SOFT COMPUTING TECHNIQUES

MASTERS OF SCIENCE (INFORMATION TECHNOLOGY)

BY

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DEPARTMENT OF INFORMATION TECHNOLOGY

MASTERS OF SCIENCE (INFORMATION TECHNOLOGY)

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DEPARTMENT OF INFORMATION TECHNOLOGY AND COMPUTER SCIENCE

CERTIFICATE

Class: M.Sc. Information Technology (Semester 1)

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This is to certify that the work entered in this journal is the work of Mr. **CHAMPANERI PARTH ASHOK** of M.Sc.IT Part 1 division Information Technology Roll No. 04 Uni. Exam No has satisfactorily completed the required number of practical and worked for the terms of the Year 2024-25 in the college laboratory as laid down by the university.

Head of the Department	External Examiner	Internal Examiner Subject teacher

Date : / / 2025 Department of IT-CS

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Practical 1a

Aim: Design a simple linear neural network model.

Code :

```
x=float(input("Enter value of x:"))
w=float(input("Enter value of weight w:"))
b=float(input("Enter value of bias b:"))
net = int(w*x+b)
if(net<0):
 out=0
elif((net>=0)&(net<=1)):
 out =net
else:
 out=1
print("net=",net)
print("output=",out)
```

Output :

```
======== RESTART: C:\Users\chaud\Desktop\SCT Practicals\Practical 1A.py ========
Enter value of x:3
Enter value of weight w:0.3
Enter value of bias b:0.5
net= 1
output= 1
```

Practical 1b

Aim: Calculate the output of neural net using both binary and bipolar sigmoidal function.

Code :

```
# number of elements as input
n = int(input("Enter number of elements : "))
# In[2]:
print("Enter the inputs")
inputs = [] # creating an empty list for inputs
# iterating till the range
for i in range(0, n):
 ele = float(input())
 inputs.append(ele) # adding the element
print(inputs)
# In[3]:
print("Enter the weights")
# creating an empty list for weights
weights = []
# iterating till the range
for i in range(0, n):
 ele = float(input())
 weights.append(ele) # adding the element
print(weights)
# In[4]:
print("The net input can be calculated as Yin = x1w1 + x2w2 + x3w3")
# In[5]:
Yin = []
for i in range(0, n):
 Yin.append(inputs[i]*weights[i])
print(round(sum(Yin),3))
```

Output:

```
========= RESTART: C:\Users\chaud\Desktop\SCT Practicals\Practical 1B.py =========
Enter number of elements : 3
Enter the inputs
0.5
0.6
0.2
[0.5, 0.6, 0.2]
Enter the weights
0.2
0.1
-0.3
[0.2, 0.1, -0.3]
The net input can be calculated as Yin = x1w1 + x2w2 + x3w3
0.1
```

Practical 2a

Aim: Generate AND/NOT function using McCulloch-Pitts neural net.

Code :

```
# enter the no of inputs
num_ip = int(input("Enter the number of inputs : "))
#Set the weights with value 1
w1 = 1
w2 = 1
print("For the ", num_ip , " inputs calculate the net input using yin = x1w1 + x2w2 ")
x1 = []
x2 = []
for j in range(0, num_ip):
 ele1 = int(input("x1 = "))
 ele2 = int(input("x2 = "))
 x1.append(ele1)
 x2.append(ele2)
print("x1 = ",x1)
print("x2 = ",x2)
n = x1 * w1
m = x2 * w2
Yin = []
for i in range(0, num_ip):
 Yin.append(n[i] + m[i])
print("Yin = ",Yin)
#Assume one weight as excitatory and the other as inhibitory, i.e.,
Yin = []
for i in range(0, num_ip):
 Yin.append(n[i] - m[i])
print("After assuming one weight as excitatory and the other as inhibitory Yin = ",Yin)
#From the calculated net inputs, now it is possible to fire the neuron for input (1, 0)
#only by fixing a threshold of 1, i.e., θ ≥ 1 for Y unit.
#Thus, w1 = 1, w2 = -1; θ ≥ 1
Y=[]
for i in range(0, num_ip):
 if(Yin[i]>=1):
  ele= 1
  Y.append(ele)
 if(Yin[i]<1):
  ele= 0
  Y.append(ele)
print("Y = ",Y)
```

Output:

```
========= RESTART: C:\Users\chaud\Desktop\SCT Practicals\Practical 2A.py =========
Enter the number of inputs : 4
For the  4  inputs calculate the net input using yin = x1w1 + x2w2
x1 = 0
x2 = 0
x1 = 0
x2 = 1
x1 = 1
x2 = 0
x1 = 1
x2 = 1
x1 =  [0, 0, 1, 1]
x2 =  [0, 1, 0, 1]
Yin =  [0, 1, 1, 2]
After assuming one weight as excitatory and the other as inhibitory Yin =  [0, -1, 1, 0]
Y =  [0, 0, 1, 0]
```

Practical 2b

Aim : Generate XOR function using McCulloch-Pitts neural net

Code:

```
import numpy as np
print('Enter weights')
w11=int(input('Weight w11='))
w12=int(input('weight w12='))
w21=int(input('Weight w21='))
w22=int(input('weight w22='))
v1=int(input('weight v1='))
v2=int(input('weight v2='))
print('Enter Threshold Value')
theta=int(input('theta='))
x1=np.array([0, 0, 1, 1])
x2=np.array([0, 1, 0, 1])
z=np.array([0, 1, 1, 0])
con=1
y1=np.zeros((4,))
y2=np.zeros((4,))
y=np.zeros((4,))
while con==1:
 zin1=np.zeros((4,))
 zin2=np.zeros((4,))
 zin1=x1*w11+x2*w21
 zin2=x1*w21+x2*w22
 print("z1",zin1)
 print("z2",zin2)
 for i in range(0,4):
  if zin1[i]>=theta:
   y1[i]=1
  else:
   y1[i]=0
   if zin2[i]>=theta:
         y2[i]=1
   else:
    y2[i]=0
 yin=np.array([])
 yin=y1*v1+y2*v2
 for i in range(0,4):
   if yin[i]>=theta:
    y[i]=1
   else:
    y[i]=0
```

```
print("yin",yin)
print('Output of Net')
y=y.astype(int)
print("y",y)
print("z",z)
if np.array_equal(y,z):
 con=0
else:
 print("Net is not learning enter another set of weights and Threshold value")
 w11=input("Weight w11=")
 w12=input("weight w12=")
 w21=input("Weight w21=")
 w22=input("weight w22=")
 v1=input("weight v1=")
 v2=input("weight v2=")
theta=input("theta=")
print("McCulloch-Pitts Net for XOR function")
print("Weights of Neuron Z1")
print(w11)
print(w21)
print("weights of Neuron Z2")
print(w12)
print(w22)
print("weights of Neuron Y")
print(v1)
print(v2)
print("Threshold value")
print(theta)
```

output:

```
======== RESTART: C:\Users\chaud\Desktop\SCT Practicals\Practical 2B.py ========
Enter weights
Weight w11=1
weight w12=-1
Weight w21=-1
weight w22=1
weight v1=1
weight v2=1
Enter Threshold Value
theta=1
z1 [ 0 -1  1  0]
z2 [ 0  1 -1  0]
yin [0. 1. 1. 0.]
Output of Net
y [0 1 1 0]
z [0 1 1 0]
theta=1
McCulloch-Pitts Net for XOR function
Weights of Neuron Z1
1
-1
weights of Neuron Z2
-1
1
weights of Neuron Y
1
1
Threshold value
1
```

Practical 3a

Aim : Write a program to implement Hebb's rule.

Code :

```
import numpy as np
#first pattern
x1=np.array([1,1,1,-1,1,-1,1,1,1])
#second pattern
x2=np.array([1,1,1,1,-1,1,1,1,1])
#initialize bais value
b=0
#define target
y=np.array([1,-1])
wtold=np.zeros((9,))
wtnew=np.zeros((9,))
wtnew=wtnew.astype(int)
wtold=wtold.astype(int)
bais=0
print("First input with target =1")
for i in range(0,9):
 wtold[i]=wtold[i]+x1[i]*y[0]
wtnew=wtold
b=b+y[0]
print("new wt =", wtnew)
print("Bias value",b)
print("Second input with target =-1")
for i in range(0,9):
 wtnew[i]=wtold[i]+x2[i]*y[1]
b=b+y[1]
print("new wt =", wtnew)
print("Bias value",b)
```

Output:

```
======== RESTART: C:\Users\chaud\Desktop\SCT Practicals\Practical 3A.py ========
First input with target =1
new wt = [ 1  1  1 -1  1 -1  1  1  1]
Bias value 1
Second input with target =-1
new wt = [ 0  0  0 -2  2 -2  0  0  0]
Bias value 0
```

Practical 3b

Aim: Write a program to implement of delta rule.

Code :

```
#supervised learning
import numpy as np
import time
np.set_printoptions(precision=2)
x=np.zeros((3,))
weights=np.zeros((3,))
desired=np.zeros((3,))
actual=np.zeros((3,))
for i in range(0,3):
 x[i]=float(input("Initial inputs:"))
for i in range(0,3):
 weights[i]=float(input("Initial weights:"))
for i in range(0,3):
 desired[i]=float(input("Desired output:"))
a=float(input("Enter learning rate:"))
actual=x*weights
print("actual",actual)
print("desired",desired)
while True:
 if np.array_equal(desired,actual):
  break #no change
 else:
  for i in range(0,3):
   weights[i]=weights[i]+a*(desired[i]-actual[i])
 actual=x*weights
 print("weights",weights)
 print("actual",actual)
 print("desired",desired)
print("*"*30)
print("Final output")
print("Corrected weights",weights)
print("actual",actual)
print("desired",desired)
```

