EAST WEST UNIVERSITY

Mini Project

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Mini Project

Question-01:

Write a program in Python to calculate income tax. Bear in mind, the program will take input from the user. The user may provide any kind of input. It is your responsibility to handle unexpected inputs with appropriate process. Please give attention to the following data-

Income	Tax
First 300k Taka	0%
Next 100k Taka	5%
Next 300k Taka	10%
Next 400k Taka	15%
Next 500k Taka	20%
Rest of ALL	25%

Some special cases=> Women and Citizens with age > 65, tax for First 350K is 0%. For Disabled => First 450K carries 0% tax. Parents of disabled pay 0% tax on First 350K. And wounded freedom fighters pay 0% on first 475K Taka.

Solution:

```
print('Type of Tax Category: ')
print('1-General case')
print('2-Women and Citizens whose age is greater than 65')
print('3-Disabled')
print('4-Parents of disabled')
print('5-Wounded Freedom Fighter')

# console input of option
n = int(input('Enter option : '))
# console input of income
try:
   income = int(input('Enter the income(k) : '))
except ValueError:
   print("Please Enter Appropriate Value !!")
else:
   print ('No exception occurred')

if (n == 1):
   if (income <= 300):
      tax = 0
   elif (income > 300 and income <= 400):
```

```
        tax = (income - 300) * 5 / 100
    elif (income > 400 and income <= 700):
        tax = (300 * 0 / 100) + (100 * 5 / 100) + (income - 400) * 10 / 100
    elif (income > 700 and income <= 1100):
        tax = (300 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (income - 700) * 15 / 100
    elif (income > 1100 and income <= 1600):
        tax = (300 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (income -
1100) * 20 / 100
    else:
        tax = (300 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (500 * 20
/ 100) + (
                income - 1600) * 25 / 100

elif (n == 2):
    if (income <= 350):
        tax = 0
    elif (income > 350 and income <= 450):
        tax = (income - 350) * 5 / 100
    elif (income > 450 and income <= 750):
        tax = (350 * 0 / 100) + (100 * 5 / 100) + (income - 450) * 10 / 100
    elif (income > 750 and income <= 1150):
        tax = (350 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (income - 750) * 15 / 100
    elif (income > 1150 and income <= 1650):
        tax = (350 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (income -
1150) * 20 / 100
    else:
        tax = (350 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (500 * 20
/ 100) + (
                income - 1650) * 25 / 100

elif (n == 3):
    if (income <= 450):
        tax = 0
    elif (income > 450 and income <= 550):
        tax = (income - 450) * 5 / 100
    elif (income > 550 and income <= 850):
        tax = (450 * 0 / 100) + (100 * 5 / 100) + (income - 550) * 10 / 100
    elif (income > 850 and income <= 1250):
        tax = (450 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (income - 850) * 15 / 100
    elif (income > 1250 and income <= 1750):
        tax = (450 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (income -
1250) * 20 / 100
    else:
        tax = (450 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (500 * 20
```

```
/ 100) + (
                income - 1750) * 25 / 100


elif (n == 4):
    if (income <= 350):
        tax = 0
    elif (income > 350 and income <= 450):
        tax = (income - 350) * 5 / 100
    elif (income > 450 and income <= 750):
        tax = (350 * 0 / 100) + (100 * 5 / 100) + (income - 450) * 10 / 100
    elif (income > 750 and income <= 1150):
        tax = (350 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (income - 750) * 15 / 100
    elif (income > 1150 and income <= 1650):
        tax = (350 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (income -
1150) * 20 / 100
    else:
        tax = (350 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (500 * 20
/ 100) + (
                income - 1650) * 25 / 100

elif (n == 5):
    if (income <= 475):
        tax = 0
    elif (income > 475 and income <= 575):
        tax = (income - 475) * 5 / 100
    elif (income > 575 and income <= 875):
        tax = (475 * 0 / 100) + (100 * 5 / 100) + (income - 575) * 10 / 100
    elif (income > 875 and income <= 1275):
        tax = (475 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (income - 875) * 15 / 100
    elif (income > 1275 and income <= 1775):
        tax = (475 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (income -
1275) * 20 / 100
    else:
        tax = (475 * 0 / 100) + (100 * 5 / 100) + (300 * 10 / 100) + (400 * 15 / 100) + (500 * 20
/ 100) + (
                income - 1775) * 25 / 100

print('Total Tax to Pay ', tax, 'Taka')
```

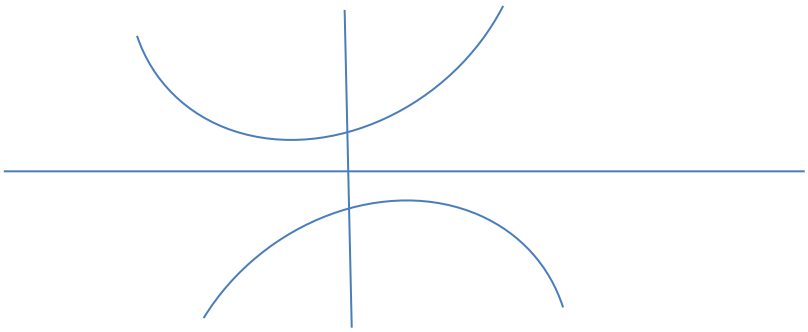
Output:

```
Type of Tax Category:

1-General case

2-Women and Citizens whose age is greater than 65

3-Disabled

4-Parents of disabled

5-Wounded Freedom Fighter

Enter option : 1

Enter the income(k) : 450

Total Tax to Pay  10.0 Taka

Enter option : 2

Enter the income(k) : 750

Total Tax to Pay  35.0 Taka

Enter option : 3

Enter the income(k) : 1050

Total Tax to Pay  65.0 Taka

Enter option : 4

Enter the income(k) : 350

Total Tax to Pay  0 Taka

Enter option : 5

Enter the income(k) : 1560

Total Tax to Pay  152.0 Taka

Enter option : 1

Enter the income(k) : abc12

Please Enter Appropriate Value !!
```

NameError: name 'income' is not defined

Question-02:

Conics: Give me the following graphs, include your code in the lab report. Describe the code also. Put the equations and name of the curve in your plot as well as report.



Solution:

The figure given above is of a Hyperbola:

Hyperbola:

Everything has a curve that belongs to the curves of conic sections. There are four types of conic sections – circles, parabola, ellipse, and hyperbola. A hyperbola is defined as a curve that is made of all the sets of points the difference of whose distances from the two fixed points in the plane is constant. The figure is the vertical hyperbola its equation has the form:

$$\frac{y^2}{a^2}-\frac{x^2}{b^2}=1$$

Description:

I first import numpy and matplotlib before plotting the hyperbola. After that, I ran from -200 to 200 to make the grid with x and y values. Then I use meshgrid to get the x,y values. The graph is then plotted on the X-axis and Y-axis.
Then I calculated a and b values using the hyperbolic equation. As per my plotting equation, a=49 and b=32. Finally, I use plt.contour(x, y,(y**2/a**2 - x**2/b**2),[1]) to display a hyperbolic equation and give it a title. The plot is then displayed using plt.show ().
The equation I plot is:

$$\frac{y^2}{49^2}-\frac{x^2}{32^2}=1$$

Code:

```
import numpy as np
import matplotlib as mpl
import matplotlib.pyplot as plt

#first creating the grid with x values and y values running from -200 to 200
x = np.linspace(-200, 200)
y = np.linspace(-200, 200)
#get x,y values from the grid
x, y = np.meshgrid(x, y)

#plot the x and Y axis
plt.axhline(0, alpha=.1)
plt.axvline(0, alpha=.1)

#set a and b value according to the hyperbolic equation
a =49
b =32
#plot hyperbolic equation
plt.contour(x, y,(y**2/a**2 - x**2/b**2) ,[1])
#add title
plt.title("HYPERBOLA\n\nEquation : y^2/49^2 - x^2/3^2 = 1")
#display the plot
plt.show()
```

Output:

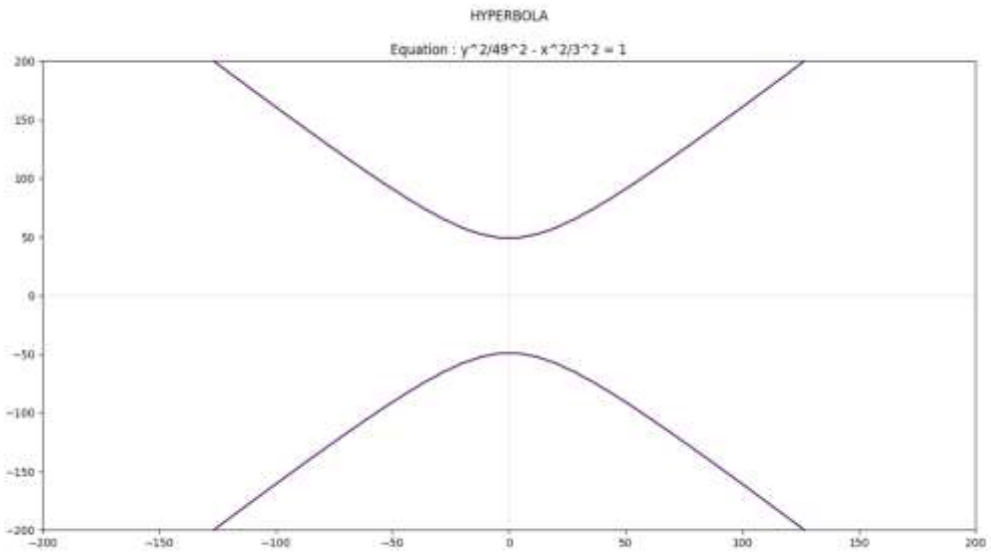


Figure: Hyperbola

Question-03:

As an AI engineer you are asked to design a robot which will be able to solve any kind of maze. Now build the maze solver code and simulate the code on your preferred IDE for Python. In this regard, you are also asked to solve it using both informed search and uninformed search techniques. Also provide a comparative code analysis showing the differences among the techniques.

Instructions: You must have to apply the search code you have written in the lab classes. Do not apply library functions for the search algorithms. Online solution is not accepted as plagiarism is strictly forbidden. But you are encouraged to study from quality materials. You may also follow any acceptable mechanism to build the following maze and to find the output.

Hints: MAP should be a variable as follows.

```
MAP = """
##############################
#            #               #  #
# ####     ########          #  #
#   o #      #               #  #
#     ###        #####   ######  #
#       #    ###    #           #
#       #      #    #   #   #  ###
#      #####     #     #   # x   #
#                #         #     #
##############################
"""
```

Where moving diagonal path cost = 1.7 and moving regular path cost = 1.0

Consider Euclidean distance for computing the heuristic values.

Solution:

Uninformed Search:

```
import time
class Maze(object):

    def __init__(self, grid, location):
        """Instances differ by their current agent locations."""
        self.grid = grid
        self.location = location
```

```
    def display(self):
        """Print the maze, marking the current agent location."""
        for r in range(len(self.grid)):
            for c in range(len(self.grid[r])):
                if (r, c) == self.location:
                    print ('#')
                else:
                    print (self.grid[r][c])
            print
        print

    def moves(self):

    def neighbor(self, move):

class Agent(object):

    def bfs(self, maze, goal):

def main():

    grid = """
    ##############################
    #     #        #  #
    # ####  ########    #  #
    # o #   #        #  #
    #  ###   ##### ######  #
    #    #  ###  #      #
    #    #   #  # # #  ###
    #   #####  #   # # x  #
    #        #    #   #
    ##############################
    """

    maze = Maze(grid, (1,1))
    maze.display()

    agent = Agent()
    goal = Maze(grid, (19,18))
    path = agent.bfs(maze, goal)

    while path:
        move = path.pop(0)
        maze = maze.neighbor(move)
        time.sleep(0.25)
        maze.display()

if __name__ == '__main__':
    main()
```

Output:

```
################################
#     #        # #
# #### ######## # #
# o #  #        # #
#  ###  ##### ###### #
#   # ### #      #
#   #  # # # # ###
#  ##### #  # # x #
#       #   #  #
################################

################################
#     #        # #
# #### ######## # #
# o #  #        # #
# ·###  ##### ###### #
#  · #  ### # ····  #
#  · #  # ··# ·# #· ###
#  ·##### ·# ·· # # x #
#  ·····# #  #
################################
```

Informed Search Method:

```
import math
# Class containing the methods to solve the maze
class MazeSolver(SearchProblem):
    # Initialize the class
    def __init__(self, board):
        self.board = board
        self.goal = (0, 0)

        for y in range(len(self.board)):
            for x in range(len(self.board[y])):
                if self.board[y][x].lower() == "o":
                    self.initial = (x, y)
                elif self.board[y][x].lower() == "x":
                    self.goal = (x, y)

        super(MazeSolver, self).__init__(initial_state=self.initial)

    # Define the method that takes actions
    # to arrive at the solution
    def actions(self, state):
        actions = []
        for action in COSTS.keys():
            newx, newy = self.result(state, action)
            if self.board[newy][newx] != "#":
                actions.append(action)

        return actions

    # Update the state based on the action
    def result(self, state, action):
        x, y = state

        if action.count("up"):
            y -= 1
        if action.count("down"):
            y += 1
        if action.count("left"):
            x -= 1
        if action.count("right"):
            x += 1

        new_state = (x, y)

        return new_state


    # Check if we have reached the goal
    def is_goal(self, state):
```

```
        return state == self.goal

    # Compute the cost of taking an action
    def cost(self, state, action, state2):
        return COSTS[action]

    # Heuristic that we use to arrive at the solution
    def heuristic(self, state):
        x, y = state
        gx, gy = self.goal

        return math.sqrt((x - gx) ** 2 + (y - gy) ** 2)

if __name__ == "__main__":
    # Define the map
    MAP = """
    ##############################
    #      #        #  #
    # ####   ########    #  #
    #  o #   #        #  #
    #   ###   ##### ######  #
    #    #  ###  #       #
    #    #   #  # # #  ###
    #   #####   #   # # x  #
    #         #    #   #
    ##############################
    """

    # Convert map to a list
    print(MAP)
    MAP = [list(x) for x in MAP.split("\n") if x]

    # Define cost of moving around the map
    cost_regular = 1.0
    cost_diagonal = 1.7

    # Create the cost dictionary
    COSTS = {
        "up": cost_regular,
        "down": cost_regular,
        "left": cost_regular,
        "right": cost_regular,
        "up left": cost_diagonal,
        "up right": cost_diagonal,
        "down left": cost_diagonal,
        "down right": cost_diagonal,
    }

    # Create maze solver object
    problem = MazeSolver(MAP)
```

```
# Run the solver
result = astar(problem, graph_search=True)

# Extract the path
path = [x[1] for x in result.path()]

# Print the result
print()
for y in range(len(MAP)):
    for x in range(len(MAP[y])):
        if (x, y) == problem.initial:
            print('o', end='')
        elif (x, y) == problem.goal:
            print('x', end='')
        elif (x, y) in path:
            print('·', end='')
        else:
            print(MAP[y][x], end='')

    print()
```

Output:

```
##############################
#     #        # #
# #### ######## # #
# o #  #        # #
#  ###  ##### ###### #
#   # ### #      #
#   #  # # # # ###
#  ##### # # # x #
#       #   #  #
##############################
##############################
#     #        # #
# #### ######## # #
# o #  #        # #
# ·###  ##### ###### #
#  ·#  ### # ····  #
#  ·#  # ··# ·# #· ###
```

An analysis of the differences between the techniques using comparison code:

Maze Runner game is a game that requires a pathfinding algorithm to get to the destination with the shortest path. This algorithm is used in an Non Player Character that will move from the start node to the destination node. However, the use of incorrect algorithms can affect the length of the computing process to find the shortest path. The longer the computing process, the longer the players have to wait. This study compared pathfinding algorithms A *, and Breadth-First Search (BFS) in the Maze Runner game.

Uniform Cost Searches are a subset of Breadth First Searches (UCS). A weighted graph search is what UCS is. Cost storage is used to decide the order in which nodes are visited. The purpose of BFS is to get from the source vertex to the goal vertex. Starting with the source vertex, some Vertex in the visited set visits the entire layer of unvisited vertexes, and recently visited vertexes are added to the visited set. By viewing the vertices as labyrinth cells, BFS can be compared to the Micro mouse maze. The BFS method in Micro mouse labels cells by searching from the start cell to all nearby neighbours. "Zero" is written in the first cell (0). The program keeps track of which cells are directly adjacent to the start cell. BFS is capable of determining the shortest route. The search will continue until the target is found. he advantage of BFS is that it will stop searching as soon as it finds the shortest path, with the drawback being that memory accesses are more scattered and play less well with caches.

We utilize the Data Structure Priority Queue to implement the A* algorithm since we need to find the cell with the lowest cost. Unlike a FIFO (First In First Out) queue, the elements in a Priority Queue are removed according to their priority. The element's value may be given precedence (highest or lowest). The Priority Queue is included in Python's Queue module, and the priority is the lowest number, making it ideal for implementing A*. The fact that it's beating A* is likely due to the overhead associated with A* not being worth the savings in spaces explored.

In Maze Runner Game, A* and Breadth First Search can be utilized to determine the shortest path. A* is the best pathfinding algorithm, especially for Maze game puzzles. This is backed up by the fact that only a small amount of computational power is required and that the search time is quite short. In terms of computing process, memory utilization, and computing time, the appropriate method can improve the game.

Question-04:

In the logic program, we specify the puzzle as follows:

- Steve has a blue car.
- The person who owns a cat live in Canada. Matthew lives in the USA.
- The person with a black car lives in Australia.
- Jack has a cat.
- Alfred lives in Australia.
- The person who has a dog live in France.
- Who has a rabbit?

The goal is the find the person who has a rabbit. Here are the full details about the four people as puzzle solver input data:

	Pet	Car Color	Country
Steve	dog	blue	France
Jack	cat	green	Canada
Matthew	rabbit	yellow	USA
Alfred	parrot	black	Australia

Solution:

```
from kanren import *

from kanren.core import lall

# Declare the variable

people = var()

# Define the rules

rules = lall(

    # There are 4 people
```

```
    (eq, (var(), var(), var(), var()), people),
    # Steve's car is blue
    (membero, ('Steve', var(), 'blue', var()), people),
    # Person who has a cat lives in Canada
    (membero, (var(), 'cat', var(), 'Canada'), people),
    # Matthew lives in USA
    (membero, ('Matthew', var(), var(), 'USA'), people),
    # The person who has a black car lives in Australia
    (membero, (var(), var(), 'black', 'Australia'), people),
    # Jack has a cat
    (membero, ('Jack', 'cat', var(), var()), people),
    # Alfred lives in Australia
    (membero, ('Alfred', var(), var(), 'Australia'), people),
    # Person who owns the dog lives in France
    (membero, (var(), 'dog', var(), 'France'), people),
    # Who has a rabbit?
    (membero, (var(), 'rabbit', var(), var()), people)
)

# Run the solver
solutions = run(0, people, rules)
# Extract the output
```

```
output = [house for house in solutions[0] if 'rabbit' in house][0][0]

# Print the output

print('\n' + output + ' is the owner of the rabbit')

print('\nHere are all the details:')

attribs = ['Name', 'Pet', 'Color', 'Country']

print('\n' + '\t\t'.join(attribs))

print('=' * 57)

for item in solutions[0]:

    print('')

    print('\t\t'.join([str(x) for x in item]))
```

Output:

```
Matthew is the owner of the rabbit

Here are all the details:

Name            Pet             Color           Country
=========================================================

Steve           dog             blue            France

Jack            cat             ~_9             Canada

Matthew         rabbit          ~_11            USA

Alfred          ~_13            black           Australia
```