B.TECH. (2020-24)
Artificial Intelligence

Lab File

on

ARTIFICIAL INTELLIGENCE
[CSE401]

Submitted To

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INDEX

S.No.	Category of Assignment	Code	Exp. No.	Name of Experiment	Date of Allotment of experiment	Date of Evaluation	Max. Marks	Marks obtained	Signature of Faculty
1.	**Mandatory Experiment***	**LR (10)**	**1**	A* Algorithm	13/01/2022	20/01/2022			
2.	**Mandatory Experiment***		**2**	Single Player Game	20/01/2022	27/01/2022			
3.	**Mandatory Experiment***		**3**	Tic-Tac-Toe game problem	27/01/2022	03/02/2022			
4.	**Mandatory Experiment***		**4**	Knapsack problem	03/02/2022	17/02/2022			
5.	**Mandatory Experiment***		**5**	Graph coloring problem	17/02/2022	03/03/2022			
6.	**Mandatory Experiment***		**6**	BFS for water jug problem	03/03/2022	10/03/2022			
7	**Mandatory Experiment***		**7**	DFS	10/03/2022	24/03/2022			
8.	**Mandatory Experiment***		**8**	Tokenization of word and Sentences	24/03/2022	31/03/2022			
9.	**Mandatory Experiment***		**9**	XOR truth table	31/03/2022	07/04/2022			
10.	**Mandatory Experiment***		**10**	SCIKIT fuzzy	13/01/2022	20/01/2022			

EXPERIMENT – 1

AIM

Write a program to implement A* algorithm in python.

PROGRAMMING LANGUAGE / TOOL USED

Python Programming Language

LIBRARIES USED

- timeit

CODE

```
from timeit import default_timer

class Graph:
    f = []

    def __init__(self,adj,h = {}):
        self.adj_list = adj

        if h == {}:
            for i in adj:
                for j in adj[i]:
                    h[j[0]] = 1

        self.h = h


    def fninsert(self,cur):
        k = 0

        while k != len(Graph.f):
            if Graph.f[k][1][-1] == cur:
                temp = Graph.f.pop(k)

                for i in self.adj_list[cur]:
                    if i[0] not in temp[1]:
                        Graph.f.insert(k,[ (temp[0] - self.h[cur] + i[1] +
self.h[i[0]]), temp[1] + (i[0],) ])

            k = k + 1

    def isExpandable(self,start,goal):
        # if min(Graph.f)[1][-1] == goal:
        #             return 2

        for path in Graph.f:
            if path[1][-1] != goal and path[1][-1] in self.adj_list:
                if len(self.adj_list[path[1][-1]]) != 1:
```

```
                    return 1
                elif self.adj_list[path[1][-1][0]][0] != start:
                    return 1
                else:
                    return 0

    def isPath(self,goal):
        for i in Graph.f:
            if i[1][-1] == goal:
                return 1

        return 0

    def astar(self,start,goal):
        stTime = default_timer()

        Graph.f.clear()

        flag = 1

        if start not in self.adj_list:
            flag = 0

        self.h[goal] = 0

        while flag == 1:

            if Graph.f == []:
                for i in self.adj_list[start]:
                    Graph.f.append([i[1] + self.h[i[0]], (start,i[0])])
            else:
                for i in Graph.f:
                    # minfn = min(Graph.f)

                    # if i[1][-1] != goal and minfn == i:
                    if i[1][-1] != goal:
                        self.fninsert(i[1][-1])

                flag = self.isExpandable(start,goal)


        if self.isPath(goal) == 1:
            print(f'Optimal Path from {start} to {goal}: {min(Graph.f)[1]}
with Path COST: {min(Graph.f)[0]}')
        else:
            print('\n!!Path not possible!!')

        print('\nTime Complexity =',default_timer()-stTime)



adj_list = {'S':[('A',1),('B',2)],
            'A':[('Y',7),('X',4)],
            'B':[('C',7),(('D',1))],
```

```
            'Y':[('E',3)],
            'X':[('E',2)],
            'C':[('E',5)],
            'D':[('E',12)]
            }

h = {'A':5,
     'B':6,
     'C':4,
     'D':15,
     'X':5,
     'Y':8
    }

g = Graph(adj_list,h)

g.astar('S','E')
```

OUTPUT

```
Optimal Path from S to E: ('S', 'A', 'X', 'E') with Path COST: 7

Time Complexity = 0.00034610000000000196
```

CONCLUSION

A* algorithm has been implemented successfully.

EXPERIMENT – 2

AIM

Write a program to implement Single Player Game.

PROGRAMMING LANGUAGE / TOOL USED

Python Programming Language

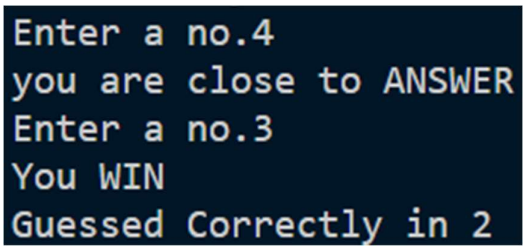
LIBRARIES USED

- math
- random

CODE

```
import math
import random

x = random.randint(1,10)
con = 2
count = 0

while(1):
    count = count + 1
    test = int(input('Enter a no.'))

    if test == x:

        print('You WIN\nGuessed Correctly in',count)
        break
    elif math.fabs(test-x) <= con:
        print('you are close to ANSWER')
    else:
        print('You are far from ANSWER')
```

OUTPUT



CONCLUSION

Single Player Game has been implemented successfully.

EXPERIMENT – 3

AIM

Write a program to implement Tic-Tac-Toe game problem.

PROGRAMMING LANGUAGE / TOOL USED

Python Programming Language

LIBRARIES USED

- os
- tabnanny

CODE

```
import os
from tabnanny import check
# Python3 program to find the next optimal move for a player
player, opponent = 'x', 'o'

# This function returns true if there are moves
# remaining on the board. It returns false if
# there are no moves left to play.
def isMovesLeft(board) :

     for i in range(3) :
          for j in range(3) :
               if (board[i][j] == '_') :
                    return True
     return False

# This is the evaluation function as discussed
# in the previous article ( http://goo.gl/sJgv68 )
def evaluate(b) :

     # Checking for Rows for X or O victory.
     for row in range(3) :
          if (b[row][0] == b[row][1] and b[row][1] == b[row][2]) :
               if (b[row][0] == player) :
                    return 10
               elif (b[row][0] == opponent) :
                    return -10

     # Checking for Columns for X or O victory.
     for col in range(3) :

          if (b[0][col] == b[1][col] and b[1][col] == b[2][col]) :

               if (b[0][col] == player) :
                    return 10
```

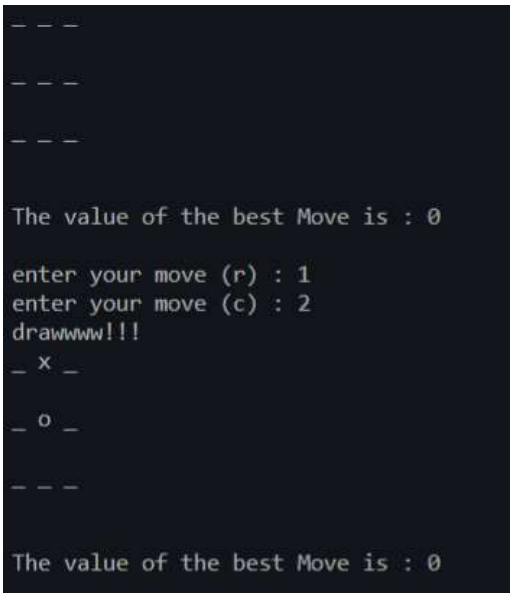
```
                elif (b[0][col] == opponent) :
                      return -10

      # Checking for Diagonals for X or O victory.
      if (b[0][0] == b[1][1] and b[1][1] == b[2][2]) :

            if (b[0][0] == player) :
                  return 10
            elif (b[0][0] == opponent) :
                  return -10

      if (b[0][2] == b[1][1] and b[1][1] == b[2][0]) :

            if (b[0][2] == player) :
                  return 10
            elif (b[0][2] == opponent) :
                  return -10

      # Else if none of them have won then return 0
      return 0

# This is the minimax function. It considers all
# the possible ways the game can go and returns
# the value of the board
def minimax(board, depth, isMax) :
      score = evaluate(board)

      # If Maximizer has won the game return his/her
      # evaluated score
      if (score == 10) :
            return score

      # If Minimizer has won the game return his/her
      # evaluated score
      if (score == -10) :
            return score

      # If there are no more moves and no winner then
      # it is a tie
      if (isMovesLeft(board) == False) :
            return 0

      # If this maximizer's move
      if (isMax) :
            best = -1000

            # Traverse all cells
            for i in range(3) :
                  for j in range(3) :

                        # Check if cell is empty
                        if (board[i][j]=='_') :

                              # Make the move
```

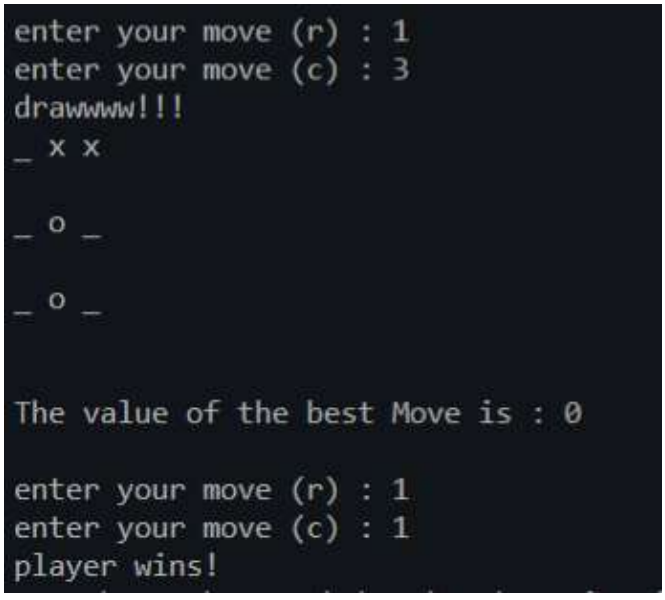
```
                        board[i][j] = opponent

                        # Call minimax recursively and choose
                        # the maximum value
                        best = max( best, minimax(board,
                                                  depth + 1,
                                                  not isMax) )

                        # Undo the move
                        board[i][j] = '_'
            return best

      # If this minimizer's move
      else :
            best = 1000

            # Traverse all cells
            for i in range(3) :
                  for j in range(3) :

                        # Check if cell is empty
                        if (board[i][j] == '_') :

                              # Make the move
                              board[i][j] = player

                              # Call minimax recursively and choose
                              # the minimum value
                              best = min(best, minimax(board, depth + 1, not
isMax))

                              # Undo the move
                              board[i][j] = '_'
            return best

# This will return the best possible move for the player
def findBestMove(board) :
      bestVal = -1000
      bestMove = (-1, -1)

      # Traverse all cells, evaluate minimax function for
      # all empty cells. And return the cell with optimal
      # value.
      for i in range(3) :
            for j in range(3) :

                  # Check if cell is empty
                  if (board[i][j] == '_') :

                        # Make the move
                        board[i][j] = opponent

                        # compute evaluation function for this
                        # move.
```

```
                        moveVal = minimax(board, 0, False)

                        # Undo the move
                        board[i][j] = '_'

                        # If the value of the current move is
                        # more than the best value, then update
                        # best/
                        if (moveVal > bestVal) :
                              bestMove = (i, j)
                              bestVal = moveVal

      print("The value of the best Move is :", bestVal)
      print()
      return bestMove

def checkWin(board):
      for r in board:
            if r == ['o','o','o']:
                  return 1
            if r == ['x','x','x']:
                  return 0
      for i in range(len(board)):
            c = []
            for j in range(len(board)):
                  c.append(board[j][i])

            if c == ['o','o','o']:
                  return 1
            if c == ['x','x','x']:
                  return 0

      if [board[0][0], board[1][1], board[2][2]] == ['o','o','o']:
            return 1
      if [board[0][0], board[1][1], board[2][2]] == ['x','x','x']:
            return 0

      if [board[0][2], board[1][1], board[2][0]] == ['o','o','o']:
            return 1
      if [board[0][2], board[1][1], board[2][0]] == ['x','x','x']:
            return 0

def printBoard(board):
      for i in board:
            for j in i:
                  print(j, end=" ")
            print("\n")
# Driver code
board = [
      [ '_', '_', '_' ],
      [ '_', '_', '_' ],
      [ '_', '_', '_' ]
]
```

```
# bestMove = findBestMove(board)

# print("The Optimal Move is :")
# print("ROW:", bestMove[0], " COL:", bestMove[1])

win = False
draw = False

while not (win or draw):
      printBoard(board)
      print()
      bestMove = findBestMove(board)
      board[bestMove[0]][bestMove[1]] = 'o'
      if checkWin(board) == 1:
            print('cpu wins!')
            win = True
            break

      r = int(input("enter your move (r) : "))
      c = int(input("enter your move (c) : "))
      board[r-1][c-1] = 'x'

      if checkWin(board) == 0:
            print('player wins!')
            win = True
            break

      if checkWin(board) != 1 or checkWin(board) != 0:
            print("drawwww!!!")
```

OUTPUT





CONCLUSION

Tic-Tac-Toe game problem has been implemented successfully.

EXPERIMENT – 4

AIM

Implement Brute force solution to the Knapsack problem in Python.

PROGRAMMING LANGUAGE / TOOL USED

Python Programming Language

CODE

```
def knapSack(W, wt, val, n):
   # initial conditions
   if n == 0 or W == 0 :
      return 0
   # If weight is higher than capacity then it is not included
   if (wt[n-1] > W):
      return knapSack(W, wt, val, n-1)
   # return either nth item being included or not
   else:
      return max(val[n-1] + knapSack(W-wt[n-1], wt, val, n-1),
         knapSack(W, wt, val, n-1))

val = [60, 100, 120]
wt = [10, 20, 30]
W = 50
n = len(val)
print (knapSack(W, wt, val, n))
```

OUTPUT

```
PS E:\Amity Data\Semester 4\AI\AI LAB> python -u "e:\Amity Data\Semester 4\AI\AI
LAB\LAB 9\knapsack.py"
220
```

CONCLUSION

Brute force implementation of Knapsack problem has been derived successfully.

EXPERIMENT – 5

AIM

Implement Graph colouring problem using python

PROGRAMMING LANGUAGE / TOOL USED

Python Programming Language

LIBRARIES USED

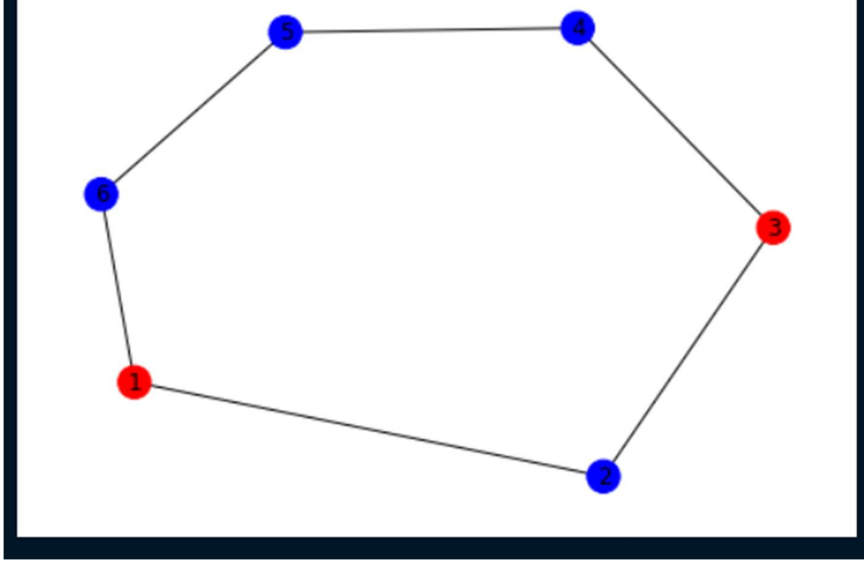
- networkx

CODE

```
import networkx as nx

n = int(input("Enter no. of nodes "))

l = [i for i in range(1,n+1)]

print(l)

network = nx.Graph()

network.add_nodes_from(l)

for i in range(1,n):
    network.add_edge(i,i+1,weight=i)

network.add_edge(1,n,weight = n)

print(network.edges())

print(network.get_edge_data(1, 2)['weight'])

color_list = []

for i in network.edges():
    if network.get_edge_data(i[0],i[1])['weight'] < 3:
        color_list.append("red")
    else:
        color_list.append("blue")


nx.draw(network,node_color = color_list,with_labels = True)
```

OUTPUT

```
[1, 2, 3, 4, 5, 6]
[(1, 2), (1, 6), (2, 3), (3, 4), (4, 5), (5, 6)]
1
```



CONCLUSION

Graph Colouring problem has been implemented successfully.

EXPERIMENT – 6

AIM

Write a program to implement BFS for water jug problem using Python.

PROGRAMMING LANGUAGE / TOOL USED

Python Programming Language

LIBRARIES USED

- collections

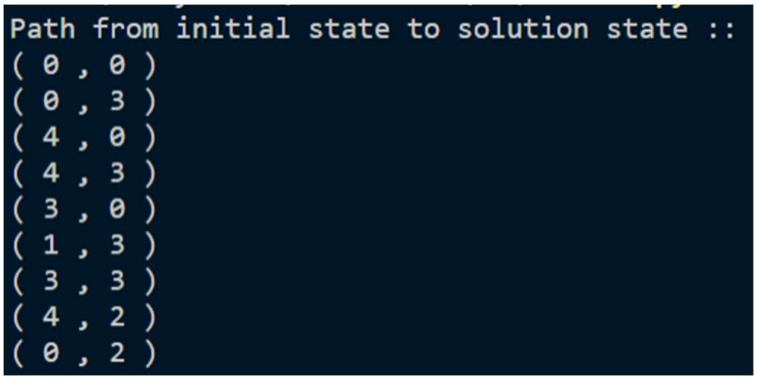
CODE

```
from collections import deque

def BFS(a, b, target):

	# Map is used to store the states, every
	# state is hashed to binary value to
	# indicate either that state is visited
	# before or not
	m = {}
	isSolvable = False
	path = []

	# Queue to maintain states
	q = deque()

	# Initialing with initial state
	q.append((0, 0))

	while (len(q) > 0):

		# Current state
		u = q.popleft()

		#q.pop() #pop off used state

		# If this state is already visited
		if ((u[0], u[1]) in m):
			continue

		# Doesn't met jug constraints
		if ((u[0] > a or u[1] > b or
			u[0] < 0 or u[1] < 0)):
			continue

		# Filling the vector for constructing
		# the solution path
		path.append([u[0], u[1]])

		# Marking current state as visited
		m[(u[0], u[1])] = 1
```

```
            # If we reach solution state, put ans=1
            if (u[0] == target or u[1] == target):
                  isSolvable = True

                  if (u[0] == target):
                        if (u[1] != 0):

                              # Fill final state
                              path.append([u[0], 0])
                  else:
                        if (u[0] != 0):

                              # Fill final state
                              path.append([0, u[1]])

                  # Print the solution path
                  sz = len(path)
                  for i in range(sz):
                        print("(", path[i][0], ",",
                                    path[i][1], ")")
                  break

            # If we have not reached final state
            # then, start developing intermediate
            # states to reach solution state
            q.append([u[0], b]) # Fill Jug2
            q.append([a, u[1]]) # Fill Jug1

            for ap in range(max(a, b) + 1):

                  # Pour amount ap from Jug2 to Jug1
                  c = u[0] + ap
                  d = u[1] - ap

                  # Check if this state is possible or not
                  if (c == a or (d == 0 and d >= 0)):
                        q.append([c, d])

                  # Pour amount ap from Jug 1 to Jug2
                  c = u[0] - ap
                  d = u[1] + ap

                  # Check if this state is possible or not
                  if ((c == 0 and c >= 0) or d == b):
                        q.append([c, d])

            # Empty Jug2
            q.append([a, 0])

            # Empty Jug1
            q.append([0, b])

      # No, solution exists if ans=0
      if (not isSolvable):
            print ("No solution")

# Driver code

Jug1, Jug2, target = 4, 3, 2
```

```
print("Path from initial state to solution state ::")

BFS(Jug1, Jug2, target)
```

OUTPUT



CONCLUSION

Water Jug problem using BFS has been implemented successfully.

EXPERIMENT – 7

AIM

Write a program to implement DFS using Python.

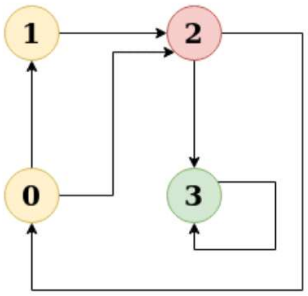
PROGRAMMING LANGUAGE / TOOL USED

Python Programming Language

LIBRARIES USED

- collections

GRAPH USED



RED Node - Start Node

CODE

```
# Python3 program to print DFS traversal
# from a given given graph
from collections import defaultdict

# This class represents a directed graph using
# adjacency list representation


class Graph:

      # Constructor
      def __init__(self):

            # default dictionary to store graph
            self.graph = defaultdict(list)

      # function to add an edge to graph
      def addEdge(self, u, v):
            self.graph[u].append(v)

      # A function used by DFS
      def DFSUtil(self, v, visited):

            # Mark the current node as visited
            # and print it
            visited.add(v)
            print(v, end=' ')
```

```
            # Recur for all the vertices
            # adjacent to this vertex
            for neighbour in self.graph[v]:
                  if neighbour not in visited:
                        self.DFSUtil(neighbour, visited)

      # The function to do DFS traversal. It uses
      # recursive DFSUtil()
      def DFS(self, v):

            # Create a set to store visited vertices
            visited = set()

            # Call the recursive helper function
            # to print DFS traversal
            self.DFSUtil(v, visited)

# Driver code


# Create a graph given
# in the above diagram
g = Graph()

g.addEdge(0, 1)
g.addEdge(0, 2)
g.addEdge(1, 2)
g.addEdge(2, 0)
g.addEdge(2, 3)
g.addEdge(3, 3)

print("Following is DFS from (starting from vertex 2)")
g.DFS(2)
```

OUTPUT

```
Following is DFS from (starting from vertex 2)
2 0 1 3
```

CONCLUSION

DFS has been implemented successfully.

EXPERIMENT – 8

AIM

Tokenization of word and Sentences with the help of NLTK package.

PROGRAMMING LANGUAGE / TOOL USED

Python Programming Language

LIBRARIES USED

- nltk

CODE

```
from nltk.tokenize import *
text = "God is Great! I won a lottery."
print(word_tokenize(text))

text = '''God is Great! I won a lottery.
i lost a lotter. help me! i died'''
print(sent_tokenize(text))
```

OUTPUT

```
['God', 'is', 'Great', '!', 'I', 'won', 'a', 'lottery', '.']
```

```
['God is Great!', 'I won a lottery.', 'i lost a lotter.', 'help me!', 'i died']
```

CONCLUSION

Tokenization of word and Sentences with the help of NLTK package has been implemented successfully.

EXPERIMENT – 9

AIM

Design an XOR truth table using Python.

PROGRAMMING LANGUAGE / TOOL USED

Python Programming Language

CODE

```
def XOR (a, b):
    if a != b:
        return 1
    else:
        return 0

print(f'A     B     OUTPUT')
print('------------------')
for i in [0,1]:
    for j in [0,1]:
        print(f'{i}     {j}       {XOR(i,j)}')
```

OUTPUT

```
A     B     OUTPUT
------------------
0     0       0
0     1       1
1     0       1
1     1       0
```

CONCLUSION

Truth table for XOR gate using Python has been constructed successfully.

EXPERIMENT – 10

AIM

Study of SCIKIT fuzzy.

THEORY

Scikit-Fuzzy is a collection of fuzzy logic algorithms intended for use in the SciPy Stack, written in the Python computing language.

This package implements many useful tools for projects involving fuzzy logic, also known as grey logic.

scikit-fuzzy (a.k.a. skfuzzy): Fuzzy logic toolbox for Python.

Scikit-fuzzy is a robust set of foundational tools for problems involving fuzzy logic and fuzzy systems. This area has been a challenge for the scientific Python community, largely because the common first exposure to this topic is through the MATLAB® Fuzzy Logic Toolbox™.

Within scikit-fuzzy, universe variables and fuzzy membership functions are represented by numpy arrays. Generation of membership functions is as simple as:

```
>>> import numpy as np
>>> import skfuzzy as fuzz
>>> x = np.arange(11)
>>> mfx = fuzz.trimf(x, [0, 5, 10])
>>> x
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10])
>>> mfx
array([ 0. ,  0.2,  0.4,  0.6,  0.8,  1. ,  0.8,  0.6,  0.4,  0.2,  0. ])
```

While most functions are available in the base namespace, the package is factored with a logical grouping of functions in submodules. The current capabilities of scikit-fuzzy include:

- fuzz.membership: Fuzzy membership function generation
- fuzz.defuzzify: Defuzzification algorithms to return crisp results from fuzzy sets
- fuzz.fuzzymath: The core of scikit-fuzzy, containing the majority of the most common fuzzy logic operations.
- fuzz.intervals: Interval mathematics. The restricted Dong, Shah, & Wong (DSW) methods for fuzzy set math live here.
- fuzz.image: Limited fuzzy logic image processing operations.
- fuzz.cluster: Fuzzy c-means clustering.
- fuzz.filters: Fuzzy Inference Ruled by Else-action (FIRE) filters in 1D and 2D.

The goals of scikit-fuzzy are to provide the community with a robust toolkit of independently developed and implemented fuzzy logic algorithms, filling a void in the capabilities of scientific and numerical Python, and to increase the attractiveness of scientific Python as a valid alternative to closed-source options. Scikit-fuzzy is structured similarly to scikit-learn and scikit-image, current source code is available on GitHub, and pull requests are welcome.

CONCLUSION

The fuzzy logic algorithms offered by the SCIKIT package have been studied.