VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.

LAB REPORT
on

MACHINE LEARNING

Submitted by

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in partial fulfillment for the award of the degree of
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in
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(Affiliated To Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

<u>CERTIFICATE</u>

This is to certify that the Lab work entitled "**LAB COURSE OF MACHINE LEARNING**" carried out by **KIRAN M K (1BM19CS073),** who is a 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 year 2022. 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 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 algorithms.

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

```
import pandas as pd

import numpy as np


df = pd.read_csv('/content/Lab1_Doc.csv')

hypo = []

for i in range(len(df.columns)-1):

  if type(i) == str:

    hypo.append("Null")

  elif type(i) == int:

    hypo.append(0)

  else:

    hypo.append(0.0)


for i in range(len(df)):

  if df.loc[i, 'Poisonous'] == "YES":

    for j in range(len(hypo)):

      if hypo[j] == "Null":

        hypo[j] = df.iloc[i, j]

      elif hypo[j] != df.iloc[i,j]:

        hypo[j] = "?"

print("The hypothesis for the given data: ", hypo)
```

OUTPUT:

	Color	Toughness	Fungus	Appearance	Poisonous
0	GREEN	HARD	NO	WRINKLED	YES
1	GREEN	HARD	YES	SMOOTH	NO
2	BROWN	SOFT	NO	WRINKLED	NO
3	ORANGE	HARD	NO	WRINKLED	YES
4	GREEN	SOFT	YES	SMOOTH	YES
5	GREEN	HARD	YES	WRINKLED	YES
6	ORANGE	HARD	NO	WRINKLED	YES

```
The hypothesis for the given data:  ['?', '?', '?', '?']
```

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.read_csv('enjoysport.csv')

concepts = np.array(data.iloc[:,0:-1])

print("\nInstances are:\n",concepts)

target = np.array(data.iloc[:,-1])

print("\nTarget Values are: ",target)

def learn(concepts, target):

    specific_h = concepts[0].copy()

    print("\nInitialization of specific_h and general_h")

    print("\nSpecific Hypothesis: ", specific_h)

    general_h = [["?" for i in range(len(specific_h))] for i in
range(len(specific_h))]

    print("\nGeneral Hypothesis: ",general_h)


    for i, h in enumerate(concepts):

        print("\nInstance", i+1 , "is ", h)

        if target[i] == "yes":

            print("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":

            print("Instance is Negative ")

            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(specific_h)
        print( general_h)
        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")
```

OUTPUT:

```
Initialization of specific_h and general_h

Specific Hypothesis:  ['sunny' 'warm' 'normal' 'strong' 'warm' 'same']

General Hypothesis:  [['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?',
'?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

Instance 1 is  ['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
Instance is Positive
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?',
'?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]


Instance 2 is  ['sunny' 'warm' 'high' 'strong' 'warm' 'same']
Instance is Positive
['sunny' 'warm' '?' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?',
'?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]


Instance 3 is  ['rainy' 'cold' 'high' 'strong' 'warm' 'change']
Instance is Negative
['sunny' 'warm' '?' 'strong' 'warm' 'same']
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'],
['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', 'same']]


Instance 4 is  ['sunny' 'warm' 'high' 'strong' 'cool' 'change']
Instance is Positive
['sunny' 'warm' '?' 'strong' '?' '?']
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'],
['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

Final Specific_h:
['sunny' 'warm' '?' 'strong' '?' '?']
Final General_h:
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?']]
```

3. Demonstration of ID3 algorithm

```
import pandas as pd

import numpy as np

from sklearn.datasets import load_iris

from sklearn.model_selection import train_test_split

from sklearn.tree import plot_tree

from sklearn.tree import DecisionTreeClassifier

from sklearn.metrics import ConfusionMatrixDisplay

import matplotlib.pyplot as plt

data = load_iris()

df = pd.DataFrame(data.data, columns = data.feature_names)

df['Species'] = data.target

#replace this with the actual names

target = np.unique(data.target)

target_names = np.unique(data.target_names)

targets = dict(zip(target, target_names))

df['Species'] = df['Species'].replace(targets)

x = df.drop(columns="Species")

y = df["Species"]

feature_names = x.columns

labels = y.unique()


X_train, test_x, y_train, test_lab = train_test_split(x,y,test_size =
0.4,random_state = 42)

clf = DecisionTreeClassifier(max_depth =4, random_state = 42,
criterion='entropy')

clf.fit(X_train, y_train)


test_pred = clf.predict(test_x)

ConfusionMatrixDisplay.from_predictions(test_lab, test_pred,
labels=['setosa', 'versicolor', 'virginica'])

fig = plt.figure(figsize=(25,20))

_ = plot_tree(clf,

                   feature_names=data.feature_names,
```

```
                      class_names=data.target_names,
                      filled=True)
```

Without Sklearn

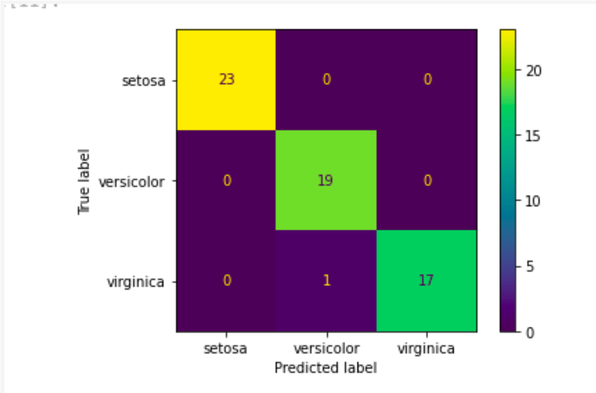
```
import math
import csv
def load_csv(filename):
  lines=csv.reader(open(filename,"r"))
  dataset = list(lines)
  headers = dataset.pop(0)
  return dataset,headers

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]]])
```

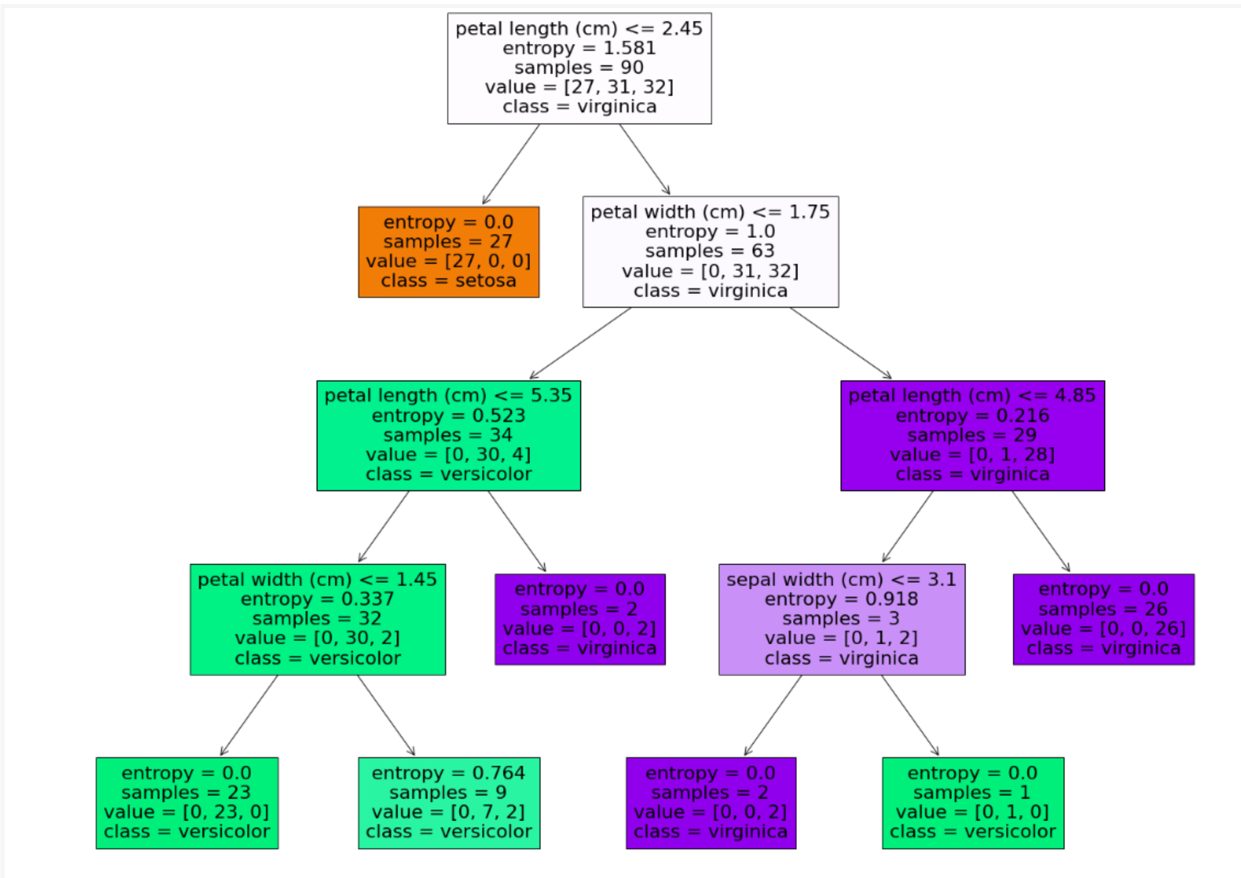
```
        total_entropy-=ratio[x]*entropies[x]
    return total_entropy

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.csv")

for xtest in testdata:
    print("The test instance:",xtest)
    print("The label for test instance:")
    classify(node1,xtest,features)
```

OUTPUT:



setosa
versicolor
virginica
True label
23
0
0
0
19
0
0
1
17
setosa
versicolor
virginica
Predicted label
20
15
10
5
0



petal length (cm) <= 2.45
entropy = 1.581
samples = 90
value = [27, 31, 32]
class = virginica
entropy = 0.0
samples = 27
value = [27, 0, 0]
class = setosa
petal width (cm) <= 1.75
entropy = 1.0
samples = 63
value = [0, 31, 32]
class = virginica
petal length (cm) <= 5.35
entropy = 0.523
samples = 34
value = [0, 30, 4]
class = versicolor
petal length (cm) <= 4.85
entropy = 0.216
samples = 29
value = [0, 1, 28]
class = virginica
petal width (cm) <= 1.45
entropy = 0.337
samples = 32
value = [0, 30, 2]
class = versicolor
entropy = 0.0
samples = 2
value = [0, 0, 2]
class = virginica
sepal width (cm) <= 3.1
entropy = 0.918
samples = 3
value = [0, 1, 2]
class = virginica
entropy = 0.0
samples = 26
value = [0, 0, 26]
class = virginica
entropy = 0.0
samples = 23
value = [0, 23, 0]
class = versicolor
entropy = 0.764
samples = 9
value = [0, 7, 2]
class = versicolor
entropy = 0.0
samples = 2
value = [0, 0, 2]
class = virginica
entropy = 0.0
samples = 1
value = [0, 1, 0]
class = versicolor

without sklearn:

```
The decision tree for the dataset using ID3 algorithm is
 Outlook
   sunny
     Humidity
       normal
         yes
       high
         no
   overcast
     yes
   rain
     Wind
       strong
         no
       weak
         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. Linear Regression without sklearn:

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.datasets import fetch_california_housing

class LR():
  def __init__(self):
    self.w = []
  def fit(self, X, y):
    self.w = np.linalg.solve(X.T@X, X.T@y)
  def predict(self, X):
    return X@self.w
  def score(self, X, y):
    SS_reg = np.sum((X@self.w - y)**2)
    SS_tot = np.sum((y - np.mean(y))**2)
    return (1 - (SS_reg/SS_tot))
data, labels = fetch_california_housing(return_X_y = True)
one = np.ones(data.shape[0])
data = np.column_stack((one, data))
X_train,X_test, y_train, y_test = train_test_split(data, labels, train_size = 0.75, random_state = 42)
lro = LR()
lro.fit(X_train, y_train)
lro.predict(X_test)
lro.score(X_test, y_test)
```

OUTPUT:

```
[30]:  0.5910509795491321
```

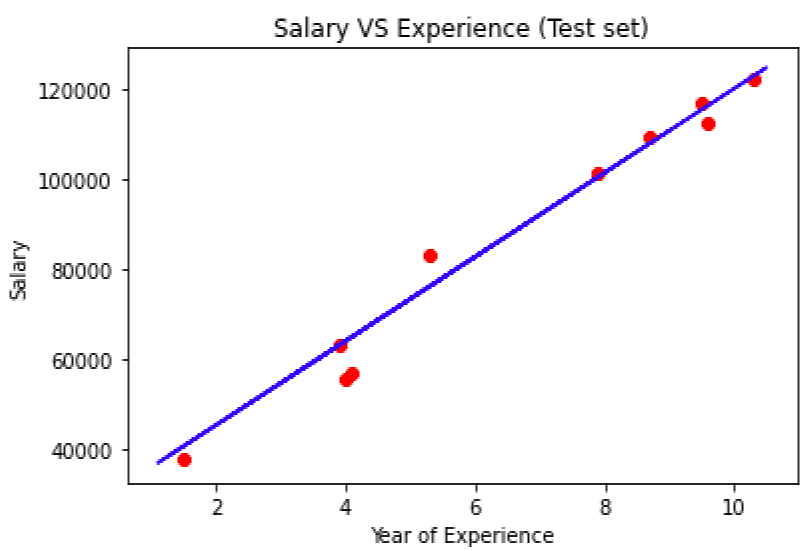
with sklearn:

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

# Importing the dataset
#dataset = pd.read_csv('181105_missing-data.csv')
dataset = pd.read_csv('salary_data.csv')
X = dataset.iloc[:, :-1].values #get a copy of dataset exclude last column
y = dataset.iloc[:, 1].values #get array of dataset in column 1st

# Splitting the dataset into the Training set and Test set
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=1/3, random_state=0)



# 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()
```

OUTPUT:


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


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

5. Naive Bayes Algorithm without sklearn:

```
import pandas as pd

data = pd.read_csv('PlayTennis.csv')
data.head()
y = list(data['PlayTennis'].values)
X = data.iloc[:,1:].values

print(f'Target Values: {y}')
print(f'Features: \n{X}')
y_train = y[:8]
y_val = y[8:]

X_train = X[:8]
X_val = X[8:]
class NaiveBayesClassifier:


    def __init__(self, X, y):

        self.X, self.y = X, y

        self.N = len(self.X)

        self.dim = len(self.X[0])

        self.attrs = [[] for _ in range(self.dim)]

        self.output_dom = {}

        self.data = []
```

```
        for i in range(len(self.X)):
            for j in range(self.dim):
                if not self.X[i][j] in self.attrs[j]:
                    self.attrs[j].append(self.X[i][j])

            if not self.y[i] in self.output_dom.keys():
                self.output_dom[self.y[i]] = 1

            else:
                self.output_dom[self.y[i]] += 1

            self.data.append([self.X[i], self.y[i]])
    def classify(self, entry):

        solve = None
        max_arg = -1

        for y in self.output_dom.keys():

            prob = self.output_dom[y]/self.N

            for i in range(self.dim):
                cases = [x for x in self.data if x[0][i] == entry[i] and x[1] == y]
                n = len(cases)
                prob *= n/self.N

            if prob > max_arg:
                max_arg = prob
                solve = y

        return solve
nbc = NaiveBayesClassifier(X_train, y_train)
```

```
total_cases = len(y_val)

good = 0
bad = 0
predictions = []

for i in range(total_cases):
    predict = nbc.classify(X_val[i])
    predictions.append(predict)

    if y_val[i] == predict:
        good += 1
    else:
        bad += 1

print('Predicted values:', predictions)
print('Actual values:', y_val)
print()
print('Total number of testing instances in the dataset:', total_cases)
print('Number of correct predictions:', good)
print('Number of wrong predictions:', bad)
print()
print('Accuracy of Bayes Classifier:', good/total_cases)
```

OUTPUT:

```
Predicted values: ['No', 'Yes', 'No', 'Yes', 'Yes', 'No']
Actual values: ['Yes', 'Yes', 'Yes', 'Yes', 'Yes', 'No']

Total number of testing instances in the dataset: 6
Number of correct predictions: 4
Number of wrong predictions: 2

Accuracy of Bayes Classifier: 0.6666666666666666
```

With sklearn:

```
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("pima_indian.csv")

feature_col_names = ['num_preg', 'glucose_conc', 'diastolic_bp', 'thickness', 'insulin', 'bmi',
'diab_pred', 'age']

predicted_class_names = ['diabetes']


X = df[feature_col_names].values # these are factors for the prediction

y = df[predicted_class_names].values # this is what we want to predict


#splitting the dataset into train and test data

print(df.head)

xtrain,xtest,ytrain,ytest=train_test_split(X,y,test_size=0.33)


print ('\n the total number of Training Data :',ytrain.shape)

print ('\n the total number of Test Data :',ytest.shape)



# Training Naive Bayes (NB) classifier on training data.


clf = GaussianNB().fit(xtrain,ytrain.ravel())

predicted = clf.predict(xtest)

predictTestData= clf.predict([[6,148,72,35,0,33.6,0.627,50]])


#printing Confusion matrix, accuracy, Precision and Recall


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:", predictTestData)

OUTPUT:

```
 the total number of Training Data : (514, 1)

 the total number of Test Data : (254, 1)

 Confusion matrix
[[147  26]
 [ 28  53]]

 Accuracy of the classifier is 0.7874015748031497

 The value of Precision 0.6708860759493671

 The value of Recall 0.654320987654321
Predicted Value for individual Test Data: [1]
```

6. Bayesian Network

without in built

```
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

trainingData = pd.read_csv('/content/bayesian-dataset.csv')

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

print('The sample instances from the dataset are:')

print(trainingData.head())

print('\n Attributes and datatypes: ')

print(trainingData.dtypes)
```

```
model =
BayesianModel([('age','heartdisease'),('sex','heartdisease'),('exang','h
eartdisease'),('cp','heartdisease'),('heartdisease','restecg'),('heartdi
sease','chol')])

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

model.fit(trainingData,estimator=MaximumLikelihoodEstimator)

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

HeartDiseasetest_infer = VariableElimination(model)

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

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

print(q1)

print('\n 2.Probability of HeartDisease given evidence = chol
(Cholestorol): 100 ')

q2 = HeartDiseasetest_infer.query(variables = ['heartdisease'],
evidence={'chol':100})

print(q2)
```

```
 1.Probability of HeartDisease given evidence = restecg (Rest ECG): 1
  0%|          | 0/4 [00:00<?, ?it/s]
  0%|          | 0/4 [00:00<?, ?it/s]
+-----------------+---------------------+
| heartdisease    |   phi(heartdisease) |
+=================+=====================+
| heartdisease(0) |              0.1012 |
+-----------------+---------------------+
| heartdisease(1) |              0.0000 |
+-----------------+---------------------+
| heartdisease(2) |              0.2392 |
+-----------------+---------------------+
| heartdisease(3) |              0.2015 |
+-----------------+---------------------+
| heartdisease(4) |              0.4581 |
+-----------------+---------------------+
```

```
  UserWarning,
  0%|          | 0/4 [00:00<?, ?it/s]
  0%|          | 0/4 [00:00<?, ?it/s]
+-----------------+---------------------+
| heartdisease    |   phi(heartdisease) |
+=================+=====================+
| heartdisease(0) |              1.0000 |
+-----------------+---------------------+
| heartdisease(1) |              0.0000 |
+-----------------+---------------------+
| heartdisease(2) |              0.0000 |
+-----------------+---------------------+
| heartdisease(3) |              0.0000 |
+-----------------+---------------------+
| heartdisease(4) |              0.0000 |
+-----------------+---------------------+
```

without in built:

```
import bayespy as bp

import numpy as np

import csv

from colorama import init

from colorama import Fore, Back, Style

init()


# Define Parameter Enum values

# Age

ageEnum = {'SuperSeniorCitizen': 0, 'SeniorCitizen': 1,

           'MiddleAged': 2, 'Youth': 3, 'Teen': 4}

# Gender

genderEnum = {'Male': 0, 'Female': 1}

# FamilyHistory

familyHistoryEnum = {'Yes': 0, 'No': 1}

# Diet(Calorie Intake)

dietEnum = {'High': 0, 'Medium': 1, 'Low': 2}

# LifeStyle

lifeStyleEnum = {'Athlete': 0, 'Active': 1, 'Moderate': 2, 'Sedetary': 3}

# Cholesterol

cholesterolEnum = {'High': 0, 'BorderLine': 1, 'Normal': 2}

# HeartDisease

heartDiseaseEnum = {'Yes': 0, 'No': 1}

import pandas as pd

data = pd.read_csv("heart_disease_data.csv")

p_age = bp.nodes.Dirichlet(1.0*np.ones(5))
age = bp.nodes.Categorical(p_age, plates=(N,))
age.observe(data[:, 0])

p_gender = bp.nodes.Dirichlet(1.0*np.ones(2))
gender = bp.nodes.Categorical(p_gender, plates=(N,))
gender.observe(data[:, 1])

p_familyhistory = bp.nodes.Dirichlet(1.0*np.ones(2))
familyhistory = bp.nodes.Categorical(p_familyhistory, plates=(N,))
familyhistory.observe(data[:, 2])
```

```
p_diet = bp.nodes.Dirichlet(1.0*np.ones(3))
diet = bp.nodes.Categorical(p_diet, plates=(N,))
diet.observe(data[:, 3])

p_lifestyle = bp.nodes.Dirichlet(1.0*np.ones(4))
lifestyle = bp.nodes.Categorical(p_lifestyle, plates=(N,))
lifestyle.observe(data[:, 4])

p_cholesterol = bp.nodes.Dirichlet(1.0*np.ones(3))
cholesterol = bp.nodes.Categorical(p_cholesterol, plates=(N,))
cholesterol.observe(data[:, 5])
p_heartdisease = bp.nodes.Dirichlet(np.ones(2), plates=(5, 2, 2, 3, 4, 3))
heartdisease = bp.nodes.MultiMixture(
    [age, gender, familyhistory, diet, lifestyle, cholesterol],
bp.nodes.Categorical, p_heartdisease)
heartdisease.observe(data[:, 6])
p_heartdisease.update()
m = 0
while m == 0:
    print("\n")
    res = bp.nodes.MultiMixture([int(input('Enter Age: ' + str(ageEnum))),
int(input('Enter Gender: ' + str(genderEnum))), int(input('Enter
FamilyHistory: ' + str(familyHistoryEnum))), int(input('Enter dietEnum: ' +
str(
        dietEnum))), int(input('Enter LifeStyle: ' + str(lifeStyleEnum))),
int(input('Enter Cholesterol: ' + str(cholesterolEnum)))],
bp.nodes.Categorical,
p_heartdisease).get_moments()[0][heartDiseaseEnum['Yes']]
    print("Probability(HeartDisease) = " + str(res))

# print(Style.RESET_ALL)
    m = int(input("Enter for Continue:0, Exit :1 "))
```

OUTPUT:

```
Enter Age: {'SuperSeniorCitizen': 0, 'SeniorCitizen': 1, 'MiddleAged': 2, 'Youth': 3, 'Teen': 4}2
Enter Gender: {'Male': 0, 'Female': 1}0
Enter FamilyHistory: {'Yes': 0, 'No': 1}0
Enter dietEnum: {'High': 0, 'Medium': 1, 'Low': 2}0
Enter LifeStyle: {'Athlete': 0, 'Active': 1, 'Moderate': 2, 'Sedetary': 3}0
Enter Cholesterol: {'High': 0, 'BorderLine': 1, 'Normal': 2}0
Probability(HeartDisease) = 0.5
Enter for Continue:0, Exit :1 1
```

7. K Means Algorithm without sklearn:

```
import math;
import sys;
import pandas as pd
import numpy as np
from random import choice
from matplotlib import pyplot
from random import shuffle, uniform;



def ReadData(fileName):
    f = open(fileName,'r')
    lines = f.read().splitlines()
    f.close()

    items = []

    for i in range(1,len(lines)):
        line = lines[i].split(',')
        itemFeatures = []

        for j in range(len(line)-1):
            v = float(line[j])
            itemFeatures.append(v)
        items.append(itemFeatures)

    shuffle(items)

    return items


def FindColMinMax(items):
    n = len(items[0])
    minima = [float('inf') for i in range(n)]
    maxima = [float('-inf') -1 for i in range(n)]

    for item in items:
        for f in range(len(item)):
            if(item[f] < minima[f]):
                minima[f] = item[f]

            if(item[f] > maxima[f]):
                maxima[f] = item[f]

    return minima,maxima

def EuclideanDistance(x,y):
    S = 0
    for i in range(len(x)):
        S += math.pow(x[i]-y[i],2)

    return math.sqrt(S)
```

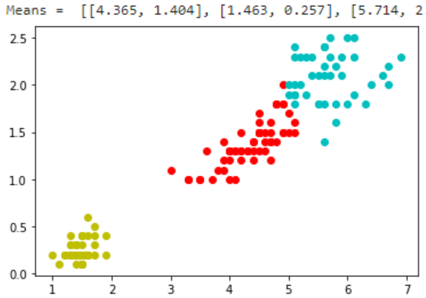
```
def InitializeMeans(items,k,cMin,cMax):
    f = len(items[0])
    means = [[0 for i in range(f)] for j in range(k)]

    for mean in means:
        for i in range(len(mean)):
            mean[i] = uniform(cMin[i]+1,cMax[i]-1)

    return means

def UpdateMean(n,mean,item):
    for i in range(len(mean)):
        m = mean[i]
        m = (m*(n-1)+item[i])/float(n)
        mean[i] = round(m,3)

    return mean


def FindClusters(means,items):
    clusters = [[] for i in range(len(means))]

    for item in items:
        index = Classify(means,item)
        clusters[index].append(item)

    return clusters

def Classify(means,item):

    minimum = float('inf');
    index = -1

    for i in range(len(means)):
        dis = EuclideanDistance(item,means[i])

        if(dis < minimum):
            minimum = dis
            index = i

    return index

def CalculateMeans(k,items,maxIterations=100000):
    cMin, cMax = FindColMinMax(items)

    means = InitializeMeans(items,k,cMin,cMax)

    clusterSizes = [0 for i in range(len(means))]

    belongsTo = [0 for i in range(len(items))]

    for e in range(maxIterations):
        noChange = True;
        for i in range(len(items)):
            item = items[i];
            index = Classify(means,item)
```

```python
            clusterSizes[index] += 1
            cSize = clusterSizes[index]
            means[index] = UpdateMean(cSize,means[index],item)

            if(index != belongsTo[i]):
                noChange = False
            belongsTo[i] = index

        if (noChange):
            break

    return means

def CutToTwoFeatures(items,indexA,indexB):
    n = len(items)
    X = []
    for i in range(n):
        item = items[i]
        newItem = [item[indexA],item[indexB]]
        X.append(newItem)

    return X

def PlotClusters(clusters):
    n = len(clusters)
    X = [[] for i in range(n)]

    for i in range(n):
        cluster = clusters[i]
        for item in cluster:
            X[i].append(item)

    colors = ['r','b','g','c','m','y']

    for x in X:
        c = choice(colors)
        colors.remove(c)

        Xa = []
        Xb = []

        for item in x:
            Xa.append(item[0])
            Xb.append(item[1])

        pyplot.plot(Xa,Xb,'o',color=c)

    pyplot.show()


def main():
    items = ReadData('data.txt')
    k = 3
    items = CutToTwoFeatures(items,2,3)
    print(items)
    means = CalculateMeans(k,items)
```

```
    print("\nMeans = ", means)

    clusters = FindClusters(means,items)

    PlotClusters(clusters)
    newItem = [1.5,0.2]
    print(Classify(means,newItem))

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

OUTPUT:

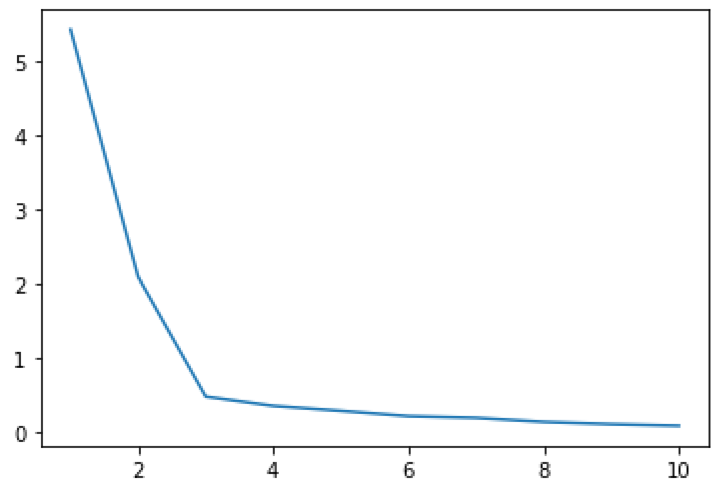
```
[[1.3, 0.2], [1.3, 0.3], [6.7, 2.0], [1.6, 0.4], [4.5, 1.5], [1.5, 0.4], [3.8, 1.1], [1.2, 0.2], [5.2, 2.0], [4.5, 1.5], [5.0, 1.9], [3.5, 1.0], [6.3,
1.8], [6.9, 2.3], [1.6, 0.2], [6.0, 1.8], [5.1, 2.3], [1.5, 0.1], [5.1, 1.9], [1.7, 0.5], [4.0, 1.3], [4.8, 1.8], [1.4, 0.3], [1.5, 0.1], [5.1, 1.5],
[4.0, 1.3], [1.4, 0.2], [1.4, 0.2], [4.5, 1.7], [1.4, 0.2], [4.1, 1.0], [5.4, 2.3], [1.4, 0.3], [6.6, 2.1], [1.3, 0.2], [3.5, 1.0], [4.0, 1.0], [4.5,
1.3], [1.4, 0.2], [6.1, 1.9], [5.4, 2.1], [3.9, 1.1], [5.9, 2.3], [1.5, 0.2], [5.6, 1.4], [1.7, 0.3], [4.4, 1.4], [4.7, 1.2], [1.5, 0.2], [1.5, 0.4],
[1.5, 0.2], [6.1, 2.5], [4.5, 1.5], [1.5, 0.2], [5.1, 2.4], [1.9, 0.4], [5.7, 2.5], [3.3, 1.0], [5.0, 2.0], [5.6, 1.8], [5.3, 2.3], [6.1, 2.3], [5.1,
1.6], [4.2, 1.3], [5.9, 2.1], [4.6, 1.4], [6.7, 2.2], [4.2, 1.2], [3.7, 1.0], [1.9, 0.2], [4.5, 1.5], [4.2, 1.5], [5.6, 2.2], [5.6, 2.1], [1.4, 0.1],
[4.9, 2.0], [4.9, 1.5], [5.7, 2.1], [5.2, 2.3], [5.1, 1.9], [4.7, 1.4], [5.6, 2.4], [3.3, 1.0], [4.3, 1.3], [5.6, 2.4], [1.6, 0.2], [1.0, 0.2], [1.2,
0.2], [6.4, 2.0], [4.4, 1.2], [5.1, 1.8], [1.3, 0.3], [3.9, 1.4], [4.7, 1.6], [4.0, 1.2], [1.6, 0.2], [4.7, 1.5], [5.1, 2.0], [4.9, 1.8], [4.4, 1.4],
[4.9, 1.8], [1.3, 0.4], [1.3, 0.2], [4.0, 1.3], [1.7, 0.4], [5.3, 1.9], [4.6, 1.5], [1.1, 0.1], [5.7, 2.3], [4.8, 1.8], [3.6, 1.3], [1.5, 0.2], [1.4,
0.3], [1.3, 0.2], [4.2, 1.3], [4.5, 1.6], [1.4, 0.2], [5.8, 1.8], [1.6, 0.6], [1.7, 0.2], [4.6, 1.3], [4.8, 1.4], [4.7, 1.4], [1.4, 0.2], [4.1, 1.3],
[5.5, 1.8], [4.3, 1.3], [1.5, 0.1], [5.8, 2.2], [1.6, 0.2], [4.8, 1.8], [5.8, 1.6], [1.5, 0.4], [4.4, 1.3], [3.0, 1.1], [4.1, 1.3], [5.0, 1.5], [1.6,
0.2], [5.0, 1.7], [1.5, 0.3], [5.5, 1.8], [1.5, 0.1], [1.4, 0.2], [3.9, 1.2], [1.5, 0.2], [4.9, 1.5], [5.5, 2.1], [4.5, 1.5], [6.0, 2.5]]

Means =  [[4.365, 1.404], [1.463, 0.257], [5.714, 2.085]]
```



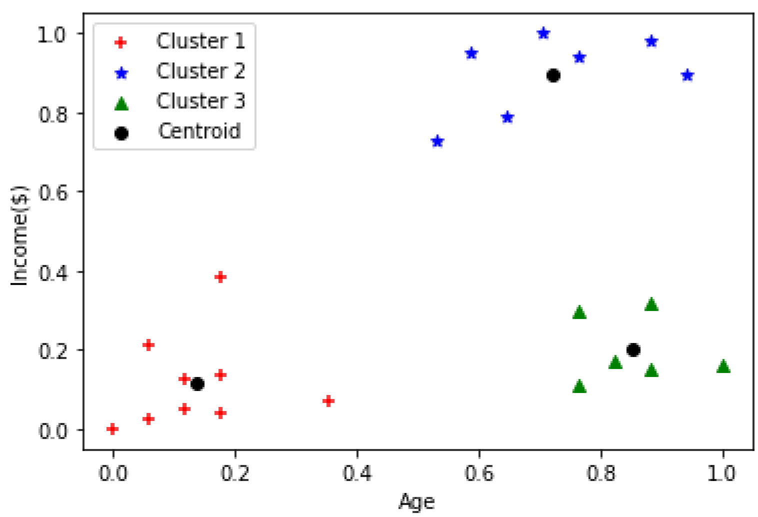
with sklearn;

```
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($)']])
    sse.append(kmc.inertia_)
sse
plt.xlabel = 'Number of Clusters'
plt.ylabel = 'Sum of Squared Errors'
plt.plot(k_range, sse)
km = KMeans(n_clusters=3)
km
y_predict = km.fit_predict(df[['Age', 'Income($)']])
y_predict
df['cluster'] = y_predict
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'))
```

OUTPUT:



Therefore, the elbow point is 3

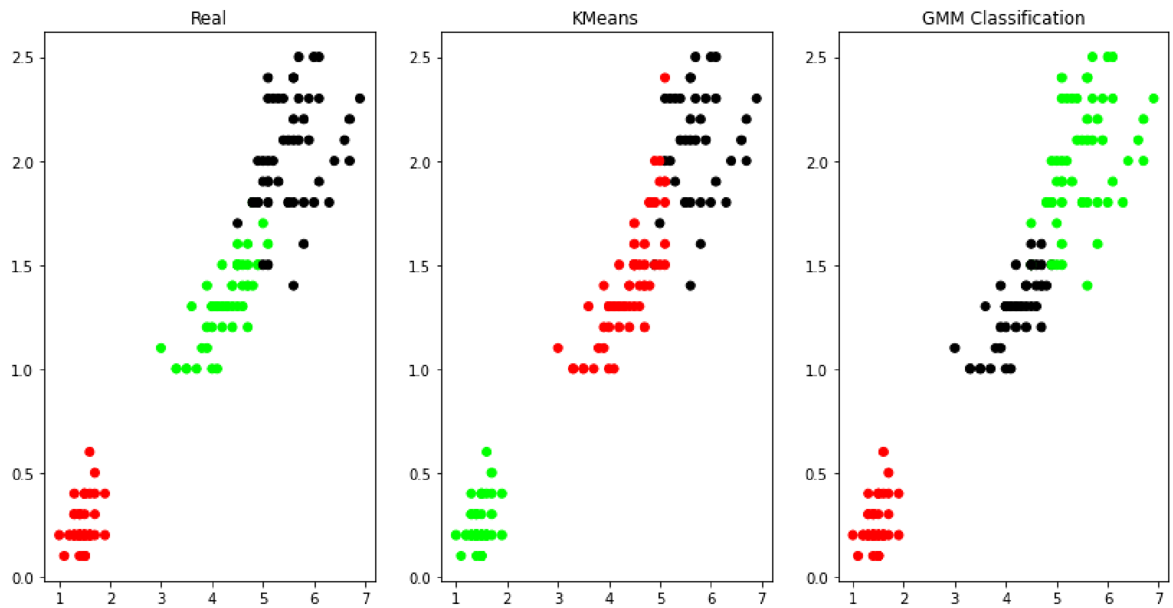


8. Comparing K Means and EM algorithm

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

names = ['Sepal_Length','Sepal_Width','Petal_Length','Petal_Width', 'Class']

dataset = pd.read_csv("/content/dataset.csv", names=names)

X = dataset.iloc[:, :-1]

label = {'Iris-setosa': 0,'Iris-versicolor': 1, 'Iris-virginica': 2}

y = [label[c] for c in dataset.iloc[:, -1]]

plt.figure(figsize=(14,7))
colormap=np.array(['red','lime','black'])


plt.subplot(1,3,1)
plt.title('Real')
plt.scatter(X.Petal_Length,X.Petal_Width,c=colormap[y])


model=KMeans(n_clusters=3, random_state=0).fit(X)
plt.subplot(1,3,2)
plt.title('KMeans')
plt.scatter(X.Petal_Length,X.Petal_Width,c=colormap[model.labels_])

print('The accuracy score of K-Mean: ',metrics.accuracy_score(y, model.labels_))
print('The Confusion matrixof K-Mean:\n',metrics.confusion_matrix(y, model.labels_))


gmm=GaussianMixture(n_components=3, random_state=0).fit(X)
y_cluster_gmm=gmm.predict(X)
plt.subplot(1,3,3)
plt.title('GMM Classification')
plt.scatter(X.Petal_Length,X.Petal_Width,c=colormap[y_cluster_gmm])

print('The accuracy score of EM: ',metrics.accuracy_score(y, y_cluster_gmm))
print('The Confusion matrix of EM:\n ',metrics.confusion_matrix(y, y_cluster_gmm))
```

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:  0.36666666666666664
The Confusion matrix of EM:
  [[50  0  0]
 [ 0  5 45]
 [ 0 50  0]]
```

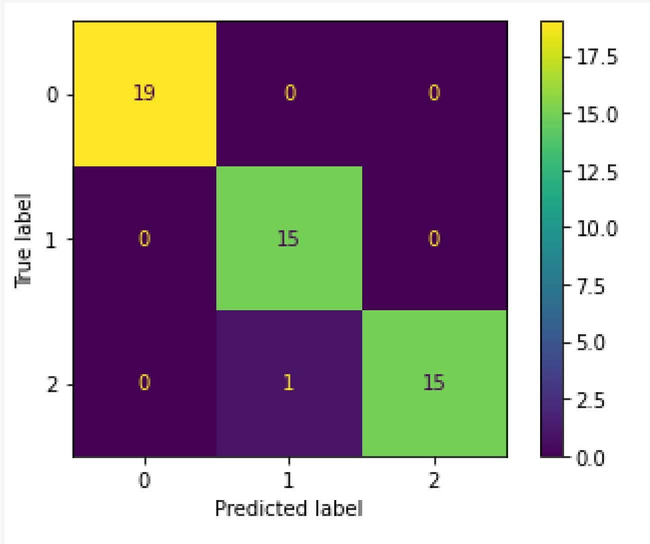


9. K Nearest Neighbors

```
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('target')
print(Y)
X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size=0.33, random_state=42)

#Training the model with Nearest nighbors K=3
knn=KNeighborsClassifier(n_neighbors=3)
knn.fit(X_train,y_train)
from sklearn.metrics import accuracy_score

y_pred=knn.predict(X_test)
matrix =confusion_matrix(y_test,y_pred)
print(" Confusion matrix:\n",matrix)
print(" Correct predicition",accuracy_score(y_test,y_pred))
print(" Wrong predicition",(1-accuracy_score(y_test,y_pred)))
print(' Accuracy Metrics')
print(classification_report(y_test,y_pred))
from sklearn.metrics import ConfusionMatrixDisplay
cm_plot = ConfusionMatrixDisplay(confusion_matrix = confusion_matrix(y_test, y_pred))
cm_plot.plot()
```

OUTPUT:

```
 Confusion matrix:
 [[19  0  0]
 [ 0 15  0]
 [ 0  1 15]]
 Correct predicition 0.98
 Wrong predicition 0.020000000000000018
 Accuracy Metrics
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        19
           1       0.94      1.00      0.97        15
           2       1.00      0.94      0.97        16

    accuracy                           0.98        50
   macro avg       0.98      0.98      0.98        50
weighted avg       0.98      0.98      0.98        50
```

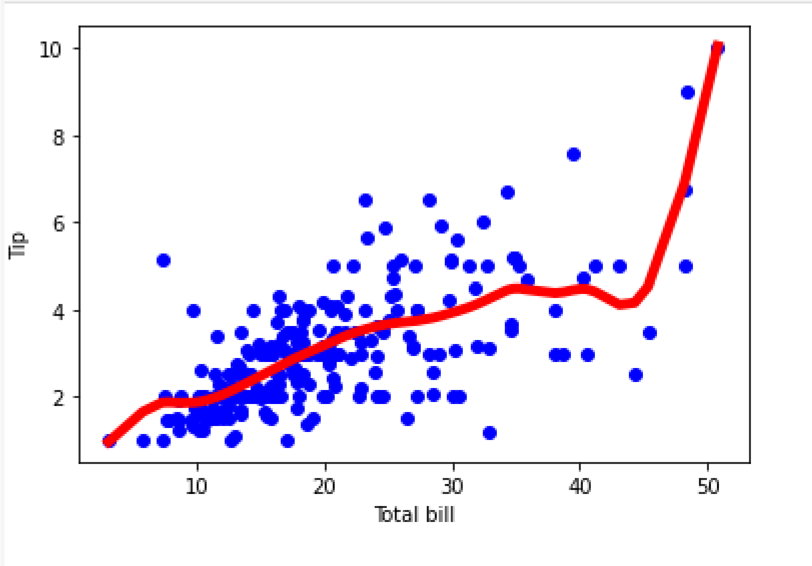


19
0
0
0
15
0
0
1
15
True label
0
1
2
Predicted label
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0

10. Locally weighted regression without sklearn

```
from numpy import *
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
def kernel(point,xmat, k):
 m,n = np1.shape(xmat)
 weights = np1.mat(np1.eye((m)))
 for j in range(m):
    diff = point - X[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 = (X.T*(wei*X)).I*(X.T*(wei*ymat.T))
        return W
def localWeightRegression(xmat,ymat,k):
        m,n = np1.shape(xmat)
        ypred = np1.zeros(m)
        for i in range(m):
           ypred[i] = xmat[i]*localWeight(xmat[i],xmat,ymat,k)
        return ypred
data = pd.read_csv('/content/tips.csv')
bill = np1.array(data.total_bill)
tip = np1.array(data.tip)
#preparing and add 1 in bill
mbill = np1.mat(bill)
mtip = np1.mat(tip) # mat is used to convert to n dimesiona to 2 dimensional array form
m= np1.shape(mbill)[1]
# print(m) 244 data is stored in m
one = np1.mat(np1.ones(m))
X= np1.hstack((one.T,mbill.T)) # create a stack of bill from ONE
#print(X)
#set k here
ypred = localWeightRegression(X,mtip,2)
SortIndex = X[:,1].argsort(0)
xsort = X[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=5)
plt.xlabel('Total bill')
plt.ylabel('Tip')
plt.show()
```

OUTPUT:



with python libraries

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

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]

 # fit model: normal equations with kernel
 xw = X.T * radial_kernel(x0, X, tau) # XTranspose * W

 beta = np.linalg.pinv(xw @ X) @ xw @ Y #@ Matrix Multiplication or Dot Product


 # predict value
 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))
# Weight or Radial Kernal Bias Function

n = 1000
# generate dataset
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])
# jitter X
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 through regression
 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)]]))
```

```
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 :
 [-3.12282223 -2.9216174  -3.14051918 -3.09805236 -3.08215798 -2.88090494
 -3.05412007 -3.12734019 -2.98129254]
 Xo Domain Space(10 Samples) :
 [-2.97993311 -2.95986622 -2.93979933 -2.91973244 -2.89966555 -2.87959866
 -2.85953177 -2.83946488 -2.81939799]
```