Output:

```
======== RESTART: C:\Users\chaud\Desktop\SCT Practicals\Practical 3B.py ========
Initial inputs:1
Initial inputs:1
Initial inputs:1
Initial weights:1
Initial weights:1
Initial weights:1
Desired output:2
Desired output:3
Desired output:4
Enter learning rate:1
actual [1. 1. 1.]
desired [2. 3. 4.]
weights [2. 3. 4.]
actual [2. 3. 4.]
desired [2. 3. 4.]
******************************
Final output
Corrected weights [2. 3. 4.]
actual [2. 3. 4.]
desired [2. 3. 4.]
```

Practical 4a

Aim: Write a program for Back Propagation Algorithm

Code :

```
import numpy as np
import decimal
import math
np.set_printoptions(precision=2)
v1=np.array([0.6, 0.3])
v2=np.array([-0.1, 0.4])
w=np.array([-0.2,0.4,0.1])
b1=0.3
b2=0.5
x1=0
x2=1
alpha=0.25
print("calculate net input to z1 layer")
zin1=round(b1+ x1*v1[0]+x2*v2[0],4)
print("z1=",round(zin1,3))
print("calculate net input to z2 layer")
zin2=round(b2+ x1*v1[1]+x2*v2[1],4)
print("z2=",round(zin2,4))
print("Apply activation function to calculate output")
z1=1/(1+math.exp(-zin1))
z1=round(z1,4)
z2=1/(1+math.exp(-zin2))
z2=round(z2,4)
print("z1=",z1)
print("z2=",z2)
print("calculate net input to output layer")
yin=w[0]+z1*w[1]+z2*w[2]
print("yin=",yin)
print("calculate net output")
y=1/(1+math.exp(-yin))
print("y=",y)
fyin=y *(1- y)
dk=(1-y)*fyin
print("dk",dk)
dw1= alpha * dk * z1
dw2= alpha * dk * z2
dw0= alpha * dk
print("compute error portion in delta")
din1=dk* w[1]
din2=dk* w[2]
print("din1=",din1)
```

```
print("din2=",din2)
print("error in delta")
fzin1= z1 *(1-z1)
print("fzin1",fzin1)
d1=din1* fzin1
fzin2= z2 *(1-z2)
print("fzin2",fzin2)
d2=din2* fzin2
print("d1=",d1)
print("d2=",d2)
print("Changes in weights between input and hidden layer")
dv11=alpha * d1 * x1
print("dv11=",dv11)
dv21=alpha * d1 * x2
print("dv21=",dv21)
dv01=alpha * d1
print("dv01=",dv01)
dv12=alpha * d2 * x1
print("dv12=",dv12)
dv22=alpha * d2 * x2
print("dv22=",dv22)
dv02=alpha * d2
print("dv02=",dv02)
print("Final weights of network")
v1[0]=v1[0]+dv11
v1[1]=v1[1]+dv12
print("v=",v1)
v2[0]=v2[0]+dv21
v2[1]=v2[1]+dv22
print("v2",v2)
w[1]=w[1]+dw1
w[2]=w[2]+dw2
b1=b1+dv01
b2=b2+dv02
w[0]=w[0]+dw0
print("w=",w)
print("bias b1=",b1, " b2=",b2)
```

Output:

```
======== RESTART: C:\Users\chaud\Desktop\SCT Practicals\Practical 4A.py ========
calculate net input to z1 layer
z1= 0.2
calculate net input to z2 layer
z2= 0.9
Apply activation function to calculate output
z1= 0.5498
z2= 0.7109
calculate net input to output layer
yin= 0.09101
calculate net output
y= 0.5227368084248941
dk 0.11906907074145694
compute error portion in delta
din1= 0.04762762829658278
din2= 0.011906907074145694
error in delta
fzin1 0.24751996
fzin2 0.20552119000000002
d1= 0.011788788650865037
d2= 0.0024471217110978417
Changes in weights between input and hidden layer
dv11= 0.0
dv21= 0.0029471971627162592
dv01= 0.0029471971627162592
dv12= 0.0
dv22= 0.0006117804277744604
dv02= 0.0006117804277744604
Final weights of network
v= [0.6 0.3]
v2 [-0.1  0.4]
w= [-0.17  0.42  0.12]
bias b1= 0.30294719716271623  b2= 0.5006117804277744
```

Practical 4b

Aim : Write a Program For Error Back Propagation Algorithm (Ebpa) Learning

Code :

```
import math
a0=-1
t=-1
w10=float(input("Enter weight first network"))
b10=float(input("Enter base first network:"))
w20=float(input("Enter weight second network:"))
b20=float(input("Enter base second network:"))
c=float(input("Enter learning coefficient:"))
n1=float(w10*c+b10)
a1=math.tanh(n1)
n2=float(w20*a1+b20)
a2=math.tanh(float(n2))
e=t-a2
s2=-2*(1-a2*a2)*e
s1=(1-a1*a1)*w20*s2
w21=w20-(c*s2*a1)
w11=w10-(c*s1*a0)
b21=b20-(c*s2)
b11=b10-(c*s1)
print("The updated weight of first n/w w11=",w11)
print("The uploaded weight of second n/w w21= ",w21)
print("The updated base of first n/w b10=",b10)
print("The updated base of second n/w b20= ",b20)
```

Output:

```
======== RESTART: C:\Users\chaud\Desktop\SCT Practicals\Practical 4B.py ========
Enter weight first network 12
Enter base first network:35
Enter weight second network:23
Enter base second network:45
Enter learning coefficient:11
The updated weight of first n/w w11= 12.0
The uploaded weight of second n/w w21=  23.0
The updated base of first n/w b10= 35.0
The updated base of second n/w b20=  45.0
```

Practical 5

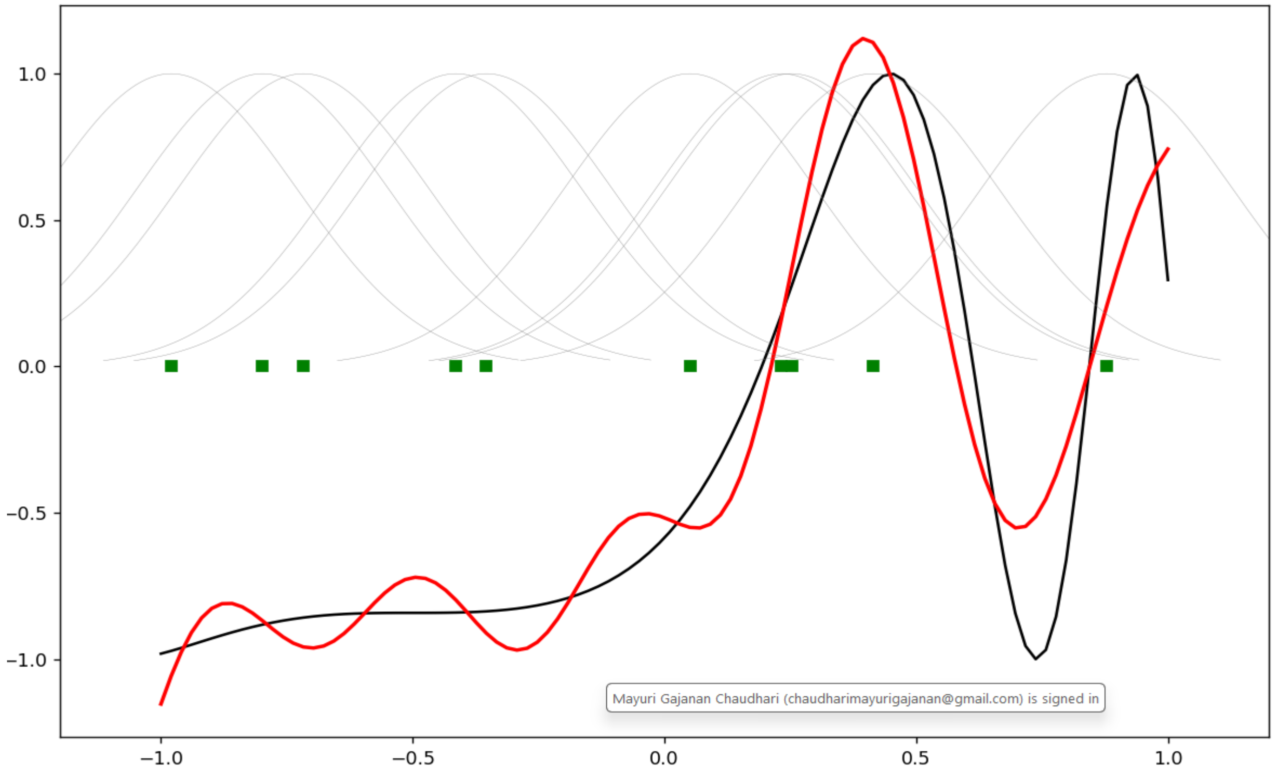
Aim: Write a program for Radial Basis function

Code:

```
from numpy import *
from scipy import *
from scipy.linalg import norm, pinv
from matplotlib import pyplot as plt
class RBF:
    def __init__(self, indim, numCenters, outdim):
        self.indim =indim
        self.outdim =outdim
        self.numCenters =numCenters
        self.centers =[random.uniform(-1, 1, indim) for i in range(numCenters)]
        self.beta =8
        self.W =random.random((self.numCenters, self.outdim))
    def _basisfunc(self, c, d):
        assert len(d) ==self.indim
        return exp(-self.beta *norm(c-d)**2)
    def _calcAct(self, X):
        G =zeros((X.shape[0], self.numCenters), float)
        for ci, c in enumerate(self.centers):
            for xi, x in enumerate(X):
                G[xi,ci] =self._basisfunc(c, x)
        return G
    def train(self, X, Y):
        """ X: matrix of dimensions n x indim
         y: column vector of dimension n x 1 """
        # choose random center vectors from training set
        rnd_idx =random.permutation(X.shape[0])[:self.numCenters]
        self.centers =[X[i,:] for i in rnd_idx]
        print("center", self.centers)
        # calculate activations of RBFs
        G =self._calcAct(X)
        print (G)
        # calculate output weights (pseudoinverse)
        self.W =dot(pinv(G), Y)
    def test(self, X):
        """ X: matrix"""
        G =self._calcAct(X)
        Y =dot(G, self.W)
        return Y
if __name__ =='__main__':
    # ----- 1D Example ------------------------------------------------
    n =100
```

```
x =mgrid[-1:1:complex(0,n)].reshape(n, 1)
# set y and add random noise
y =sin(3*(x+0.5)**3-1)
    # y += random.normal(0, 0.1, y.shape)
# rbf regression

rbf =RBF(1, 10, 1)
rbf.train(x, y)
z =rbf.test(x)
# plot original data
plt.figure(figsize=(12, 8))
plt.plot(x, y, 'k-')
# plot learned model
plt.plot(x, z, 'r-', linewidth=2)
# plot rbfs
plt.plot(rbf.centers, zeros(rbf.numCenters), 'gs')
for c in rbf.centers:
    # RF prediction lines
    cx =arange(c-0.7, c+0.7, 0.01)
    cy =[rbf._basisfunc(array([cx_]), array([c])) for cx_ in cx]
    plt.plot(cx, cy, '-', color='gray', linewidth=0.2)
plt.xlim(-1.2, 1.2)
plt.show()
```

Output:



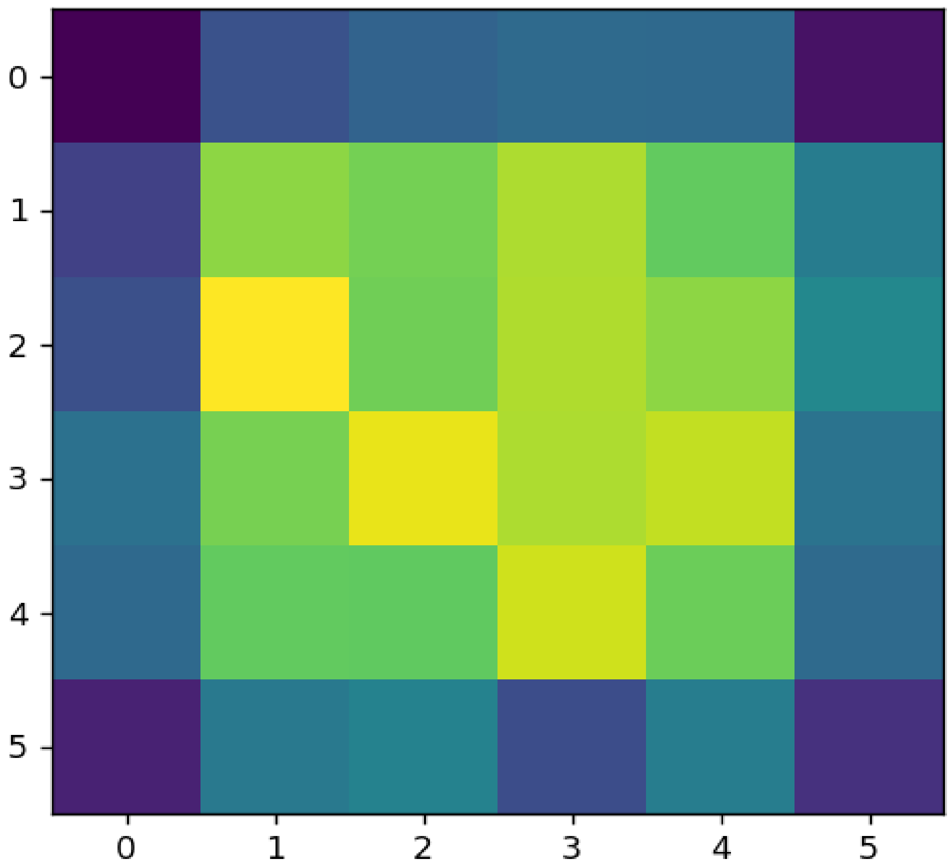
Practical 6

Aim: Write a program for Kohonen Self organizing map

Code :

```
from minisom import MiniSom
import matplotlib.pyplot as plt
data = [[ 0.80, 0.55, 0.22, 0.03],
[ 0.82, 0.50, 0.23, 0.03],
[ 0.80, 0.54, 0.22, 0.03],
[ 0.80, 0.53, 0.26, 0.03],
[ 0.79, 0.56, 0.22, 0.03],
[ 0.75, 0.60, 0.25, 0.03],
[ 0.77, 0.59, 0.22, 0.03]]
som = MiniSom(6, 6, 4, sigma=0.3, learning_rate=0.5) # initialization of 6x6 SOM
som.train_random(data, 100) # trains the SOM with 100 iterations
plt.imshow(som.distance_map())
plt.show()
```

Output:



Practical 7a

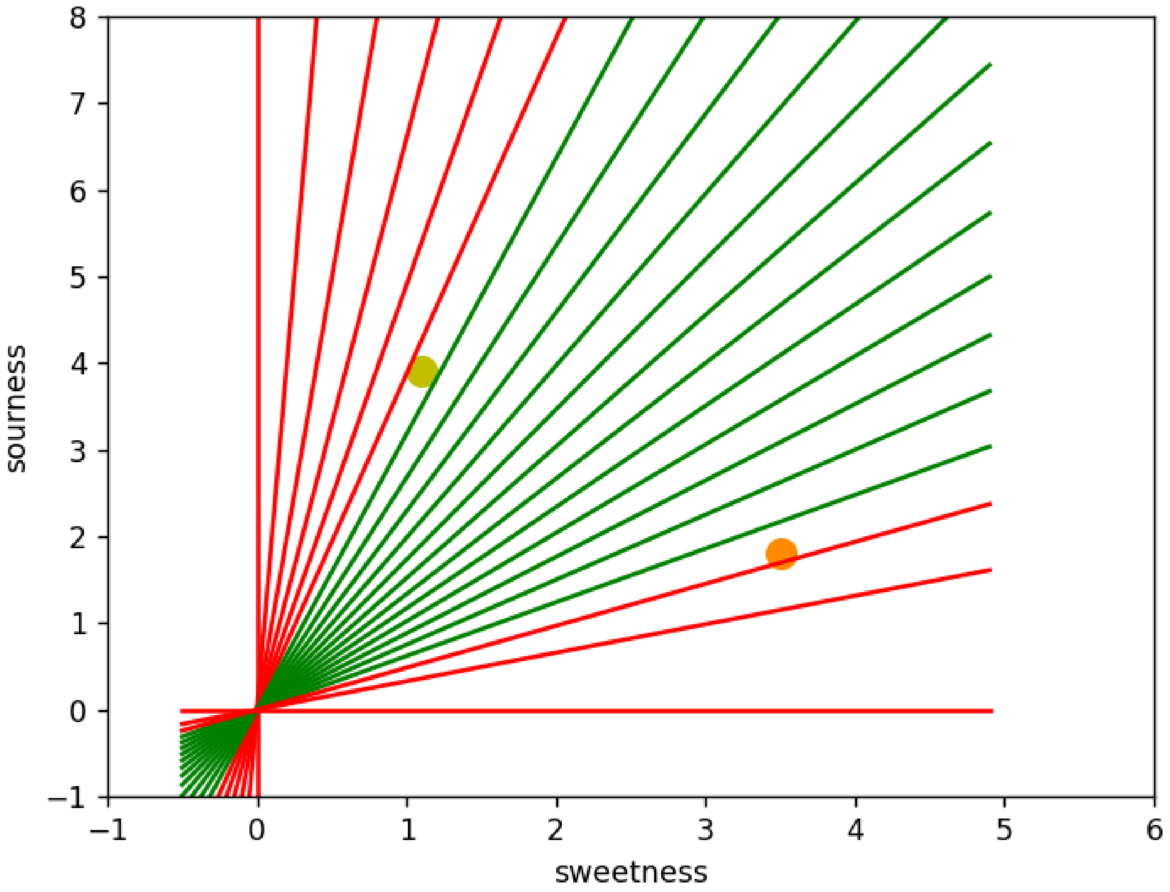
Aim: Write a program for Linear separation.

Code :

```
import numpy as np
import matplotlib.pyplot as plt
def create_distance_function(a, b, c):
 """ 0 = ax + by + c """
 def distance(x, y):
  """ returns tuple (d, pos)
   d is the distance
   If pos == -1 point is below the line,
   0 on the line and +1 if above the line
  """
  nom = a * x + b * y + c
  if nom == 0:
   pos = 0
  elif (nom<0 and b<0) or (nom>0 and b>0):
   pos = -1
  else:
   pos = 1
  return (np.absolute(nom) / np.sqrt( a ** 2 + b ** 2), pos)
 return distance
points = [ (3.5, 1.8), (1.1, 3.9) ]
fig, ax = plt.subplots()
ax.set_xlabel("sweetness")
ax.set_ylabel("sourness")
ax.set_xlim([-1, 6])
ax.set_ylim([-1, 8])
X = np.arange(-0.5, 5, 0.1)
colors = ["r", ""] # for the samples
size = 10
for (index, (x, y)) in enumerate(points):
 if index== 0:
  ax.plot(x, y, "o", color="darkorange", markersize=size)
 else:
  ax.plot(x, y, "oy", markersize=size)
  step = 0.05
for x in np.arange(0, 1+step, step):
 slope = np.tan(np.arccos(x))
 dist4line1 = create_distance_function(slope, -1, 0)
 #print("x: ", x, "slope: ", slope)
 Y = slope * X
 results = []
 for point in points:
```

```
 results.append(dist4line1(*point))
 #print(slope, results)
if (results[0][1] != results[1][1]):
 ax.plot(X, Y, "g-")
else:
 ax.plot(X, Y, "r-")
plt.show()
```

Output:



Practical 8a

Aim: Membership and Identity Operators | in, not in,

Code :

```
# Python program to illustrate
# Finding common member in list
# without using 'in' operator
# Define a function() that takes two lists
def overlapping(list1,list2):
 c=0
 d=0
 for i in list1:
  c+=1
 for i in list2:
  d+=1
 for i in range(0,c):
  for j in range(0,d):
   if(list1[i]==list2[j]):
    return 1
 return 0
list1=[1,2,3,4,6]
list2=[6,7,8,9]
if(overlapping(list1,list2)):
 print("overlapping")
else:
 print("not overlapping")
```

Output: overlapping

Practical 8 b

Aim: Membership and Identity Operators is, is not

Code :

```
# Python program to illustrate the use
# of 'is' identity operator
'''x = 5
if (type(x) is int):
 print ("true")
else:
 print ("false")'''
# Python program to illustrate the
# use of 'is not' identity operator
x = 1
if (type(x) is not int):
 print ("true")
else:
 print ("false")
```

Output: false

Practical 9a

Aim: Find the ratios using fuzzy logic

Code :

```
# Python code showing all the ratios together,
# make sure you have installed fuzzywuzzy module
from fuzzywuzzy import fuzz
from fuzzywuzzy import process
s1 = "I love fuzzysforfuzzys"
s2 = "I am loving fuzzysforfuzzys"
print ("FuzzyWuzzy Ratio:", fuzz.ratio(s1, s2))
print ("FuzzyWuzzyPartialRatio: ", fuzz.partial_ratio(s1, s2))
print ("FuzzyWuzzyTokenSortRatio: ", fuzz.token_sort_ratio(s1, s2))
print ("FuzzyWuzzyTokenSetRatio: ", fuzz.token_set_ratio(s1, s2))
print ("FuzzyWuzzyWRatio: ", fuzz.WRatio(s1, s2),'\n\n')
# for process library,
query = 'fuzzys for fuzzys'
choices = ['fuzzy for fuzzy', 'fuzzy fuzzy', 'g. for fuzzys']
print ("List of ratios: ")
print (process.extract(query, choices), '\n')
print ("Best among the above list: ",process.extractOne(query, choices))
```

Output:

```
FuzzyWuzzy Ratio: 86
FuzzyWuzzyPartialRatio:  86
FuzzyWuzzyTokenSortRatio:  86
FuzzyWuzzyTokenSetRatio:  87
FuzzyWuzzyWRatio:  86


List of ratios:
[('g. for fuzzys', 95), ('fuzzy for fuzzy', 94), ('fuzzy fuzzy', 86)]

Best among the above list:  ('g. for fuzzys', 95)
```

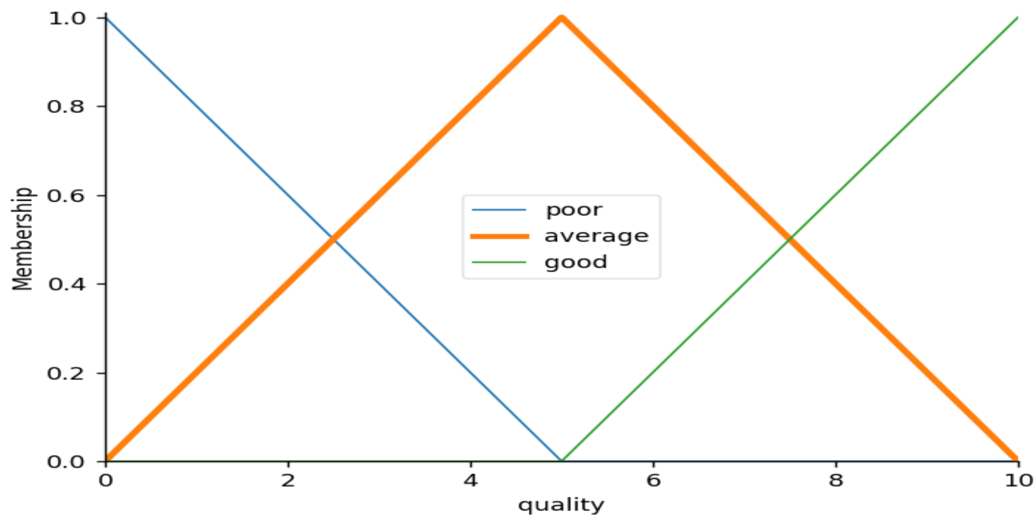
Practical 9b

Aim: Solve Tipping Problem using fuzzy logic

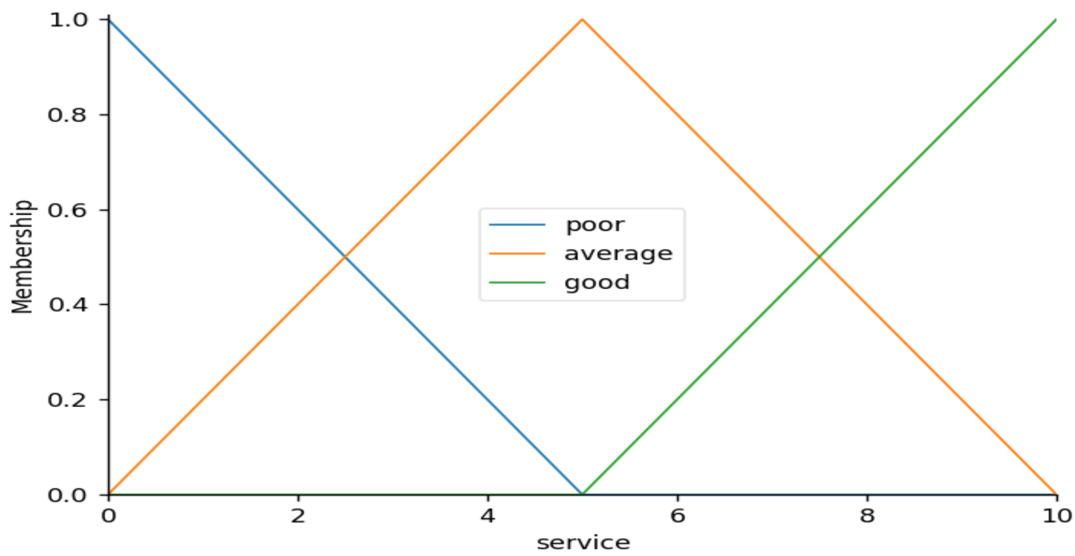
Code :

```
import numpy as np

import skfuzzy as fuzz

from skfuzzy import control as ctrl

quality = ctrl.Antecedent(np.arange(0, 11, 1), 'quality')

service = ctrl.Antecedent(np.arange(0, 11, 1), 'service')

tip = ctrl.Consequent(np.arange(0, 26, 1), 'tip')

quality.automf(3)

service.automf(3)

tip['low'] = fuzz.trimf(tip.universe, [0, 0, 13])

tip['medium'] = fuzz.trimf(tip.universe, [0, 13, 25])

tip['high'] = fuzz.trimf(tip.universe, [13, 25, 25])

quality['average'].view()

service.view()

tip.view()

rule1 = ctrl.Rule(quality['poor'] | service['poor'], tip['low'])

rule2 = ctrl.Rule(service['average'], tip['medium'])

rule3 = ctrl.Rule(service['good'] | quality['good'], tip['high'])

rule1.view()

tipping_ctrl = ctrl.ControlSystem([rule1, rule2, rule3])

tipping = ctrl.ControlSystemSimulation(tipping_ctrl)

# Pass inputs to the ControlSystem using Antecedent labels with Pythonic API

tipping.input['quality'] = 6.5

tipping.input['service'] = 9.8

# Crunch the numbers

tipping.compute()

print(tipping.output['tip'])

tip.view(sim=tipping)
```

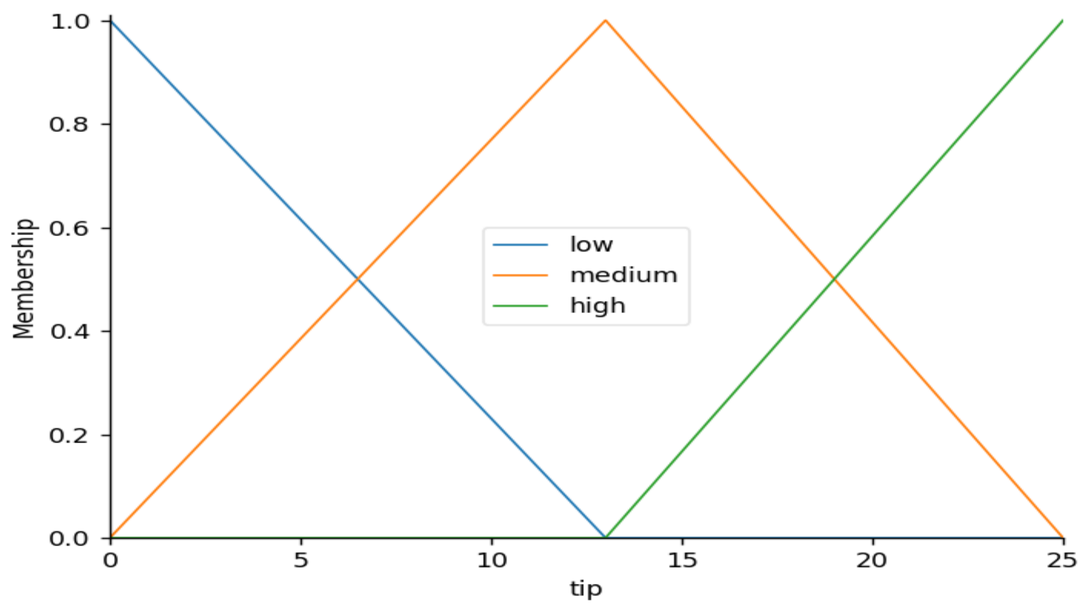
Output:



1.0
0.8
0.6
0.4
0.2
0.0
Membership
poor
average
good
0
2
4
6
8
10
quality



1.0
0.8
0.6
0.4
0.2
0.0
Membership
poor
average
good
0
2
4
6
8
10
service



1.0
0.8
0.6
0.4
0.2
0.0
Membership
low
medium
high
0
5
10
15
20
25
tip