VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaNangama", Belgaum -590014, Karnataka.

LAB REPORT on

Machine Learning

Submitted by

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in partial fulfilment for the award of the degree of

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in

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(Autonomous Institution under VTU)

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "Machine Learning" carried out byNOOR FATHIMA ARFA **(1BM19CS108),** 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 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 the different learning algorithms.
CO2	Ability to analyse 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.

a) Using CSV as input:

```
import csv

def updateHypothesis(x,h):
 if h==[]:
 return x

 for i in range(0,len(h)):
 if x[i].upper()!=h[i].upper():
 h[i] = '?'

 return h

if __name__ == "__main__":
 data = []
 h = []

 # reading csv file
 with open('Desktop/FindS.csv', 'r') as file:
 reader = csv.reader(file)
 print("Data: ")
 for row in reader:
 data.append(row)
 print(row)
 if data:
 for x in data:
 if x[-1].upper()=="YES":
 x.pop() # removing last field
 h = updateHypothesis(x,h)
 print("\nHypothesis: ",h)
```

Output:

```
Data:
['Time', 'Weather', 'Temperature', 'Company', 'Humidity', 'Wind', 'Goes']
['Morning', 'Sunny', 'Warm', 'Yes', 'Mild', 'Strong', 'Yes']
['Evening', 'Rainy', 'Cold', 'No', 'Mild', 'Normal', 'No']
['Morning', 'Sunny', 'Moderate', 'Yes', 'Normal', 'Normal', 'Yes']
['Evening', 'Sunny', 'Cold', 'Yes', 'High', 'Strong', 'Yes']

Hypothesis:  ['?', 'Sunny', '?', 'Yes', '?', '?']
```

B) Using user Input:

```
import numpy as np
import pandas as pd

n=int(input("Enter the number of attributes "))
l=int(input("Enter the number of rows "))

print("Enter the ",n,"ättributes")
attributes=[]
for i in range(1,n+1):
 print("Enter the name of ",i," attribute ")
 name=input()

for i in range(1,l+1):
 print("Ënter the values of ",i," row")
 print("Enter the values of attributes")
 res=[]
 for j in range(1,l+1):
 res.append(input())
 attributes.append(res)

print("Enter the target values")
target=[]
for i in range(1,l+1):
 print("Enter the value of ",i," target")
 x=input()
 target.append(x)

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(attributes,target))
```

Output:

```
Enter the  3 ättributes
Enter the name of  1  attribute

Enter the name of  2  attribute

Enter the name of  3  attribute

Ënter the values of  1  row
Enter the values of attributes

Ënter the values of  2  row
Enter the values of attributes

Ënter the values of  3  row
Enter the values of attributes

Enter the target values
Enter the value of  1  target

Enter the value of  2  target

Enter the value of  3  target

 The final hypothesis is: ['?', 'Rainy', 'Cold']
```


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

```
import numpy as np
import pandas as pd

#to read the data in the csv file
data = pd.DataFrame(data=pd.read_csv('/content/drive/MyDrive/enjoysport.csv'))
print(data,"\n")

#making an array of all the attributes
concepts = np.array(data.iloc[:,0:-1])
print("The attributes are: ",concepts)
```

```
#segregating the target that has positive and negative examples
target = np.array(data.iloc[:,-1])
print("\n The target is: ",target)

#training function to implement candidate_elimination algorithm
def learn(concepts, target):
 specific_h = concepts[0].copy()
 print("\n Initialization of specific_h and general_h")
 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":
 for x in range(len(specific_h)):
 if h[x]!= specific_h[x]:
 specific_h[x] ='?'
 general_h[x][x] ='?'
 # print(specific_h)
 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("\n Steps of Candidate Elimination Algorithm",i+1)
 print(specific_h)
 print(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)

#obtaining the final hypothesis
print("\nFinal Specific_h:", s_final, sep="\n")
```



```
print("\nFinal General_h:", g_final, sep="\n")
```

Output:

```
     sky  temp humidity    wind water forcast enjoysport
0  sunny  warm   normal  strong  warm    same       yes
1  sunny  warm     high  strong  warm    same       yes
2  rainy  cold     high  strong  warm  change        no
3  sunny  warm     high  strong  cool  change       yes

The attributes are:  [['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
 ['sunny' 'warm' 'high' 'strong' 'warm' 'same']
 ['rainy' 'cold' 'high' 'strong' 'warm' 'change']
 ['sunny' 'warm' 'high' 'strong' 'cool' 'change']]

 The target is:  ['yes' 'yes' 'no' 'yes']

 Initialization of specific_h and general_h
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?
'?', '?'], ['?', '?', '?', '?', '?', '?']]

 Steps of Candidate Elimination Algorithm 1
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?
'?', '?'], ['?', '?', '?', '?', '?', '?']]

 Steps of Candidate Elimination Algorithm 2
['sunny' 'warm' '?' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?
'?', '?'], ['?', '?', '?', '?', '?', '?']]

 Steps of Candidate Elimination Algorithm 3
['sunny' 'warm' '?' 'strong' 'warm' 'same']
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?',
'?', '?', '?'], ['?', '?', '?', '?', '?', 'same']]

 Steps of Candidate Elimination Algorithm 4
['sunny' 'warm' '?' 'strong' '?' '?']
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?',
'?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

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.

a)ID3 :

```
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.csv")

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


Output:

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


b) Using SKlearn:

import pandas **as** pd

```
import numpy as np

from sklearn.datasets import load_iris

data = load_iris()
```

In [2]:

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

In [3]:

```
df.head()
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)
```

In [5]:

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

y = df["Species"]
```

In [6]:

```
feature_names = x.columns
labels = y.unique()
```

In [7]:

```
from sklearn.model_selection import train_test_split

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

In [8]:

```
 from sklearn.tree import DecisionTreeClassifier
 clf = DecisionTreeClassifier(max_depth =4, random_state = 42)
```

In [9]:

```
clf.fit(X_train, y_train)
test_pred = clf.predict(test_x)
```

In [11]:

```
from sklearn import metrics

 import seaborn as sns

 import matplotlib.pyplot as plt
```



```
confusion_matrix = metrics.confusion_matrix(test_lab,test_pred)
```

In [12]:

```
confusion_matrix

matrix_df = pd.DataFrame(confusion_matrix)
ax = plt.axes()
sns.set(font_scale=1.3)
plt.figure(figsize=(10,7))
sns.heatmap(matrix_df, annot=True, fmt="g", ax=ax, cmap="magma")
ax.set_title('Confusion Matrix - Decision Tree')
ax.set_xlabel("Predicted label", fontsize =15)
ax.set_xticklabels([""]+labels)
ax.set_ylabel("True Label", fontsize=15)
ax.set_yticklabels(list(labels), rotation = 0)
plt.show()

clf.score(test_x,test_lab)

from sklearn import tree
fig = plt.figure(figsize=(25,20))
_ = tree.plot_tree(clf,
 feature_names=data.feature_names,
 class_names=data.target_names,
 filled=True)
```

Output:

Out[3]:

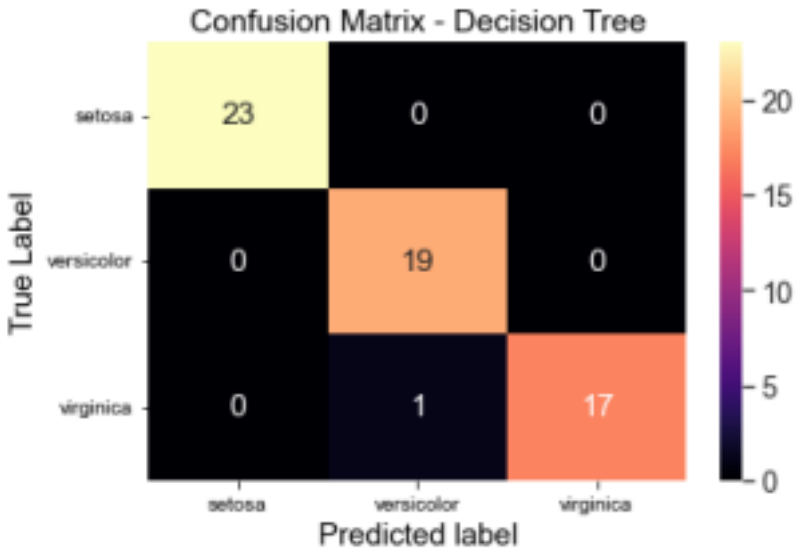
	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
0	5.1	3.5	1.4	0.2
1	4.9	3.0	1.4	0.2
2	4.7	3.2	1.3	0.2
3	4.6	3.1	1.5	0.2
4	5.0	3.6	1.4	0.2

Out[9]:

```
DecisionTreeClassifier(max_depth=4, random_state=42)
```

Out[12]:

```
array([[23,  0,  0],
       [ 0, 19,  0],
       [ 0,  1, 17]], dtype=int64)
```



In [14]: clf

Out[14]: 0.98

gini
samp
value =
class =

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

a) Without using SKlearn:

```
import numpy as np
import pandas as pd

data = pd.read_csv('/content/dataset.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:]
print(f"Number of instances in training set: {len(X_train)}")
print(f"Number of instances in testing set: {len(X_val)}")
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
```



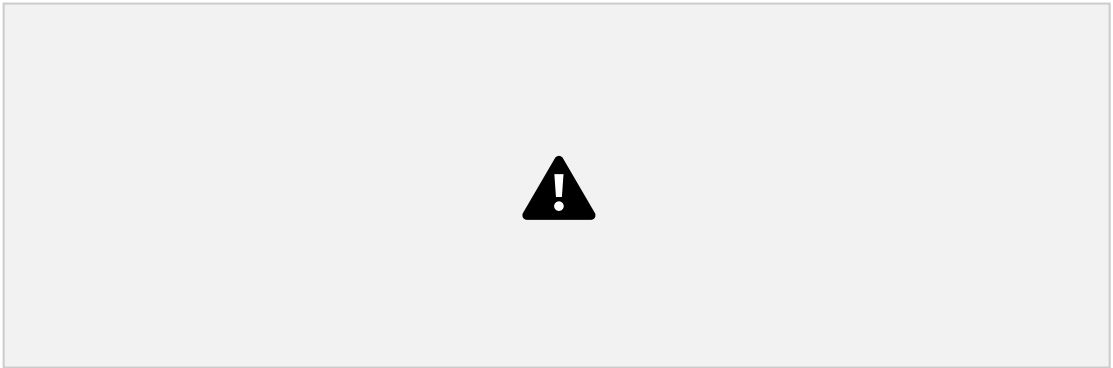
```
 return solve
nbc = NaiveBayesClassifier(X_train, y_train)
total_cases = len(y_val)
good = 0
bad = 0
predictions = []
for i in range(total_cases):
 predict = nbc.classify(X_val[i])
 predictions.append(predict)
 if y_val[i] == predict:
 good += 1
 else:
 bad += 1
print('Predicted values:', predictions)
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:

Out[2]:

	PlayTennis	Outlook	Temperature	Humidity	Wind
0	No	Sunny	Hot	High	Weak
1	No	Sunny	Hot	High	Strong
2	Yes	Overcast	Hot	High	Weak
3	Yes	Rain	Mild	High	Weak
4	Yes	Rain	Cool	Normal	Weak

```
Target Values: ['No', 'No', 'Yes', 'Yes', 'Yes', 'No', 'Yes', 'No', 'Yes', 'Yes', 'Yes', 'Yes', 'Yes', 'No']
Features:
[['Sunny' 'Hot' 'High' 'Weak']
 ['Sunny' 'Hot' 'High' 'Strong']
 ['Overcast' 'Hot' 'High' 'Weak']
 ['Rain' 'Mild' 'High' 'Weak']
 ['Rain' 'Cool' 'Normal' 'Weak']
 ['Rain' 'Cool' 'Normal' 'Strong']
 ['Overcast' 'Cool' 'Normal' 'Strong']
 ['Sunny' 'Mild' 'High' 'Weak']
 ['Sunny' 'Cool' 'Normal' 'Weak']
 ['Rain' 'Mild' 'Normal' 'Weak']
 ['Sunny' 'Mild' 'Normal' 'Strong']
 ['Overcast' 'Mild' 'High' 'Strong']
 ['Overcast' 'Hot' 'Normal' 'Weak']
 ['Rain' 'Mild' 'High' 'Strong']]
```

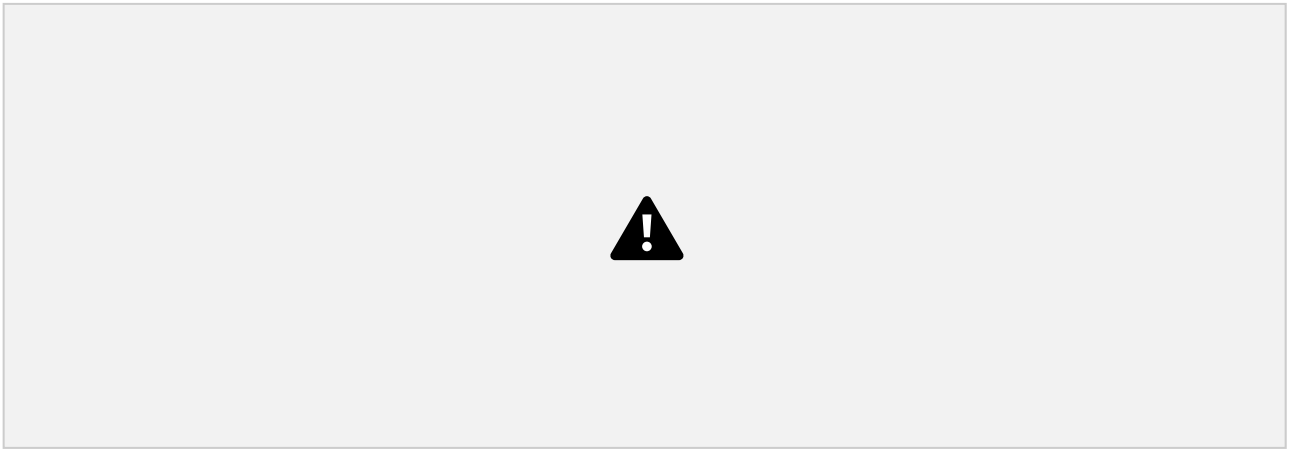



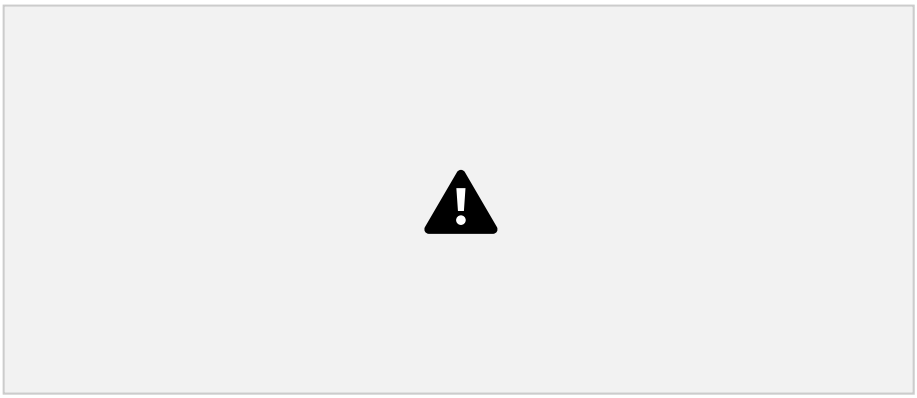
b)Using SKlearn:

```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
```

```
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import GaussianNB
from sklearn import metrics

df = pd.read_csv("/content/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
y = df[predicted_class_names].values
print(df.head)
xtrain,xtest,ytrain,ytest=train_test_split(X,y,test_size=0.33)
print ('\nThe total number of Training Data:',ytrain.shape)
print ('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('\nConfusion matrix')
print(metrics.confusion_matrix(ytest,predicted))
print('\nAccuracy of the classifier:',metrics.accuracy_score(ytest,predicted))
print('The value of Precision:', metrics.precision_score(ytest,predicted))
print('The value of Recall:', metrics.recall_score(ytest,predicted))
print("Predicted Value for individual Test Data:", predictTestData)
```


Output:





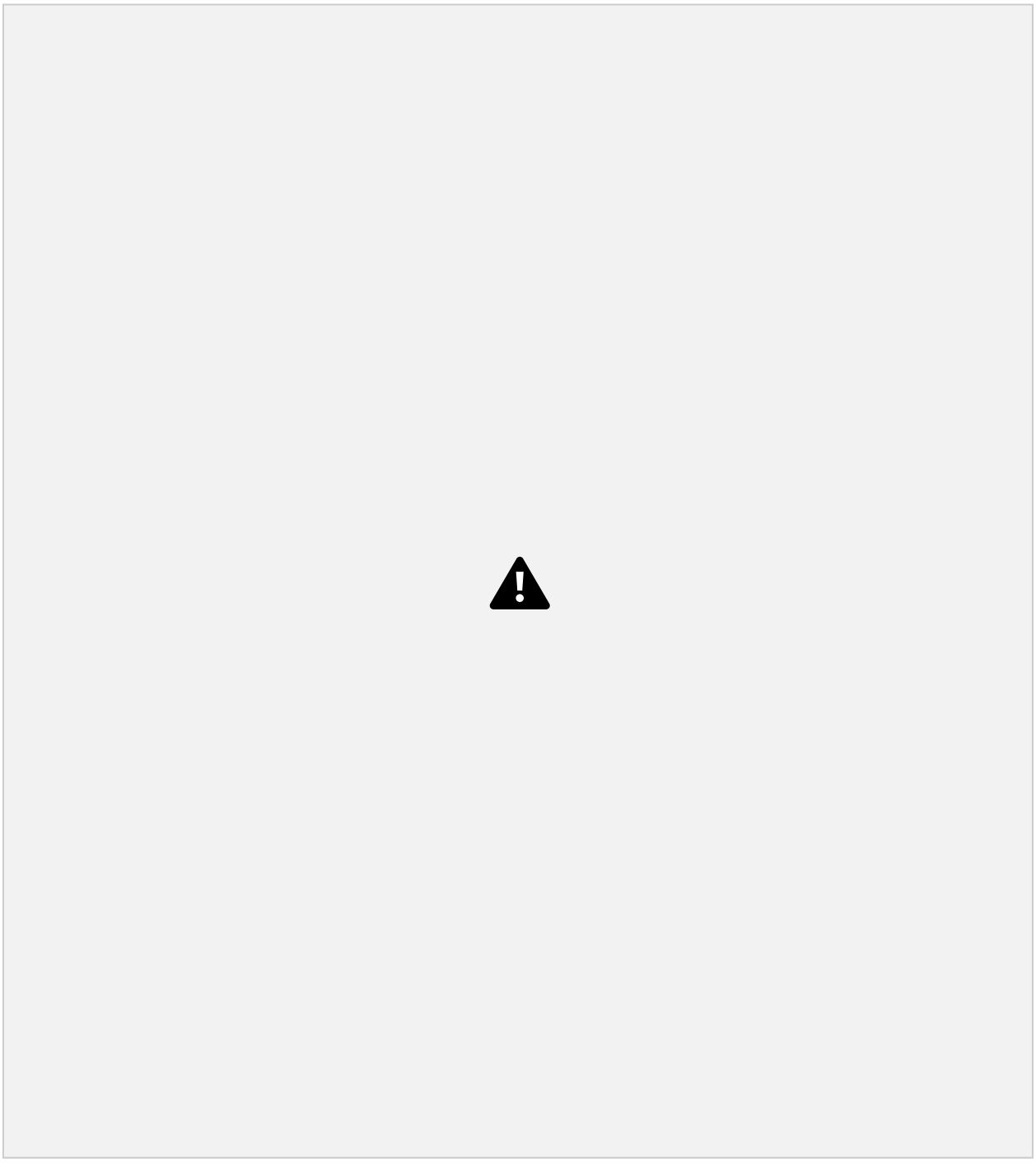
5)Implement the Linear Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

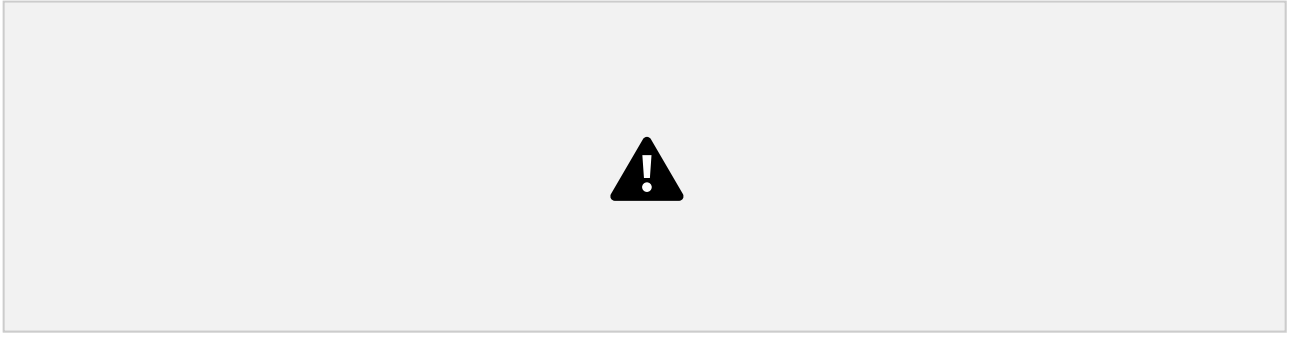
a)Using SKlearn:

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

# Importing the dataset
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)

# 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()
# Predicting the Test set results
y_pred = regressor.predict(X_test)
print(y_pred)
```


Output:

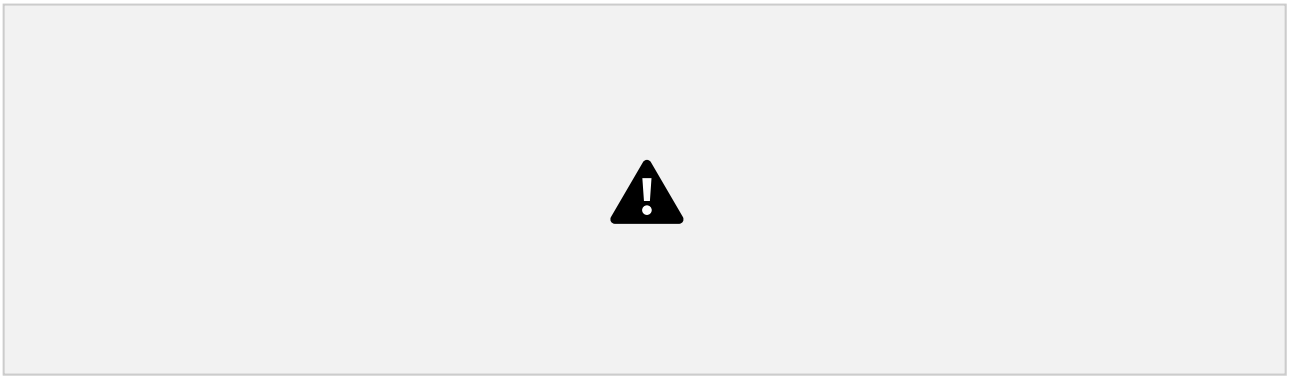




b) Without using SKlearn:

```
import pandas as pd
import numpy as np

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))


from sklearn.model_selection import train_test_split
from sklearn.datasets import fetch_california_housing

fetch_california_housing

data, labels = fetch_california_housing(return_X_y = True)

data.shape, labels.shape

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.w

lro.predict(X_test)


lro.score(X_test, y_test)
```


Output:



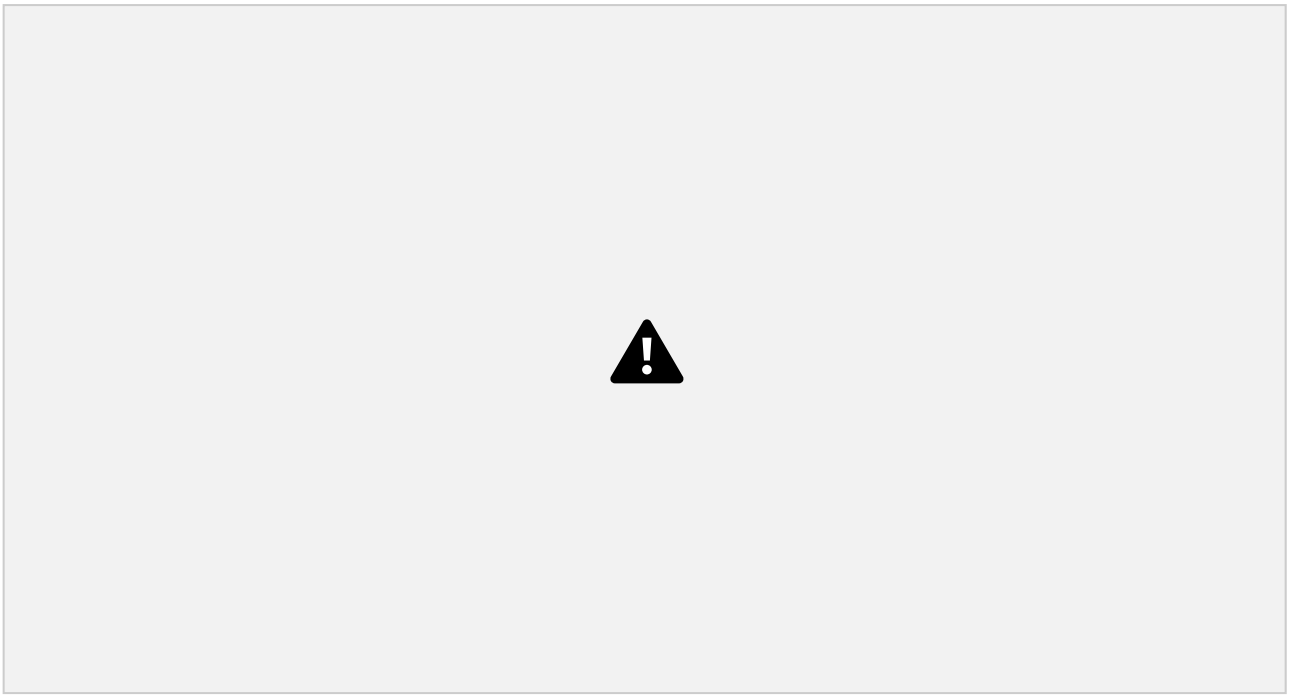
6) Write a program to construct a Bayesian network considering training data. Use this model to make predictions.

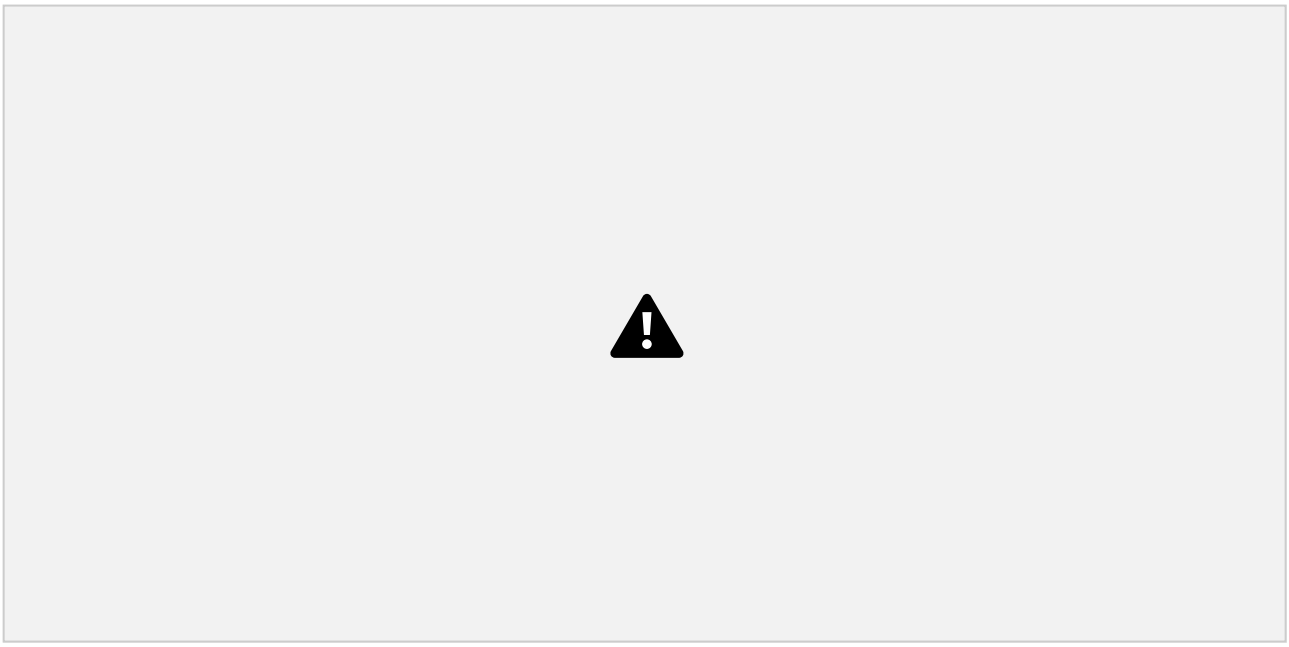
a) Using built-in:

```
!pip install pgmpy
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('heart_disease.csv')
heartDisease = heartDisease.replace('?',np.nan)

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

print('\n Attributes and datatypes')
print(heartDisease.dtypes)
model=
BayesianModel([('age','Heartdisease'),('sex','Heartdisease'),('exang','Heartdisease'),('cp','Heartdisease'),('He
artdisease','restecg'),('Heartdisease','chol')])
print('\nLearning 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')
q1=HeartDiseasetest_infer.query(variables=['Heartdisease'],evidence={'restecg':1})
print(q1)

print('\n 2. Probability of HeartDisease given evidence= cp ')
q2=HeartDiseasetest_infer.query(variables=['Heartdisease'],evidence={'cp':2})
print(q2)
```


Output:





b) Without using built-in:

```
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
```

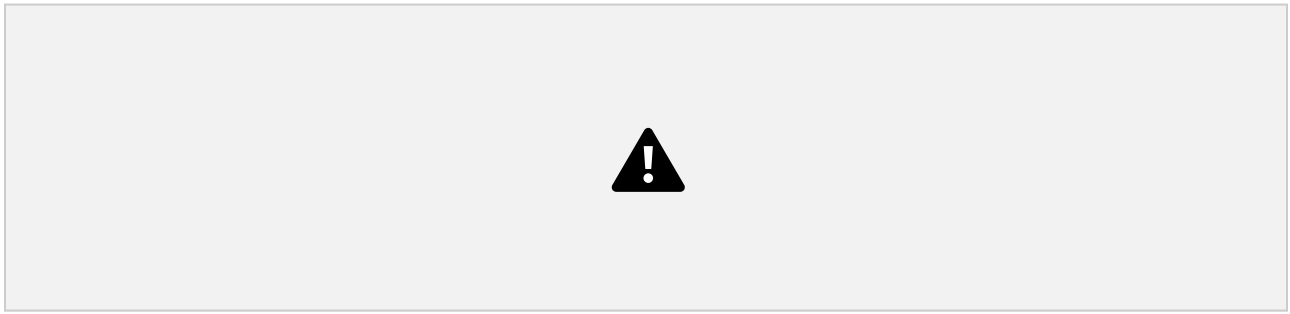
```
# Age
ageEnum = {'SuperSeniorCitizen': 0, 'SeniorCitizen': 1,
'MiddleAged': 2, 'Youth': 3, 'Teen': 4}
# Gender
genderEnum = {'Male': 0, 'Female': 1}
# FamilyHistory
familyHistoryEnum = {'Yes': 0, 'No': 1}
# Diet(Calorie Intake)
dietEnum = {'High': 0, 'Medium': 1, 'Low': 2}
# LifeStyle
lifeStyleEnum = {'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")
data =np.array(data, dtype='int8')
N = len(data)
# Input data column assignment
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:



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

a) Using built-in:

```
import pandas as pd
from sklearn.cluster import KMeans
from sklearn.preprocessing import MinMaxScaler
```

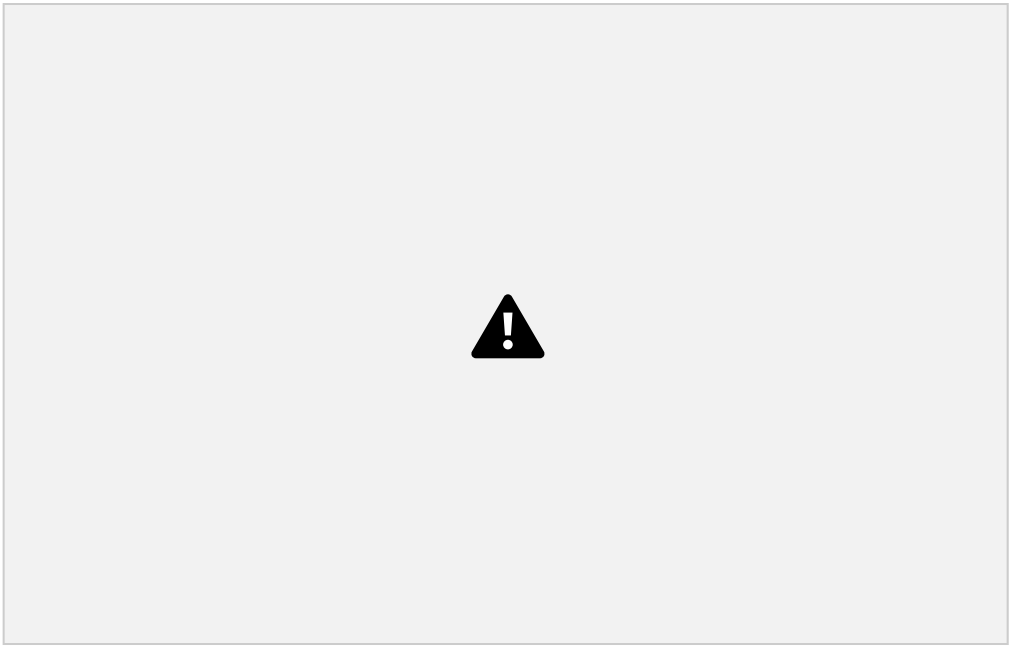
```
from matplotlib import pyplot as plt
%matplotlib inline
df = pd.read_csv('income.csv')
df.head(10)
scaler = MinMaxScaler()
scaler.fit(df[['Age']])
df[['Age']] = scaler.transform(df[['Age']])

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_)
plt.xlabel = 'Number of Clusters'
plt.ylabel = 'Sum of Squared Errors'
plt.plot(k_range, sse)

km = KMeans(n_clusters=3)
km
df0 = df[df.cluster == 0]
df0
df1 = df[df.cluster == 1]
df1
df2 = df[df.cluster == 2]
df2
```



```
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:



b) Without using built-in:

```
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)
 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
```

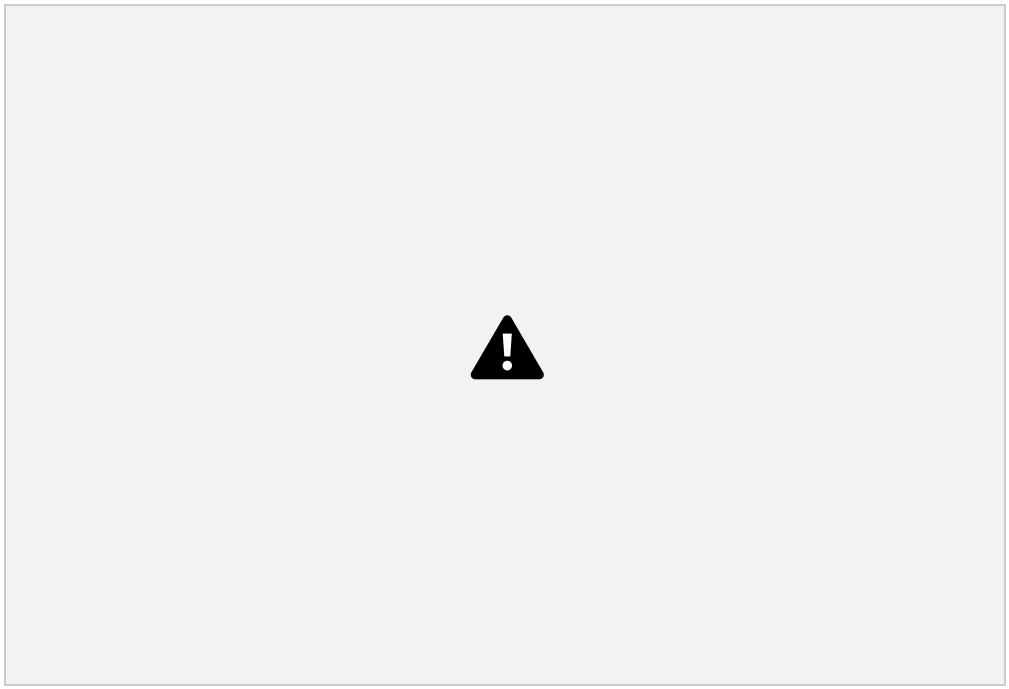
```
def CutToTwoFeatures(items,indexA,indexB):
n = len(items)
 X = []
 for i in range(n):
 item = items[i]
 newItem = [item[indexA],item[indexB]]
X.append(newItem)
 return X

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: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8) Apply EM algorithm to cluster a set of data stored in a .CSV file. Compare the results of k-Means algorithm 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'])
# Plot the Original Classifications
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')
# Plot the Models Classifications
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)
```



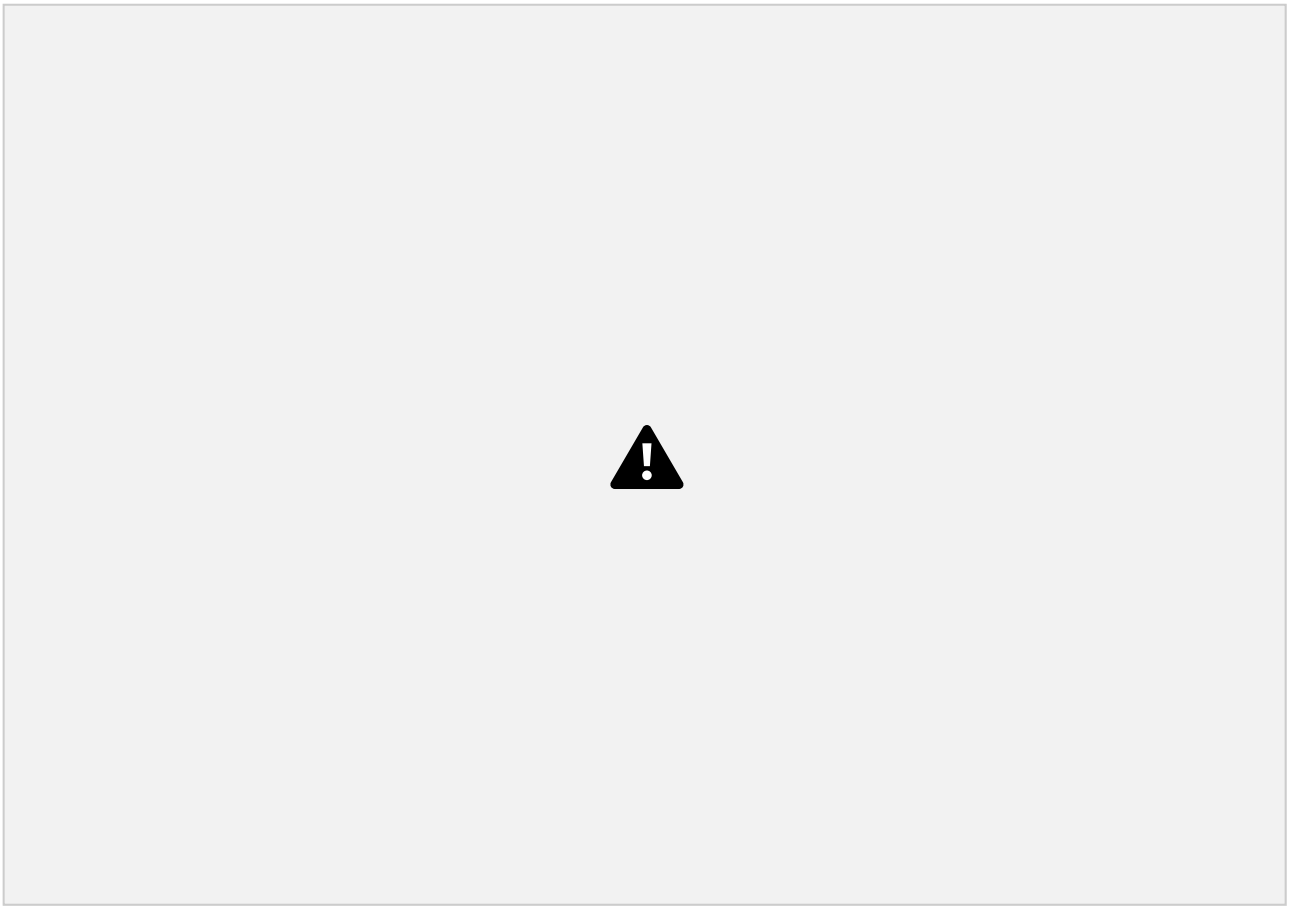
```
#xs.sample(5)

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

y_gmm = gmm.predict(xs)
#y_cluster_gmm
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))
```

Output:



9) Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.

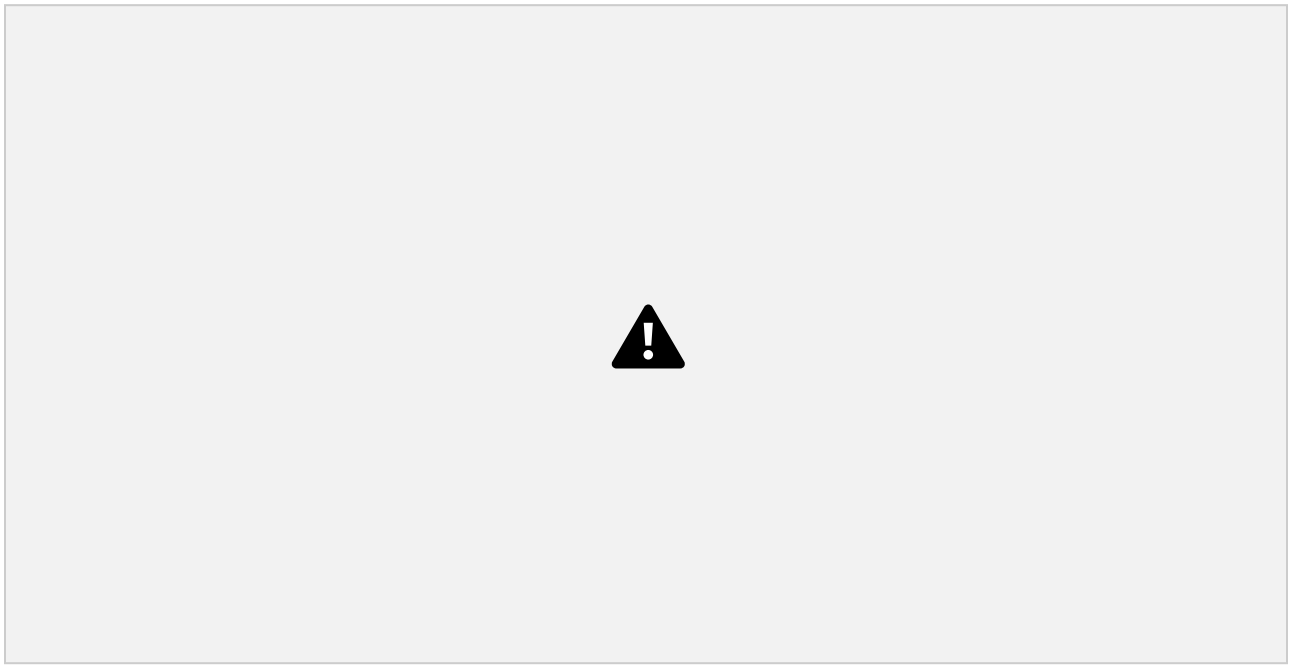
```
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import classification_report, confusion_matrix
from sklearn import datasets

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)
#To Training the model and Nearest nighbors K=5
classifier = KNeighborsClassifier(n_neighbors=5)
classifier.fit(x_train, y_train)
#To make predictions on our test data
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))
```


Output:



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

a) Using built-in:

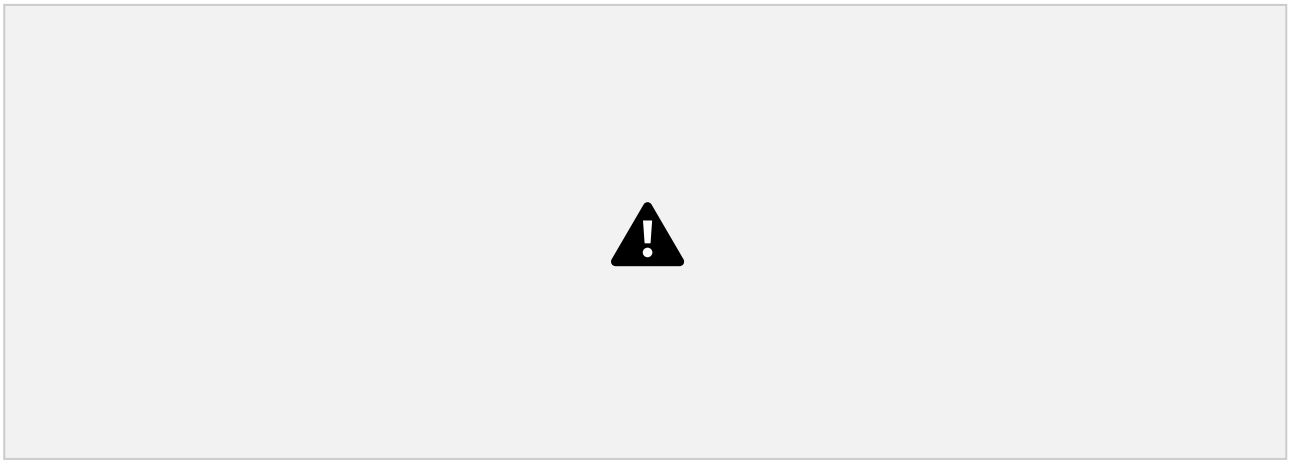
```
import numpy as np
from bokeh.plotting import figure, show, output_notebook
from bokeh.layouts import gridplot
from bokeh.io import push_notebook

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)]]))
```

Output:



b) Without using built-in:

```
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
data = pd.read_csv('10-dataset.csv')
bill = np.array(data.total_bill)
tip = np.array(data.tip)
```

```
#preparing and add 1 in bill
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))
ypred = localWeightRegression(X,mtip,0.5)
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();
```


Output: