ax[1].hist(white.alcohol, 10, facecolor='white', ec="black", lw=0.5, alpha=0.5, label="White wine")

fig.subplots_adjust(left=0, right=1, bottom=0, top=0.5, hspace=0.05, wspace=1)

ax[0].set_ylim([0, 1000])

ax[0].set_xlabel("Alcohol in % Vol")

ax[0].set_ylabel("Frequency")

ax[1].set_xlabel("Alcohol in % Vol")

ax[1].set_ylabel("Frequency")

#ax[0].legend(loc='best')

#ax[1].legend(loc='best')
```

```
fig.suptitle("Distribution of Alcohol in % Vol")

plt.show()
```

Output: