# KALPATARU INSTITUTE OF TECHNOLOGY

**DEPARMENT OF COMPUTER SCIENCE& ENGINEERING**

## Artificial Intelligence and Machine Learning Laboratory(18CSL76)

### 1. Implement A* Search algorithm.

```
def aStarAlgo(start_node,stop_node):
    open_set=set(start_node)
    closed_set=set()
    g={}
    parents={}
    g[start_node]=0
    parents[start_node]=start_node
    while len(open_set)> 0:
        n=None
        for v in open_set:
            if n == None or g[v]+ heuristic(v) < g[n]+heuristic(n):
                n=v
        if n==stop_node or Graph_nodes[n]==None:
            pass
        else:
            for(m,weight)in get_neighbors(n):
                if m not in open_set and m not in closed_set:
                    open_set.add(m)
                    parents[m]=n
                    g[m]=g[n]+weight
                else:
                    if g[m]>g[n]+weight:
                        g[m]=g[n]+weight
                        parents[m]=n

                        if m in closed_set:
                            closed_set.remove(m)
```

```
                    open_set.add(m)
        if n==None:
            print('Path does not exist!')
            return None
        if n==stop_node:
            path=[]
            while parents[n]!=n:
                path.append(n)
                n=parents[n]

            path.append(start_node)
            path.reverse()
            print('Path found:{}'.format(path))
            return path
        open_set.remove(n)
        closed_set.add(n)
    print('Path does not exist!')
    return None
def get_neighbors(v):
    if v in Graph_nodes:
        return Graph_nodes[v]
    else:
        return None
def heuristic(n):
    H_dist={
        'A':11,
        'B':6,
        'C':99,
        'D':1,
        'E':7,
        'G':0,
    }
    return H_dist[n]
Graph_nodes={
    'A':[('B',2),('E',3)],
```

```
    'B':[('C',1),('G',9)],
    'C':None,
    'E':[('D',6)],
    'D':[('G',1)],
    }
aStarAlgo('A','G')
```

## 2. Implement AO* Search algorithm

```
class Graph:
    def __init__(self, graph, heuristicNodeList, startNode):
        self.graph=graph
        self.H=heuristicNodeList
        self.start=startNode
        self.parent={}
        self.status={}
        self.solutionGraph={}
    def applyAOStar(self):
        self.aoStar(self.start,False)

    def getNeighbors(self,v):
        return self.graph.get(v,'')

    def getStatus(self,v):
        return self.status.get(v,0)

    def setStatus(self,v,val):
        self.status[v]=val

    def getHeuristicNodeValue(self,n):
        return self.H.get(n,0)

    def setHeuristicNodeValue(self,n,value):
        self.H[n]=value

    def printSolution(self):
        print("FOR GRAPH SOLUTION,TRAVERSE THE GRAPH FROM THE
START NODE:",self.start)

print("_______________________________________________________________
______")
        print(self.solutionGraph)
```

```
print("_____________________________________________________________
______")

    def computeMinimumCostChildNodes(self,v):
        minimumCost=0
        costToChildNodeListDict={}
        costToChildNodeListDict[minimumCost]=[]
        flag=True

        for nodeInfoTupleList in self.getNeighbors(v):
            cost=0
            nodeList=[]

            for c,weight in nodeInfoTupleList:
                cost=cost+self.getHeuristicNodeValue(c)+weight
                nodeList.append(c)
            if flag==True:
                minimumCost=cost
                costToChildNodeListDict[minimumCost]=nodeList
                flag=False
            else:
                if minimumCost>cost:
                    minimumCost=cost
                    costToChildNodeListDict[minimumCost]=nodeList
        return minimumCost,costToChildNodeListDict[minimumCost]

    def aoStar(self,v,backTracking):
        print("HEURISTIC VALUES:",self.H)
        print("SOLUTION GHAPH:",self.solutionGraph)
        print("PROCESSING NODE:",v)
        print("_________________________________________")
        if self.getStatus(v)>=0:
            minimumCost,childNodeList=self.computeMinimumCostChildNodes(v)
            print(minimumCost,childNodeList)
```

```
            self.setHeuristicNodeValue(v,minimumCost)
            self.setStatus(v,len(childNodeList))
            solved=True
            for childNode in childNodeList:
                self.parent[childNode]=v
                if self.getStatus(childNode)!=-1:
                    solved=solved & False
            if solved==True:
                self.setStatus(v,-1)
                self.solutionGraph[v]=childNodeList
            if v!=self.start:
                self.aoStar(self.parent[v],True)
            if backTracking==False:
                for childNode in childNodeList:
                    self.setStatus(childNode,0)
                    self.aoStar(childNode,False)

print("Graph -1")
h1={'A':1,'B':6,'C':2,'D':12,'E':2,'F':1,'G':5,'H':7,'I':7,'J':1}
graph1={
    'A':[[('B',1),('C',1)],[('D',1)]],
    'B':[[('G',1)],[('H',1)]],
    'C':[[('J',1)]],
    'D':[[('E',1),('F',1)]],
    'G':[[('I',1)]]
}

G1=Graph(graph1, h1, 'A')
G1.applyAOStar()
G1.printSolution()
```

**3)CANDIDTE ELIMINATION ALGORITHM**

```
import numpy as np
import pandas as pd
data = pd.DataFrame(data=pd.read_csv('2aabb.csv'))
concepts = np.array(data.iloc[:,0:-1])
target = np.array(data.iloc[:,-1])
def learn(concepts, target):
    print("list of attributes")
    attributes = ['Sky','Temp','Humidity','Wind','Water','Forecast']
    print(attributes)
    num_attributes = len(attributes)
    specific_h = ['0'] * num_attributes
    print("Initial specific hypothesis\n",specific_h)
    general_h = [["?" for i in range(len(specific_h))] for i in range (len(specific_h))]
    print("Initital General hypothesis\n",general_h)
    specific_h = concepts[0].copy()
    for i, h in enumerate(concepts):
        if target[i] == "YES":
            for x in range(len(specific_h)):
                if h[x] != specific_h[x]:
                    specific_h[x] = '?'
                    general_h[x][x] = '?'
        if target[i] == "NO":
            for x in range(len(specific_h)):
                if h[x] != specific_h[x]:
                    general_h[x][x] = specific_h[x]
                else:
                    general_h[x][x] = '?'
        print("steps of Candidate Elemination Algorithem",i+1)
        print("Instance",h)
        print("S",i+1,'=',specific_h)
        print("G",i+1,'=',general_h)
    indices = [i for i, val in enumerate(general_h) if val == ['?', '?', '?', '?', '?', '?']]
    for i in indices:
        general_h.remove(['?','?','?','?','?','?'])
    return specific_h, general_h
s_final, g_final = learn(concepts, target)
print("Final Specific hypothesis", s_final, sep="\n")
print("Final General hypothesis", g_final, sep="\n")
```

**DATABASE**

| | | | | | | |
|---|---|---|---|---|---|---|
| sunny | warm | normal | strong | warm | same | YES |
| sunny | warm | high | strong | warm | same | YES |
| rainy | cold | high | strong | warm | change | NO |
| sunny | warm | high | strong | cool | change | YES |

**OUTPUT**

list of attributes
['Sky', 'Temp', 'Humidity', 'Wind', 'Water', 'Forecast']
Initial specific hypothesis
 ['0', '0', '0', '0', '0', '0']
Initital General hypothesis
 [['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]
steps of Candidate Elemination Algorithem 1
Instance ['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
S 1 = ['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
G 1 = [['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]
steps of Candidate Elemination Algorithem 2
Instance ['sunny' 'warm' 'high' 'strong' 'warm' 'same']
S 2 = ['sunny' 'warm' '?' 'strong' 'warm' 'same']
G 2 = [['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]
steps of Candidate Elemination Algorithem 3
Instance ['rainy' 'cold' 'high' 'strong' 'warm' 'change']
S 3 = ['sunny' 'warm' '?' 'strong' 'warm' 'same']
G 3 = [['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', 'same']]
steps of Candidate Elemination Algorithem 4
Instance ['sunny' 'warm' 'high' 'strong' 'cool' 'change']
S 4 = ['sunny' 'warm' '?' 'strong' '?' '?']
G 4 = [['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]
Final Specific hypothesis
['sunny' 'warm' '?' 'strong' '?' '?']
Final General hypothesis
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?']]

**4) ID3 Algorithm**

```
import math
import csv
def load_csv(filename):
    lines = csv.reader(open(filename, "r"));
    dataset = list(lines)
    headers = dataset.pop(0)
    return dataset, headers
class Node:
    def __init__(self, attribute):
        self.attribute = attribute
        self.children = []
        self.answer = ""

def subtables(data, col, delete):
    dic = {}
    coldata = [ row[col] for row in data]
    attr = list(set(coldata))

    for k in attr:
        dic[k] = []

    for y in range(len(data)):
        key = data[y][col]
        if delete:
            del data[y][col]
        dic[key].append(data[y])

    return attr, dic

def entropy(S):
    attr = list(set(S))
    if len(attr) == 1:
        return 0

    counts = [0,0]
    for i in range(2):
        counts[i] = sum( [1 for x in S if attr[i] == x] ) / (len(S) * 1.0)

    sums = 0
```

```
    for cnt in counts:
        sums += -1 * cnt * math.log(cnt, 2)
    return sums

def compute_gain(data, col):
    attValues, dic = subtables(data, col, delete=False)
    total_entropy = entropy([row[-1] for row in data])
    for x in range(len(attValues)):
        ratio = len(dic[attValues[x]]) / ( len(data) * 1.0)
        entro = entropy([row[-1] for row in dic[attValues[x]]])
        total_entropy -= ratio*entro
    return total_entropy

def build_tree(data, features):
    lastcol = [row[-1] for row in data]
    if (len(set(lastcol))) == 1:
        node=Node("")
        node.answer = lastcol[0]
        return node

    n = len(data[0])-1
    gains = [compute_gain(data, col) for col in range(n) ]

    split = gains.index(max(gains))
    node = Node(features[split])
    fea = features[:split]+features[split+1:]

    attr, dic = subtables(data, split, delete=True)
    for x in range(len(attr)):
        child = build_tree(dic[attr[x]], fea)
        node.children.append((attr[x], child))

    return node
def print_tree(node, level):
    if node.answer != "":
        print(" "*level, node.answer)
        return

    print(" "*level, node.attribute)
    for value, n in node.children:
```

```
        print(" "*(level+1), value)
        print_tree(n, level + 2)

def classify(node, x_test, features):
    if node.answer != "":
        print(node.answer)
        return

    pos = features.index(node.attribute)
    for value, n in node.children:
        if x_test[pos]==value:
            classify(n, x_test, features)

''' Main program '''
dataset, features = load_csv("3rddb.csv") # Read Tennis data
node = build_tree(dataset, features) # Build decision tree
print("The decision tree for the dataset using ID3 algorithm is ")
print_tree(node, 0)
testdata, features = load_csv("3rddb1.csv")
for xtest in testdata:
    print("The test instance : ",xtest)
    print("The predicted label : ", end="")
    classify(node,xtest,features)
```

**<u>DATABASE</u>**

**Firstdatabase**

| Outlook | Temperature | Humidity | Wind | Target |
|---|---|---|---|---|
| Sunny | Hot | High | Weak | No |
| Sunny | Hot | High | Strong | No |
| Overcast | Hot | High | Weak | yes |
| Rainy | Mild | High | Weak | yes |
| Rainy | Cool | Normal | Weak | yes |
| Rainy | Cool | Normal | Strong | No |
| Overcast | Cool | Normal | Strong | yes |
| Sunny | Mild | High | Weak | No |
| Sunny | Cool | Normal | Weak | yes |
| Rainy | Mild | Normal | Weak | yes |
| Sunny | Mild | Normal | Strong | yes |
| Overcast | Mild | High | Strong | yes |
| Overcast | Hot | Normal | Weak | yes |

| | | | | |
|---|---|---|---|---|
| Rainy | Mild | High | Strong | No |

**second database**

| Outlook | Temperature | Humidity | Wind |
|---|---|---|---|
| Rainy | Cool | Normal | Strong |
| Sunny | Mild | Normal | Strong |

**<u>OUTPUT</u>**

```
The decision tree for the dataset using ID3 algorithm is
Outlook
 Sunny
  Humidity
   High
    No
   Normal
    yes
 Overcast
  yes
 Rainy
  Wind
   Strong
    No
   Weak
    yes
The test instance :  ['Rainy', 'Cool', 'Normal', 'Strong']
The predicted label : No
The test instance :  ['Sunny', 'Mild', 'Normal', 'Strong']
The predicted label : yes
```

## 5) Backpropogation algorithm

```
import numpy as np
X=np.array(([2,9],[1,5],[3,6]),dtype=float)
y=np.array(([92],[86],[89]),dtype=float)
X=X/np.amax(X,axis=0)
y=y/100
def sigmoid(x):
   return 1/(1+np.exp(-x))
def derivatives_sigmoid(x):
   return x*(1-x)
epoch=7000
learning_rate=0.1
inputlayer_neurons=2
hiddenlayer_neurons=3
output_neurons=1
wh=np.random.uniform(size=(inputlayer_neurons,hiddenlayer_neurons))
bh=np.random.uniform(size=(1,hiddenlayer_neurons))
wo=np.random.uniform(size=(hiddenlayer_neurons,output_neurons))
bo=np.random.uniform(size=(1,output_neurons))
for i in range(epoch):
   net_h=np.dot(X,wh)+bh
   sigma_h=sigmoid(net_h)
   net_o=np.dot(sigma_h,wo)+ bo
   output = sigmoid(net_o)
   deltaK =(y-output)*derivatives_sigmoid(output)
   deltaH = deltaK.dot(wo.T)*derivatives_sigmoid(sigma_h)
   wo = wo+sigma_h.T.dot(deltaK)*learning_rate
   wh = wh+X.T.dot(deltaH)*learning_rate
print("Input: \n"+str(X))
print("Actual Output: \n"+str(y))
print("Predicted Output: \n",output)
```

**OUTPUT**

```
Input:
[[0.66666667 1.        ]
 [0.33333333 0.55555556]
 [1.         0.66666667]]
Actual Output:
[[0.92]
```

```
 [0.86]
 [0.89]]
Predicted Output:
 [[0.89504105]
 [0.88132429]
 [0.89368279]]
```

**6)Naïve Bayesin Classifier Calculate accuracy**

```
import numpy as np
import math
import csv
import pdb
def read_data(filename):

    with open(filename,'r') as csvfile:
        datareader = csv.reader(csvfile)
        metadata = next(datareader)
        traindata=[]
        for row in datareader:
            traindata.append(row)

    return (metadata, traindata)

def splitDataset(dataset, splitRatio):
    trainSize = int(len(dataset) * splitRatio)
    trainSet = []
    testset = list(dataset)
    i=0
    while len(trainSet) < trainSize:
        trainSet.append(testset.pop(i))
    return [trainSet, testset]

def classify(data,test):

    total_size = data.shape[0]
    print("training data size=",total_size)
    print("test data size=",test.shape[0])

    countYes = 0
    countNo = 0
    probYes = 0
    probNo = 0
    print("target    count    probability")

    for x in range(data.shape[0]):
        if data[x,data.shape[1]-1] == 'yes':
            countYes +=1
```

```
    if data[x,data.shape[1]-1] == 'no':
        countNo +=1

probYes=countYes/total_size
probNo= countNo / total_size

print('Yes',"\t",countYes,"\t",probYes)
print('No',"\t",countNo,"\t",probNo)


prob0 =np.zeros((test.shape[1]-1))
prob1 =np.zeros((test.shape[1]-1))
accuracy=0
print("instance prediction  target")

for t in range(test.shape[0]):
    for k in range (test.shape[1]-1):
        count1=count0=0
        for j in range (data.shape[0]):
            #how many times appeared with no
            if test[t,k] == data[j,k] and data[j,data.shape[1]-1]=='no':
                count0+=1
            #how many times appeared with yes
            if test[t,k]==data[j,k] and data[j,data.shape[1]-1]=='yes':
                count1+=1
        prob0[k]=count0/countNo
        prob1[k]=count1/countYes

    probno=probNo
    probyes=probYes
    for i in range(test.shape[1]-1):
        probno=probno*prob0[i]
        probyes=probyes*prob1[i]
    if probno>probyes:
        predict='no'
    else:
        predict='yes'

    print(t+1,"\t",predict,"\t    ",test[t,test.shape[1]-1])
    if predict == test[t,test.shape[1]-1]:
```

```
            accuracy+=1
    final_accuracy=(accuracy/test.shape[0])*100
    print("accuracy",final_accuracy,"%")
    return

metadata,traindata= read_data("5thdb.csv")
splitRatio=0.6
trainingset, testset=splitDataset(traindata, splitRatio)
training=np.array(trainingset)
testing=np.array(testset)

classify(training,testing)
```

**DATABASE**

| outlook | temp | humidity | windy | play |
|---|---|---|---|---|
| sunny | hot | high | Weak | no |
| sunny | hot | high | Strong | no |
| overcast | hot | high | Weak | yes |
| rainy | mild | high | Weak | yes |
| rainy | cool | normal | Weak | yes |
| rainy | cool | normal | Strong | no |
| overcast | cool | normal | Strong | yes |
| sunny | mild | high | Weak | no |
| sunny | cool | normal | Weak | yes |
| rainy | mild | normal | Weak | yes |
| sunny | mild | normal | Strong | yes |
| overcast | mild | high | Strong | yes |
| overcast | hot | normal | Weak | yes |
| rainy | mild | high | Strong | no |

**OUTPUT**

```
training data size= 8
test data size= 6
target   count   probability
Yes      4       0.5
No       4       0.5
instance prediction  target
1        no          yes
2        yes         yes
3        no          yes
```

| | | |
|---|---|---|
| 4 | yes | yes |
| 5 | yes | yes |
| 6 | no | no |

accuracy 66.66666666666666 %

**7)EM algorithm and k-means algorithm**

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.cluster import KMeans
from sklearn.mixture import GaussianMixture
import pdb
df1 = pd.read_csv("8thdb.csv")
print(df1)
f1 = df1['Distance_Feature'].values
f2 = df1['Speeding_Feature'].values

X = np.matrix(list(zip(f1,f2)))
plt.plot(1)
plt.subplot(511)
plt.xlim([0, 100])
plt.ylim([0, 50])
plt.title('Dataset')
plt.ylabel('speeding_feature')
plt.xlabel('distance_feature')
plt.scatter(f1,f2)

colors = ['b', 'g', 'r']
markers = ['o', 'v', 's']
# create new plot and data for K- means algorithm
plt.plot(2)
ax=plt.subplot(513)
kmeans_model = KMeans(n_clusters=3).fit(X)

for i, l in enumerate(kmeans_model.labels_):
   plt.plot(f1[i], f2[i], color=colors[l],marker=markers[l])

plt.xlim([0, 100])
plt.ylim([0, 50])
plt.title('K- Means')
plt.ylabel('speeding_feature')
plt.xlabel('distance_feature')
```

```
# create new plot and data for gaussian mixture
plt.plot(3)
plt.subplot(515)
gmm=GaussianMixture(n_components=3).fit(X)
labels= gmm.predict(X)

for i, l in enumerate(labels):
    plt.plot(f1[i], f2[i], color=colors[l], marker=markers[l])

plt.xlim([0, 100])
plt.ylim([0, 50])
plt.title('Gaussian Mixture')
plt.ylabel('speeding_feature')
plt.xlabel('distance_feature')


plt.show()
pdb.set_trace()
```

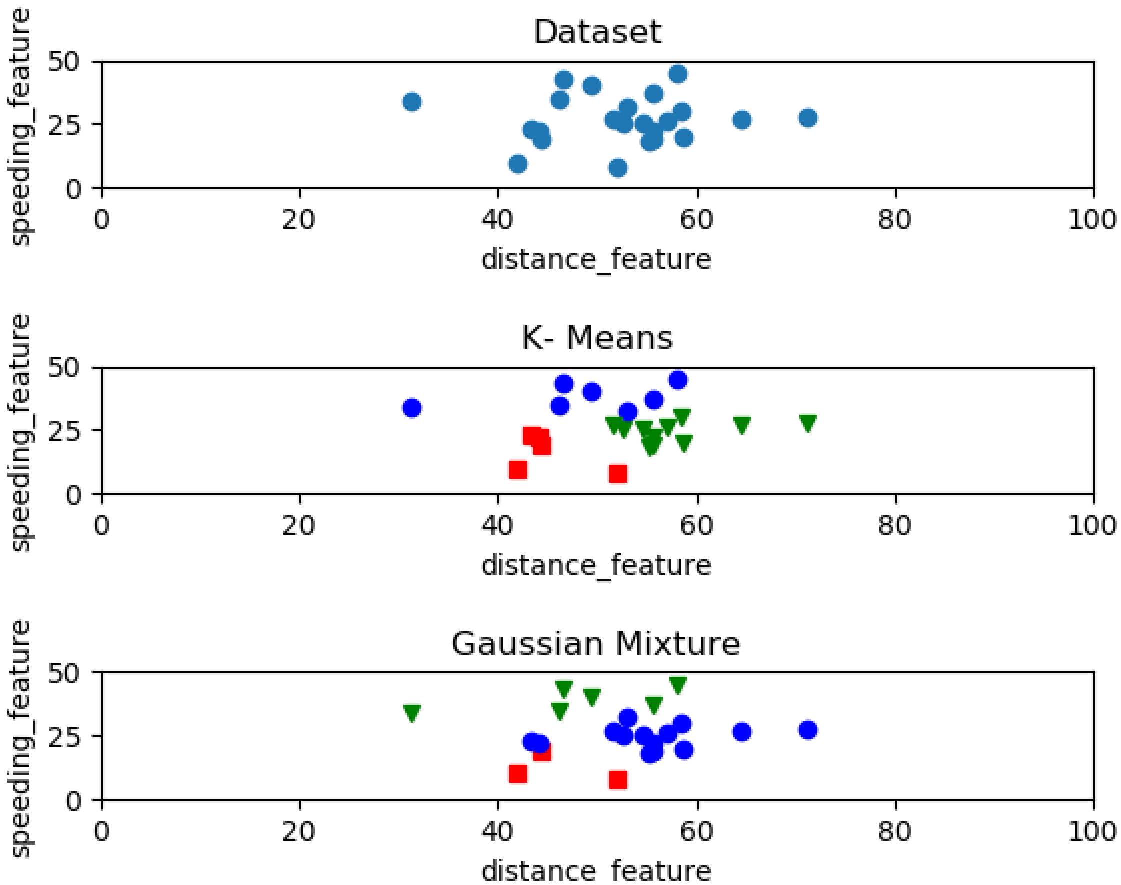
**DATABASE**

| Driver_ID | Distance_Feature | Speeding_Feature |
|---|---|---|
| 3.42E+09 | 71.24 | 28 |
| 3.42E+09 | 52.53 | 25 |
| 3.42E+09 | 64.54 | 27 |
| 3.42E+09 | 55.69 | 22 |
| 3.42E+09 | 54.58 | 25 |
| 3.42E+09 | 41.91 | 10 |
| 3.42E+09 | 58.64 | 20 |
| 3.42E+09 | 52.02 | 8 |
| 3.42E+09 | 31.25 | 34 |
| 3.42E+09 | 44.31 | 19 |
| 3.42E+09 | 49.35 | 40 |
| 3.42E+09 | 58.07 | 45 |
| 3.42E+09 | 44.22 | 22 |
| 3.42E+09 | 55.73 | 19 |
| 3.42E+09 | 46.63 | 43 |
| 3.42E+09 | 52.97 | 32 |
| 3.42E+09 | 46.25 | 35 |
| 3.42E+09 | 51.55 | 27 |

| | | |
|---|---|---|
| 3.42E+09 | 57.05 | 26 |
| 3.42E+09 | 58.45 | 30 |
| 3.42E+09 | 43.42 | 23 |
| 3.42E+09 | 55.68 | 37 |
| 3.42E+09 | 55.15 | 18 |

**OUTPUT**

| | Driver_ID | Distance_Feature | Speeding_Feature |
|---|---|---|---|
| 0 | 3423311935 | 71.24 | 28 |
| 1 | 3423313212 | 52.53 | 25 |
| 2 | 3423313724 | 64.54 | 27 |
| 3 | 3423311373 | 55.69 | 22 |
| 4 | 3423310999 | 54.58 | 25 |
| 5 | 3423313857 | 41.91 | 10 |
| 6 | 3423312432 | 58.64 | 20 |
| 7 | 3423311434 | 52.02 | 8 |
| 8 | 3423311328 | 31.25 | 34 |
| 9 | 3423312488 | 44.31 | 19 |
| 10 | 3423311254 | 49.35 | 40 |
| 11 | 3423312943 | 58.07 | 45 |
| 12 | 3423312536 | 44.22 | 22 |
| 13 | 3423311542 | 55.73 | 19 |
| 14 | 3423312176 | 46.63 | 43 |
| 15 | 3423314176 | 52.97 | 32 |
| 16 | 3423314202 | 46.25 | 35 |
| 17 | 3423311346 | 51.55 | 27 |
| 18 | 3423310666 | 57.05 | 26 |
| 19 | 3423313527 | 58.45 | 30 |
| 20 | 3423312182 | 43.42 | 23 |
| 21 | 3423313590 | 55.68 | 37 |
| 22 | 3423312268 | 55.15 | 18 |


Dataset
K- Means
Gaussian Mixture
speeding_feature
distance_feature
0
25
50
0
20
40
60
80
100

**8) K Nearest Neighnour Algorithm**

```
from sklearn import datasets
iris=datasets.load_iris()
iris_data=iris.data
iris_labels=iris.target

from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(iris_data,iris_labels,test_size=0.30)

from sklearn.neighbors import KNeighborsClassifier
classifier=KNeighborsClassifier(n_neighbors=5)
classifier.fit(x_train,y_train)
y_pred=classifier.predict(x_test)

from sklearn.metrics import classification_report,confusion_matrix
print('Confusion matrix is as follows')
print(confusion_matrix(y_test,y_pred))
print('Accuracy Matrics')
print(classification_report(y_test,y_pred))
```

**OUTPUT**

```
Confusion matrix is as follows
[[13  0  0]
 [ 0 16  0]
 [ 0  0 16]]
Accuracy Matrics
             precision    recall  f1-score   support

          0       1.00      1.00      1.00        13
          1       1.00      1.00      1.00        16
          2       1.00      1.00      1.00        16

avg / total       1.00      1.00      1.00        45
```

## 9) LOCALLY WEIGHTED REGRESSION ALGORITHM

```
import operator
from os import listdir
import matplotlib
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np1
import numpy.linalg as np
from scipy.stats.stats import pearsonr
import pdb
def kernel(point, xmat, k):
    m,n=np1.shape(xmat)  #size of matrix m
    weights=np1.mat(np1.eye(m)) #np.eye returns mat with 1 in the diagonal
    for j in range(m):
        diff=point-xmat[j]
        weights[j,j]=np1.exp(diff*diff.T/(-2.0*k**2))
    return weights

def localWeight(point,xmat,ymat,k):
    wei=kernel(point,xmat,k)
    W=(xmat.T*(wei*xmat)).I*(xmat.T*(wei*ymat.T))
    return W

def localWeightRegression(xmat,ymat,k):
    row,col=np1.shape(xmat) #return 244 rows and  2 columns
    ypred=np1.zeros(row)
    for i in range(row):
        ypred[i]=xmat[i]*localWeight(xmat[i],xmat,ymat,k)
    return ypred

data=pd.read_csv('10thdb.csv')
bill=np1.array(data.total_bill)
tip=np1.array(data.tip)

mbill=np1.mat(bill)
mtip=np1.mat(tip)

mbillMatCol=np1.shape(mbill)[1] # 1 for vertical i.e columns
onesArray=np1.mat(np1.ones(mbillMatCol))
```

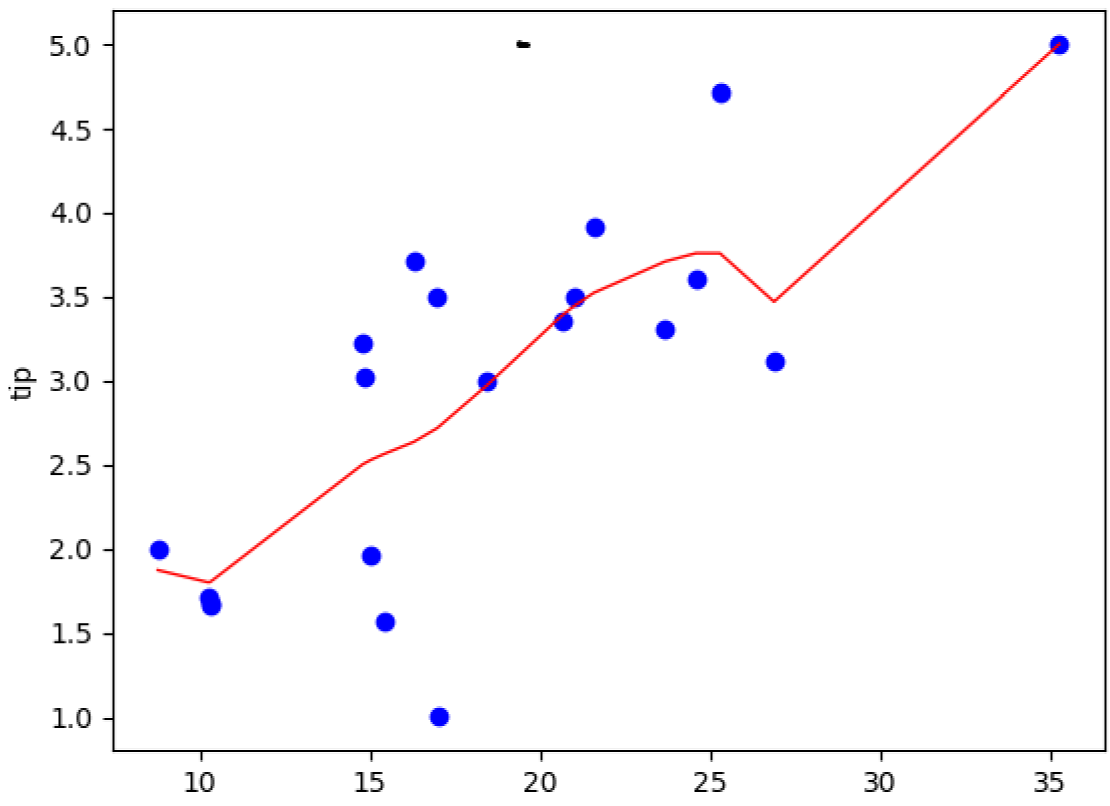
```
xmat=np1.hstack((onesArray.T,mbill.T)) #hstack concate horizontal lists it takes one value from the fist and one from the second
print(xmat)

ypred=localWeightRegression(xmat,mtip,2)
SortIndex=xmat[ :,1].argsort(0) #argsort take the index of each and sort them according to the orginal value
xsort=xmat[SortIndex][:,0]

fig= plt.figure()
ax=fig.add_subplot(1,1,1)
ax.scatter(bill,tip,color='blue')
ax.plot(xsort[:,1],ypred[SortIndex],color='red',linewidth=1)
plt.xlabel('Total bill')
plt.ylabel('tip')
plt.show();
pdb.set_trace()
```

**DATABASE**

| total_bill | tip |
|---|---|
| 16.99 | 1.01 |
| 10.34 | 1.66 |
| 21.01 | 3.5 |
| 23.68 | 3.31 |
| 24.59 | 3.61 |
| 25.29 | 4.71 |
| 8.77 | 2 |
| 26.88 | 3.12 |
| 15.04 | 1.96 |
| 14.78 | 3.23 |
| 10.27 | 1.71 |
| 35.26 | 5 |
| 15.42 | 1.57 |
| 18.43 | 3 |
| 14.83 | 3.02 |
| 21.58 | 3.92 |
| 10.33 | 1.67 |
| 16.29 | 3.71 |
| 16.97 | 3.5 |
| 20.65 | 3.35 |

**OUTPUT**

```
[[ 1.   16.99]
 [ 1.   10.34]
 [ 1.   21.01]
 [ 1.   23.68]
 [ 1.   24.59]
 [ 1.   25.29]
 [ 1.    8.77]
 [ 1.   26.88]
 [ 1.   15.04]
 [ 1.   14.78]
 [ 1.   10.27]
 [ 1.   35.26]
 [ 1.   15.42]
 [ 1.   18.43]
 [ 1.   14.83]
 [ 1.   21.58]
 [ 1.   10.33]
 [ 1.   16.29]
 [ 1.   16.97]
 [ 1.   20.65]]
```



tip
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
10
15
20
25
30
35