VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

Machine Learning
(20CS6PCMAL)

Submitted by

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in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)
BENGALURU-560019

May-2022 to July-2022

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CERTIFICATE

This is to certify that the Lab work entitled "Machine Learning" carried out by N.Akhilesh Kumar Dutt **(1BM19CS092),** who is bonafide student of **B. M. S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year2022. The Lab report has been approved as it satisfies the academic requirements in respect of a **Machine Learning (20CS6PCMAL)** work prescribed for the said degree.

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Course Outcome

CO1	Ability to apply the different learning algorithms.
CO2	Ability to analyze the learning techniques for given dataset.
CO3	Ability to design a model using machine learning to solve a problem.
CO4	Ability to conduct practical experiments to solve problems using appropriate machine learning techniques

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples.

```
import numpy as np
import pandas as pd
data=pd.read_csv
("testdemo.csv")
data
d = np.array(data)[:,:-1]
print("\n The attributes are: ",d)
target = np.array(data)[:,-1]
print("\n The target is: ",target)
def findS(c,t):
    for i, val in enumerate(t):
        if val == "Yes":
            specific_hypothesis = c[i].copy()
            break

    for i, val in enumerate(c):
        if t[i] == "Yes":
            for x in range(len(specific_hypothesis)):
                if val[x] != specific_hypothesis[x]:
                    specific_hypothesis[x] = '?'
                else:
                    pass

    return specific_hypothesis

print("\n The final hypothesis is:",findS(d,target))
```

Dataset:

	Sky	AirTemp	Humidity	Wind	Water	Forecast	EnjoySport
2	Sunny	Warm	Normal	Strong	Warm	Same	Yes
3	Sunny	Warm	High	Strong	Warm	Same	Yes
4	Rainy	Cold	High	Strong	Warm	Change	No
5	Sunny	Warm	High	Strong	Cool	Change	Yes

Output:

The final hypothesis is: ['?' 'Sunny' '?' 'Yes' '?' '?']

2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.

```
import numpy as np
import pandas as pd
data=pd.DataFrame(data=pd.read_csv('candidate_elimina
tion.csv'))
data
concepts=np.array(data.iloc[:,0:-1])
print("The attributes are : ",concepts)
target=np.array(data.iloc[:,-1])
print ("\n The target is =",target)
def learn(concepts,target):
    specific_h=concepts[0].copy()
    print("\n Initialization of specfic_h and generalization")
    print(specific_h)
    general_h = [["?" for i in range(len(specific_h))] for i in range(len(specific_h))]
    print(general_h)

    for i,h in enumerate(concepts):
        if target[i] =="yes":
            print("If instance is positive")
            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 elimination algorithm",i+1)
        print(specific_h)
        print(general_h)
        print("\n")
        print("\n")
    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_h:",s_final,sep="\n")
print("Final General_h:",g_final,sep="\n")
```

Dataset:

1	Sky	AirTemp	Humidity	Wind	Water	Forecast	EnjoySport
2	Sunny	Warm	Normal	Strong	Warm	Same	Yes
3	Sunny	Warm	High	Strong	Warm	Same	Yes
4	Rainy	Cold	High	Strong	Warm	Change	No
5	Sunny	Warm	High	Strong	Cool	Change	Yes

Output:

```
[['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
 ['sunny' 'warm' 'high' 'strong' 'warn' 'same']
 ['rainy' 'cold' 'high' 'strong' 'warm' 'change']
 ['sunny' 'warm' 'high' 'strong' 'cool' 'change']]
['yes' 'yes' 'no' 'yes']
initialization of specific_h and general_h
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?',
'?', '?'], ['?', '?', '?', '?', '?', '?']]
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' '?' 'same']
['sunny' 'warm' '?' 'strong' '?' 'same']
 steps of Candidate Elimination Algorithm 3
['sunny' 'warm' '?' 'strong' '?' 'same']
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?',
'?', '?', '?'], ['?', '?', '?', '?', '?', '?']]
['sunny' 'warm' '?' 'strong' '?' 'same']
['sunny' 'warm' '?' 'strong' '?' 'same']
['sunny' 'warm' '?' 'strong' '?' 'same']
['sunny' 'warm' '?' 'strong' '?' 'same']
['sunny' 'warm' '?' 'strong' '?' '?']
['sunny' 'warm' '?' 'strong' '?' '?']
Final Specific_h:
['sunny' 'warm' '?' 'strong' '?' '?']
Final General_h:
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]
```

3. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

```
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))

    counts=[0]*len(attr)
    r=len(data)
    c=len(data[0])
    for x in range(len(attr)):
        for y in range(r):
            if data[y][col]==attr[x]:
                counts[x]+=1
    for x in range(len(attr)):
        dic[attr[x]]=[[0 for i in range(c)] for j in range(counts[x])]
        pos=0
        for y in range(r):
            if data[y][col]==attr[x]:
                if delete:
                    del data[y][col]
                dic[attr[x]][pos]=data[y]
                pos+=1
    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):
    attr,dic = subtables(data,col,delete=False)

    total_size=len(data)
    entropies=[0]*len(attr)
    ratio=[0]*len(attr)

    total_entropy=entropy([row[-1] for row in data])
    for x in range(len(attr)):
        ratio[x]=len(dic[attr[x]])/(total_size*1.0)
        entropies[x]=entropy([row[-1] for row in dic[attr[x]]])
        total_entropy-=ratio[x]*entropies[x]
    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=[0]*n
    for col in range(n):
        gains[col]=compute_gain(data,col)
    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("id3.csv")
node1=build_tree(dataset,features)

print("The decision tree for the dataset using ID3 algorithm is")
print_tree(node1,0)
testdata,features=load_csv("id3_test_1.csv")
for xtest in testdata:
    print("The test instance:",xtest)
    print("The label for test instance:",end=" ")
    classify(node1,xtest,features)
```

Dataset:

Outlook	Temperature	Humidity	Wind	Answer
sunny	hot	high	weak	no
sunny	hot	high	strong	no
overcast	hot	high	weak	yes
rain	mild	high	weak	yes
rain	cool	normal	weak	yes
rain	cool	normal	strong	no
overcast	cool	normal	strong	yes
sunny	mild	high	weak	no
sunny	cool	normal	weak	yes
rain	mild	normal	weak	yes
sunny	mild	normal	strong	yes
overcast	mild	high	strong	yes
overcast	hot	normal	weak	yes
rain	mild	high	strong	no

Output:

```
The decision tree for the dataset using ID3 algorithm is
 Outlook
   rain
     Wind
       weak
         yes
       strong
         no
   sunny
     Humidity
       normal
         yes
       high
         no
   overcast
     yes
The test instance: ['rain', 'cool', 'normal', 'strong']
The label for test instance:   no
The test instance: ['sunny', 'mild', 'normal', 'strong']
The label for test instance:   yes
```

4. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import GaussianNB
from sklearn import metrics
df = pd.read_csv("diabetes.csv")
col_names = ['num_preg', 'glucose_conc', 'diastolic_bp', 'thickness', 'insulin', 'bmi', 'diab_pred', 'age']
predicted_class = ['diabetes']
X = df[col_names].values
y = df[predicted_class].values
print(df.head)
xtrain,xtest,ytrain,ytest=train_test_split(X,y,test_size=0.4)

print ('\n the total number of Training Data :',ytrain.shape)
print ('\n the total number of Test Data :',ytest.shape)
clf = GaussianNB().fit(xtrain,ytrain.ravel())
predicted = clf.predict(xtest)
predictTestData= clf.predict([[6,148,72,35,0,33.6,0.627,50]])
print('\n Confusion matrix')
print(metrics.confusion_matrix(ytest,predicted))
print('\n Accuracy of the classifier is',metrics.accuracy_score(ytest,predicted))
print('\n The value of Precision', metrics.precision_score(ytest,predicted))
print('\n The value of Recall', metrics.recall_score(ytest,predicted))
print("Predicted Value for individual Test Data:", predictTestDat
```

Dataset:

	num_preg	glucose_conc	diastolic_bp	thickness	insulin	bmi	diab_pred	age	diabetes
0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1
3	1	89	66	23	94	28.1	0.167	21	0
4	0	137	40	35	168	43.1	2.288	33	1
...	...	...	...	...	...	...	...	...	...
140	3	128	78	0	0	21.1	0.268	55	0
141	5	106	82	30	0	39.5	0.286	38	0
142	2	108	52	26	63	32.5	0.318	22	0
143	10	108	66	0	0	32.4	0.272	42	1
144	4	154	62	31	284	32.8	0.237	23	0

Output:

```
 Confusion matrix
[[166  37]
 [ 44  61]]

 Accuracy of the classifier is 0.737012987012987

 The value of Precision 0.6224489795918368

 The value of Recall 0.580952380952381
Predicted Value for individual Test Data: [1]
```

5. Implement the Linear Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
dataset = pd.read_csv('salary_data.csv')
X = dataset.iloc[:, :-1].values
y = dataset.iloc[:, 1].values
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=
# Fitting Simple Linear Regression to the Training set
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train, y_train)
# Predicting the Test set results
y_pred = regressor.predict(X_test)
# Visualizing the Training set results
viz_train = plt
viz_train.scatter(X_train, y_train, color='red')
viz_train.plot(X_train, regressor.predict(X_train), color='blue')
viz_train.title('Salary VS Experience (Training set)')
viz_train.xlabel('Year of Experience')
viz_train.ylabel('Salary')
viz_train.show()
# Visualizing the Test set results
viz_test = plt
viz_test.scatter(X_test, y_test, color='red')
viz_test.plot(X_train, regressor.predict(X_train), color='blue')
viz_test.title('Salary VS Experience (Test set)')
viz_test.xlabel('Year of Experience')
viz_test.ylabel('Salary')
viz_test.show()
regressor.score(X_train,y_train)
print(regressor.score(X_test,y_test))
```

Dataset:

	YearsExperience	Salary
2	1.1	39343
3	1.3	46205
4	1.5	37731
5	2.0	43525
6	2.2	39891
7	2.9	56642
8	3.0	60150
9	3.2	54445
10	3.2	64445
11	3.7	57189
12	3.9	63218
13	4.0	55794
14	4.0	56957
15	4.1	57081
16	4.5	61111
17	4.9	67938

Output:


Salary VS Experience (Training set)
Salary
Year of Experience
120000
100000
80000
60000
40000
2
4
6
8
10


Salary VS Experience (Test set)
Salary
Year of Experience
120000
100000
80000
60000
40000
2
4
6
8
10

6. Write a program to construct a Bayesian network considering training data.Use this model to make predictions.

```
import numpy as np
import pandas as pd
import csv
from pgmpy.estimators import MaximumLikelihoodEstimator
from pgmpy.models import BayesianModel
from pgmpy.inference import VariableElimination

heartDisease = pd.read_csv('/content/heart.csv')

heartDisease = heartDisease.replace('?',np.nan)

print('Sample instances from the dataset are given below')

print(heartDisease.head())

model = BayesianModel([('age','heartdisease'),('sex','heartdisease'),('exang','heartdisease'),  ('cp','heartdisease'),
        ('heartdisease','restecg'),('heartdisease','chol')])

print('\n Learning CPD using Maximum likelihood estimators')

model.fit(heartDisease,estimator=MaximumLikelihoodEstimator)

 print('\n Inferencing with Bayesian Network:')

HeartDiseasetest_infer = VariableElimination(model)

print('\n 1.Probability of HeartDisease given evidence= restecg :1')

q1=HeartDiseasetest_infer.query(variables=['heartdisease'],evidence={'restecg':1})

print(q1)
```

Dataset:

age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	heartdisease
63	1	1	145	233	1	2	150	0	2.3	3	0	6	0
67	1	4	160	286	0	2	108	1	1.5	2	3	3	2
67	1	4	120	229	0	2	129	1	2.6	2	2	7	1
37	1	3	130	250	0	0	187	0	3.5	3	0	3	0
41	0	2	130	204	0	2	172	0	1.4	1	0	3	0
56	1	2	120	236	0	0	178	0	0.8	1	0	3	0
62	0	4	140	268	0	2	160	0	3.6	3	2	3	3
57	0	4	120	354	0	0	163	1	0.6	1	0	3	0
63	1	4	130	254	0	2	147	0	1.4	2	1	7	2
53	1	4	140	203	1	2	155	1	3.1	3	0	7	1
57	1	4	140	192	0	0	148	0	0.4	2	0	6	0
56	0	2	140	294	0	2	153	0	1.3	2	0	3	0
56	1	3	130	256	1	2	142	1	0.6	2	1	6	2
44	1	2	120	263	0	0	173	0	0	1	0	7	0
52	1	3	172	199	1	0	162	0	0.5	1	0	7	0
57	1	3	150	168	0	0	174	0	1.6	1	0	3	0
48	1	2	110	229	0	0	168	0	1	3	0	7	1
54	1	4	140	239	0	0	160	0	1.2	1	0	3	0
48	0	3	130	275	0	0	139	0	0.2	1	0	3	0
49	1	2	130	266	0	0	171	0	0.6	1	0	3	0
64	1	1	110	211	0	2	144	1	1.8	2	0	3	0
58	0	1	150	283	1	2	162	0	1	1	0	3	0
58	1	2	120	284	0	2	160	0	1.8	2	0	3	1
58	1	3	132	224	0	2	173	0	3.2	1	2	7	3
60	1	4	130	206	0	2	132	1	2.4	2	2	7	4
50	0	3	120	219	0	0	158	0	1.6	2	0	3	0
58	0	3	120	340	0	0	172	0	0	1	0	3	0
66	0	1	150	226	0	0	114	0	2.6	3	0	3	0

Output:

1.Probability of HeartDisease given evidence= restecg :1

Finding Elimination Order: : 100% 4/4 [00:02<00:00, 1.35it/s]

Eliminating: sex: 100% 4/4 [00:00<00:00, 72.57it/s]

heartdisease	phi(heartdisease)
heartdisease(0)	0.1012
heartdisease(1)	0.0000
heartdisease(2)	0.2392
heartdisease(3)	0.2015
heartdisease(4)	0.4581

2. Probability of HeartDisease given evidence= cp

Finding Elimination Order: : 100% 3/3 [00:00<00:00, 60.16it/s]

Eliminating: exang: 100% 3/3 [00:00<00:00, 91.15it/s]

Heartdisease	phi(Heartdisease)
Heartdisease(0)	0.3610
Heartdisease(1)	0.2159
Heartdisease(2)	0.1373
Heartdisease(3)	0.1537
Heartdisease(4)	0.1321

7. Apply K-Means algorithm to cluster a set of data stored in a .CSV file.

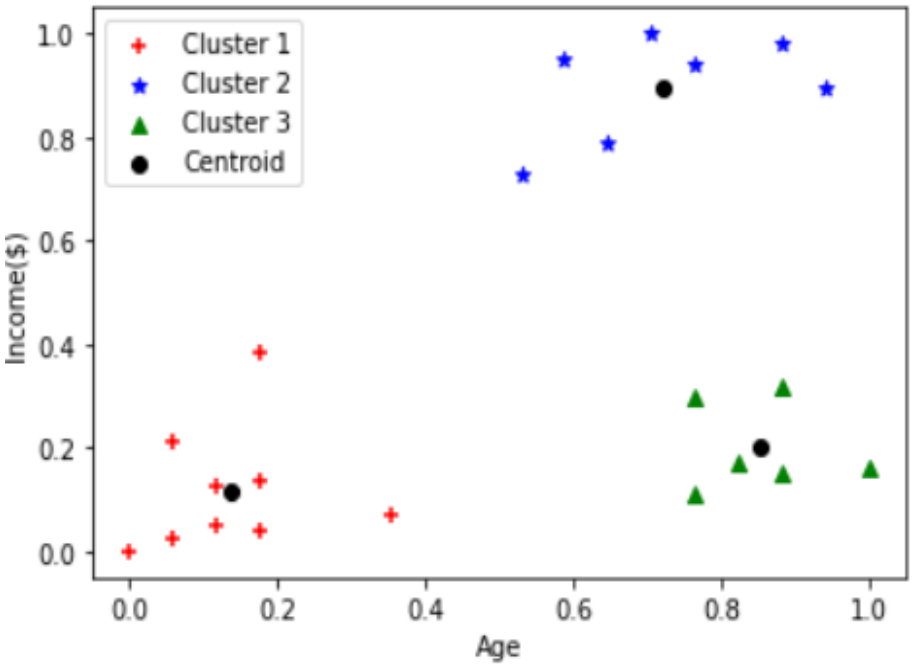
```
import pandas as pd
from sklearn.cluster import KMeans
from sklearn.preprocessing import MinMaxScaler
from matplotlib import pyplot as plt
%matplotlib inline
df = pd.read_csv('income.csv')
df.head(10)
scaler = MinMaxScaler()

scaler.fit(df[['Age']])

df[['Age']] = scaler.transform(df[['Age']])

scaler.fit(df[['Income($)']])

df[['Income($)']] = scaler.transform(df[['Income($)']])

df.head(10)

plt.scatter(df['Age'], df['Income($)'])

k_range = range(1, 11)

sse = []
for k in k_range:
kmc = KMeans(n_clusters=k)
kmc.fit(df[['Age', 'Income($)']])
sse.append(kmc.inertia_)
sse

    km = KMeans(n_clusters=3)
km

KMeans(n_clusters=3)

y_predict = km.fit_predict(df[['Age', 'Income($)']])

y_predict

array([0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 2, 2, 2, 2, 2, 2],
  dtype=int32)

df['cluster'] = y_predict

df.head()

df0 = df[df.cluster == 0]
df0
```

```
df1 = df[df.cluster == 1]
df1
df2 = df[df.cluster == 2]
df2

km.cluster_centers_

p1 = plt.scatter(df0['Age'], df0['Income($)'], marker='+', color='red')
p2 = plt.scatter(df1['Age'], df1['Income($)'], marker='*', color='blue')
p3 = plt.scatter(df2['Age'], df2['Income($)'], marker='^', color='green')
c = plt.scatter(km.cluster_centers_[:,0], km.cluster_centers_[:,1], color='black')
plt.xlabel('Age')
plt.ylabel('Income($)')
plt.legend((p1, p2, p3, c),
        ('Cluster 1', 'Cluster 2', 'Cluster 3', 'Centroid'))
```

Dataset:

Name	Age	Income($)
Rob	27	70000
Michael	29	90000
Mohan	29	61000
Ismail	28	60000
Kory	42	150000
Gautam	39	155000
David	41	160000
Andrea	38	162000
Brad	36	156000
Angelina	35	130000
Donald	37	137000
Tom	26	45000
Arnold	27	48000
Jared	28	51000
Stark	29	49500
Ranbir	32	53000
Dipika	40	65000
Priyanka	41	63000
Nick	43	64000
Alia	39	80000
Sid	41	82000
Abdul	39	58000

Output:


Cluster 1
Cluster 2
Cluster 3
Centroid
Income($)
Age
0.0
0.2
0.4
0.6
0.8
1.0

8. Apply EM algorithm to cluster a set of data stored in a .CSV file. Compare the results of k-Means and EM algorithm.

```
 import matplotlib.pyplot as plt
 from sklearn import datasets
 from sklearn.cluster import KMeans
 import sklearn.metrics as sm
 import pandas as pd
 import numpy as np

iris = datasets.load_iris()

X = pd.DataFrame(iris.data)
X.columns = ['Sepal_Length','Sepal_Width','Petal_Length','Petal_Width']

y = pd.DataFrame(iris.target)
y.columns = ['Targets']

model = KMeans(n_clusters=3)
model.fit(X)


plt.figure(figsize=(14,7))

colormap = np.array(['red', 'lime', 'black'])

plt.subplot(1, 2, 1)
plt.scatter(X.Petal_Length, X.Petal_Width, c=colormap[y.Targets], s=40)
plt.title('Real Classification')
plt.xlabel('Petal Length')
plt.ylabel('Petal Width')


 plt.subplot(1, 2, 2)
plt.scatter(X.Petal_Length, X.Petal_Width, c=colormap[model.labels_], s=40)
plt.title('K Mean Classification')
plt.xlabel('Petal Length')
plt.ylabel('Petal Width')
print('The accuracy score of K-Mean: ',sm.accuracy_score(y, model.labels_))
print('The Confusion matrixof K-Mean: ',sm.confusion_matrix(y, model.labels_))


from sklearn import preprocessing
scaler = preprocessing.StandardScaler()
scaler.fit(X)
xsa = scaler.transform(X)
xs = pd.DataFrame(xsa, columns = X.columns)

from sklearn.mixture import GaussianMixture
gmm = GaussianMixture(n_components=3)
gmm.fit(xs)

y_gmm = gmm.predict(xs)

plt.subplot(2, 2, 3)
plt.scatter(X.Petal_Length, X.Petal_Width, c=colormap[y_gmm], s=40)
plt.title('GMM Classification')
```

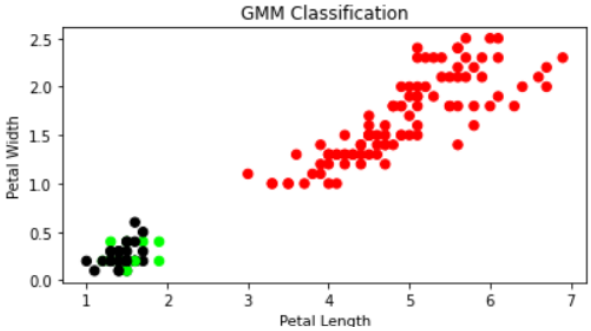
```
plt.xlabel('Petal Length')
plt.ylabel('Petal Width')

print('The accuracy score of EM: ',sm.accuracy_score(y, y_gmm))
print('The Confusion matrix of EM: ',sm.confusion_matrix(y, y_gmm))
```

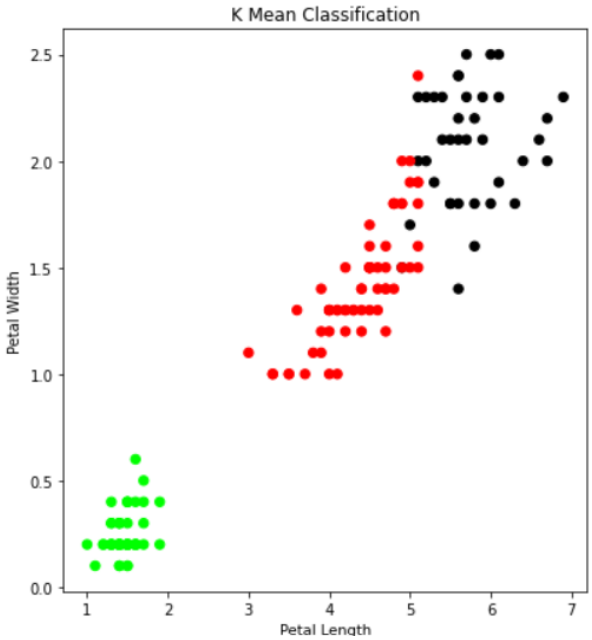
Dataset:

Id	SepalLengt	SepalWidt	PetalLengt	PetalWidt	Species
1	5.1	3.5	1.4	0.2	Iris-setosa
2	4.9	3	1.4	0.2	Iris-setosa
3	4.7	3.2	1.3	0.2	Iris-setosa
4	4.6	3.1	1.5	0.2	Iris-setosa
5	5	3.6	1.4	0.2	Iris-setosa
6	5.4	3.9	1.7	0.4	Iris-setosa
7	4.6	3.4	1.4	0.3	Iris-setosa
8	5	3.4	1.5	0.2	Iris-setosa
9	4.4	2.9	1.4	0.2	Iris-setosa
10	4.9	3.1	1.5	0.1	Iris-setosa
11	5.4	3.7	1.5	0.2	Iris-setosa
12	4.8	3.4	1.6	0.2	Iris-setosa
13	4.8	3	1.4	0.1	Iris-setosa
14	4.3	3	1.1	0.1	Iris-setosa
15	5.8	4	1.2	0.2	Iris-setosa
16	5.7	4.4	1.5	0.4	Iris-setosa
17	5.4	3.9	1.3	0.4	Iris-setosa
18	5.1	3.5	1.4	0.3	Iris-setosa
19	5.7	3.8	1.7	0.3	Iris-setosa
20	5.1	3.8	1.5	0.3	Iris-setosa
21	5.4	3.4	1.7	0.2	Iris-setosa
22	5.1	3.7	1.5	0.4	Iris-setosa
23	4.6	3.6	1	0.2	Iris-setosa
24	5.1	3.3	1.7	0.5	Iris-setosa
25	4.8	3.4	1.9	0.2	Iris-setosa
26	5	3	1.6	0.2	Iris-setosa
27	5	3.4	1.6	0.4	Iris-setosa
28	5.2	3.5	1.5	0.2	Iris-setosa

Output:

```
The accuracy score of K-Mean:  0.24
The Confusion matrixof K-Mean:  [[ 0 50  0]
 [48  0  2]
 [14  0 36]]
The accuracy score of EM:  0.0
The Confusion matrix of EM:  [[ 0 10 40]
 [50  0  0]
 [50  0  0]]
```





9. Write a Program to implement k-Nearest Neighbour algorithm to classify the iris dataset. Print both correct and wrong predictions.

```
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import classification_report, confusion_matrix
from sklearn import datasets

iris=datasets.load_iris()

x = iris.data
y = iris.target

print ('sepal-length', 'sepal-width', 'petal-length', 'petal-width')
print(x)
print('class: 0-Iris-Setosa, 1- Iris-Versicolour, 2- Iris-Virginica')
print(y)

x_train, x_test, y_train, y_test = train_test_split(x,y,test_size=0.3)

classifier = KNeighborsClassifier(n_neighbors=5)
classifier.fit(x_train, y_train)

y_pred=classifier.predict(x_test)

print('Confusion Matrix')
print(confusion_matrix(y_test,y_pred))
print('Accuracy Metrics')
print(classification_report(y_test,y_pred))
```

Dataset:

Id	SepalLengt	SepalWidt	PetalLengt	PetalWidt	Species
1	5.1	3.5	1.4	0.2	Iris-setosa
2	4.9	3	1.4	0.2	Iris-setosa
3	4.7	3.2	1.3	0.2	Iris-setosa
4	4.6	3.1	1.5	0.2	Iris-setosa
5	5	3.6	1.4	0.2	Iris-setosa
6	5.4	3.9	1.7	0.4	Iris-setosa
7	4.6	3.4	1.4	0.3	Iris-setosa
8	5	3.4	1.5	0.2	Iris-setosa
9	4.4	2.9	1.4	0.2	Iris-setosa
10	4.9	3.1	1.5	0.1	Iris-setosa
11	5.4	3.7	1.5	0.2	Iris-setosa
12	4.8	3.4	1.6	0.2	Iris-setosa
13	4.8	3	1.4	0.1	Iris-setosa
14	4.3	3	1.1	0.1	Iris-setosa
15	5.8	4	1.2	0.2	Iris-setosa
16	5.7	4.4	1.5	0.4	Iris-setosa
17	5.4	3.9	1.3	0.4	Iris-setosa
18	5.1	3.5	1.4	0.3	Iris-setosa
19	5.7	3.8	1.7	0.3	Iris-setosa
20	5.1	3.8	1.5	0.3	Iris-setosa
21	5.4	3.4	1.7	0.2	Iris-setosa
22	5.1	3.7	1.5	0.4	Iris-setosa
23	4.6	3.6	1	0.2	Iris-setosa
24	5.1	3.3	1.7	0.5	Iris-setosa
25	4.8	3.4	1.9	0.2	Iris-setosa
26	5	3	1.6	0.2	Iris-setosa
27	5	3.4	1.6	0.4	Iris-setosa
28	5.2	3.5	1.5	0.2	Iris-setosa

Output:

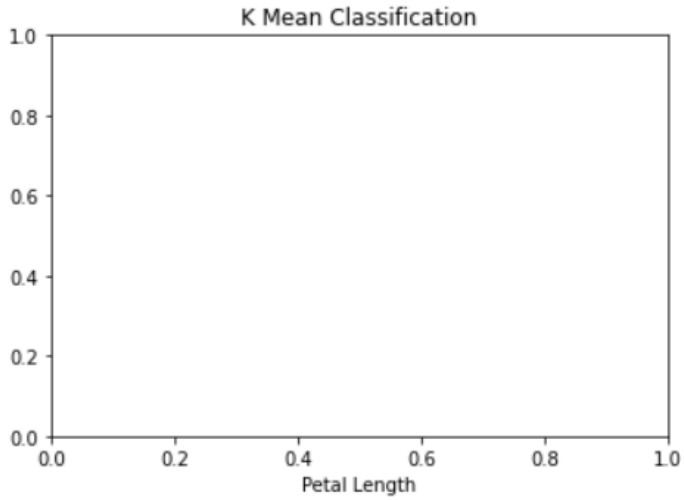
```
Confusion Matrix
[[11  0  0]
 [ 0 16  1]
 [ 0  1 16]]
Accuracy Metrics
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        11
           1       0.94      0.94      0.94        17
           2       0.94      0.94      0.94        17

    accuracy                           0.96        45
   macro avg       0.96      0.96      0.96        45
weighted avg       0.96      0.96      0.96        45
```

10. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Print Select appropriate data set for your experiment and draw graphs.

```
import numpy as np
from bokeh.plotting import figure, show, output_notebook
from bokeh.layouts import gridplot
from bokeh.io import push_notebook
from matplotlib import pyplot as plt

def local_regression(x0, X, Y, tau):# add bias term
x0 = np.r_[1, x0] # Add one to avoid the loss in information
X = np.c_[np.ones(len(X)), X]


xw = X.T * radial_kernel(x0, X, tau) # XTranspose * W

beta = np.linalg.pinv(xw @ X)


return x0 @ beta # @ Matrix Multiplication or Dot Product for prediction
def radial_kernel(x0, X, tau):
return np.exp(np.sum((X - x0) ** 2, axis=1) / (-2 * tau * tau))

 n = 1000
 X = np.linspace(-3, 3, num=n)
 print("The Data Set ( 10 Samples) X :\n",X[1:10])
 Y = np.log(np.abs(X ** 2 - 1) + .5)
 print("The Fitting Curve Data Set (10 Samples) Y :\n",Y[1:10])
 X += np.random.normal(scale=.1, size=n)
 print("Normalised (10 Samples) X :\n",X[1:10])
 domain = np.linspace(-3, 3, num=300)
 print(" Xo Domain Space(10 Samples) :\n",domain[1:10])
def plot_lwr(tau):
prediction = [local_regression(x0, X, Y, tau) for x0 in domain]
plot = figure(plot_width=400, plot_height=400)
plot.title.text='tau=%g' % tau
plot.scatter(X, Y, alpha=.3)
plot.line(domain, prediction, line_width=2, color='red')
return plot

show(gridplot([
[plot_lwr(10.), plot_lwr(1.)],
[plot_lwr(0.1), plot_lwr(0.01)]]))
plt.title('K Mean Classification')
plt.xlabel('Petal Length')
```

```
The Data Set ( 10 Samples) X :
 [-2.99399399 -2.98798799 -2.98198198 -2.97597598 -2.96996997 -2.96396396
 -2.95795796 -2.95195195 -2.94594595]
The Fitting Curve Data Set (10 Samples) Y :
 [2.13582188 2.13156806 2.12730467 2.12303166 2.11874898 2.11445659
 2.11015444 2.10584249 2.10152068]
Normalised (10 Samples) X :
 [-2.86327233 -2.86956667 -2.82337772 -2.88923105 -2.77788044 -3.02341724
 -2.95836131 -2.96057068 -2.95988289]
 Xo Domain Space(10 Samples) :
 [-2.97993311 -2.95986622 -2.93979933 -2.91973244 -2.89966555 -2.87959866
 -2.85953177 -2.83946488 -2.81939799]
Text(0.5, 0, 'Petal Length')
```

ut[4]:



```
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np

def kernel(point,xmat, k):
    m,n = np.shape(xmat)
    weights = np.mat(np.eye((m)))
    for j in range(m):
        diff = point - X[j]
        weights[j,j] = np.exp(diff*diff.T/(-2.0*k**2))
    return weights

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

def localWeightRegression(xmat,ymat,k):
    m,n = np.shape(xmat)
    ypred = np.zeros(m)
    for i in range(m):
        ypred[i] = xmat[i]*localWeight(xmat[i],xmat,ymat,k)
    return ypred

def graphPlot(X,ypred):
    sortindex = X[:,1].argsort(0)
    xsort = X[sortindex][:,0]
    fig = plt.figure()
    ax = fig.add_subplot(1,1,1)
    ax.scatter(bill,tip, color='green')
    ax.plot(xsort[:,1],ypred[sortindex], color = 'red', linewidth=5)
    plt.xlabel('Total bill')
    plt.ylabel('Tip')
    plt.show();

data = pd.read_csv('/content/tips.csv')
bill = np.array(data.total_bill)
tip = np.array(data.tip)

mbill = np.mat(bill)
mtip = np.mat(tip)
m= np.shape(mbill)[1]
one = np.mat(np.ones(m))
X = np.hstack((one.T,mbill.T)) # 244 rows, 2 cols


ypred = localWeightRegression(X,mtip,3)
graphPlot(X,ypred)
```

Dataset:

total_bill	tip	sex	smoker	day	time	size
16.99	1.01	Female	No	Sun	Dinner	2
10.34	1.66	Male	No	Sun	Dinner	3
21.01	3.5	Male	No	Sun	Dinner	3
23.68	3.31	Male	No	Sun	Dinner	2
24.59	3.61	Female	No	Sun	Dinner	4
25.29	4.71	Male	No	Sun	Dinner	4
8.77	2	Male	No	Sun	Dinner	2
26.88	3.12	Male	No	Sun	Dinner	4
15.04	1.96	Male	No	Sun	Dinner	2
14.78	3.23	Male	No	Sun	Dinner	2
10.27	1.71	Male	No	Sun	Dinner	2
35.26	5	Female	No	Sun	Dinner	4
15.42	1.57	Male	No	Sun	Dinner	2
18.43	3	Male	No	Sun	Dinner	4
14.83	3.02	Female	No	Sun	Dinner	2
21.58	3.92	Male	No	Sun	Dinner	2
10.33	1.67	Female	No	Sun	Dinner	3
16.29	3.71	Male	No	Sun	Dinner	3
16.97	3.5	Female	No	Sun	Dinner	3
20.65	3.35	Male	No	Sat	Dinner	3
17.92	4.08	Male	No	Sat	Dinner	2
20.29	2.75	Female	No	Sat	Dinner	2
15.77	2.23	Female	No	Sat	Dinner	2
39.42	7.58	Male	No	Sat	Dinner	4
19.82	3.18	Male	No	Sat	Dinner	2
17.81	2.34	Male	No	Sat	Dinner	4
13.37	2	Male	No	Sat	Dinner	2
12.69	2	Male	No	Sat	Dinner	2

Output: