VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

MACHINE LEARNING
(20CS6PCMAL)

Submitted by

SAMPREETH P (1BM19CS142)

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

B. M. S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**MACHINE LEARNING**"was carried out by **SAMPREETH P (1BM19CS142),** who isa bona fide 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 ofthe course**MACHINE LEARNING(20CS6PCMAL)**work prescribed for the said degree.

Name of the Lab-In charge	**SARITHA A N**
Designation	Assistant Professor
Department of CSE	Department of CSE
BMSCE, Bengaluru	BMSCE, Bengaluru

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Index Sheet

Course Outcome:-

At the end of the course the student will be able to

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.

Lab Program -1 :-

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

<u>Source code and output :-</u>

+*In[1]:*+

[source, ipython3]

```
import csv
hypo = ['%','%','%','%','%','%'];

with open(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\lab 1\finds.csv') as csv_file:
    readcsv = csv.reader(csv_file, delimiter=',')
    print(readcsv)

    data = []
    print("\nThe given training examples are:")
    for row in readcsv:
        print(row)
        if row[len(row)-1].upper() == "YES":
            data.append(row)
```

+*Out[1]:*+

```
<_csv.reader object at 0x0000013B7E4DFD60>
```

The given training examples are:

['sky', 'air temp', 'humidity', 'wind', 'water', 'forecast', 'enjoy sport']

['sunny', 'warm', 'normal', 'strong', 'warm', 'same', 'yes']

['sunny', 'warm', 'high', 'strong', 'warm', 'same', 'yes']

['rainy', 'cold', 'high', 'strong', 'warm', 'change', 'no']

['sunny', 'warm', 'high', 'strong', 'cool', 'change', 'yes']

+*In[2]:*+

[source, ipython3]

```
print("\nThe positive examples are:");
for x in data:
    print(x);
print("\n");
```

+*Out[2]:*+

The positive examples are:

['sunny', 'warm', 'normal', 'strong', 'warm', 'same', 'yes']

['sunny', 'warm', 'high', 'strong', 'warm', 'same', 'yes']

['sunny', 'warm', 'high', 'strong', 'cool', 'change', 'yes']

+*In[3]:*+

[source, ipython3]

```
TotalExamples = len(data);
i=0;
j=0;
k=0;
print("The steps of the Find-s algorithm are :\n",hypo);
list = [];
p=0;
d=len(data[p])-1;
for j in range(d):
    list.append(data[i][j]);
hypo=list;
i=1;
for i in range(TotalExamples):
    for k in range(d):
        if hypo[k]!=data[i][k]:
            hypo[k]='?';
            k=k+1;
        else:
            hypo[k];
    print(hypo);
i=i+1;
```

+*Out[3]:*+

The steps of the Find-s algorithm are :

 ['%', '%', '%', '%', '%', '%']

['sunny', 'warm', 'normal', 'strong', 'warm', 'same']

['sunny', 'warm', '?', 'strong', 'warm', 'same']

['sunny', 'warm', '?', 'strong', '?', '?']

+*In[4]:*+

[source, ipython3]

```
print("\nThe maximally specific Find-s hypothesis for the given training examples is :");
list=[];
for i in range(d):
    list.append(hypo[i]);
print(list);
```

+*Out[4]:*+

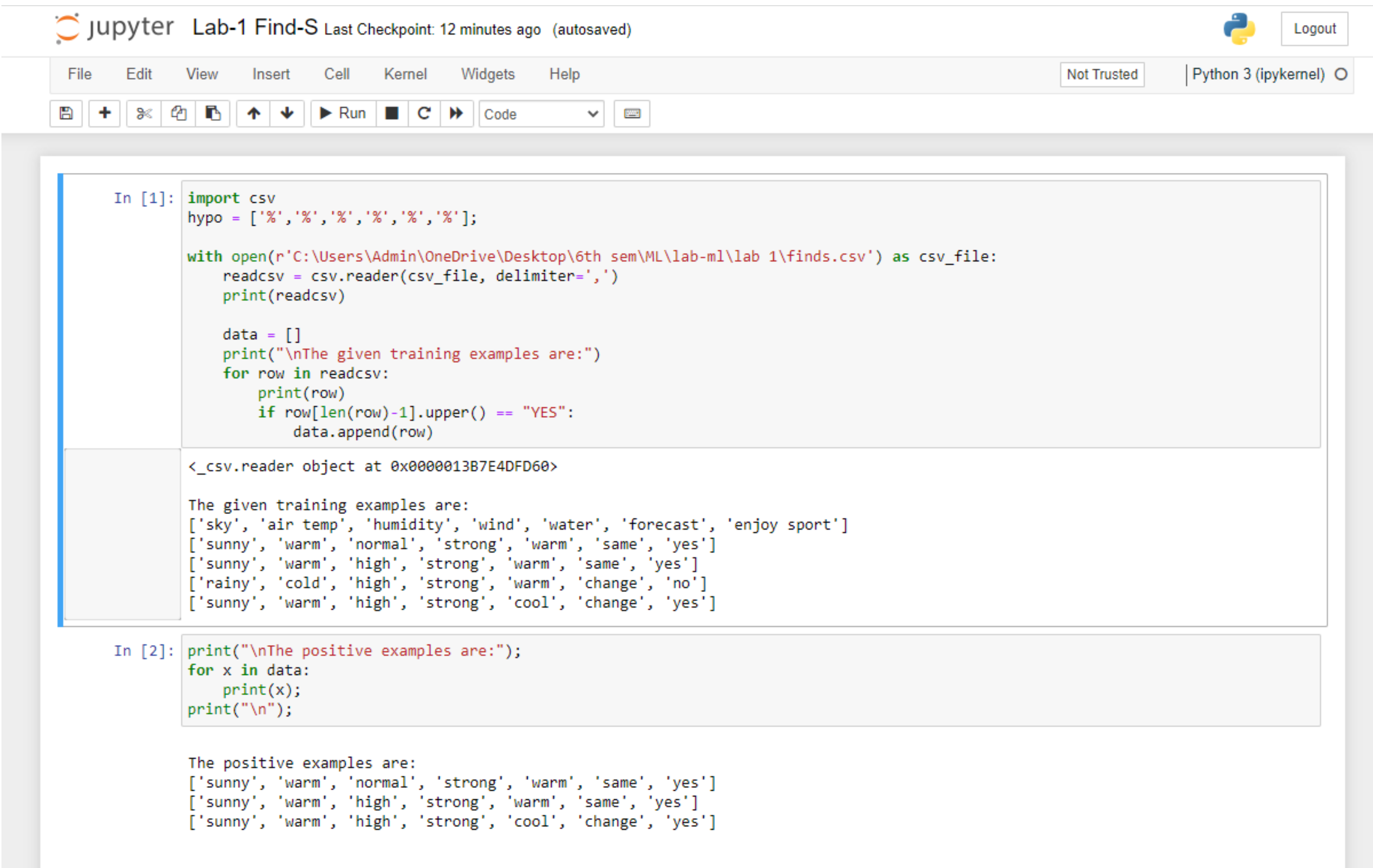
The maximally specific Find-s hypothesis for the given training examples is :

['sunny', 'warm', '?', 'strong', '?', '?']

+*In[ ]:*+

[source, ipython3]

<u>Output screenshots :-</u>




```
import csv
hypo = ['%','%','%','%','%','%'];

with open(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\lab 1\finds.csv') as csv_file:
    readcsv = csv.reader(csv_file, delimiter=',')
    print(readcsv)

    data = []
    print("\nThe given training examples are:")
    for row in readcsv:
        print(row)
        if row[len(row)-1].upper() == "YES":
            data.append(row)
```

```
<_csv.reader object at 0x0000013B7E4DFD60>

The given training examples are:
['sky', 'air temp', 'humidity', 'wind', 'water', 'forecast', 'enjoy sport']
['sunny', 'warm', 'normal', 'strong', 'warm', 'same', 'yes']
['sunny', 'warm', 'high', 'strong', 'warm', 'same', 'yes']
['rainy', 'cold', 'high', 'strong', 'warm', 'change', 'no']
['sunny', 'warm', 'high', 'strong', 'cool', 'change', 'yes']
```



```
print("\nThe positive examples are:");
for x in data:
    print(x);
print("\n");
```

```

The positive examples are:
['sunny', 'warm', 'normal', 'strong', 'warm', 'same', 'yes']
['sunny', 'warm', 'high', 'strong', 'warm', 'same', 'yes']
['sunny', 'warm', 'high', 'strong', 'cool', 'change', 'yes']
```

jupyter Lab-1 Find-S 1BM19CS159 Last Checkpoint: 14 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help

Not Trusted

Python 3 (ipykernel)

Run Code

```
['sunny', 'warm', 'high', 'strong', 'cool', 'change', 'yes']
```

In [3]:

```python
TotalExamples = len(data);
i=0;
j=0;
k=0;
print("The steps of the Find-s algorithm are :\n",hypo);
list = [];
p=0;
d=len(data[p])-1;
for j in range(d):
    list.append(data[i][j]);
hypo=list;
i=1;
for i in range(TotalExamples):
    for k in range(d):
        if hypo[k]!=data[i][k]:
            hypo[k]='?';
            k=k+1;
        else:
            hypo[k];
    print(hypo);
i=i+1;
```

```
The steps of the Find-s algorithm are :
 ['%', '%', '%', '%', '%', '%']
['sunny', 'warm', 'normal', 'strong', 'warm', 'same']
['sunny', 'warm', '?', 'strong', 'warm', 'same']
['sunny', 'warm', '?', 'strong', '?', '?']
```

In [4]:

```python
print("\nThe maximally specific Find-s hypothesis for the given training examples is :");
list=[];
for i in range(d):
    list.append(hypo[i]);
print(list);
```

```
The maximally specific Find-s hypothesis for the given training examples is :
['sunny', 'warm', '?', 'strong', '?', '?']
```

In [ ]:

	A	B	C	D	E	F	G	H
1	sky	air temp	humidity	wind	water	forecast	enjoy sport	
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	
6								
7								
8								

Lab Program -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.

Source code and output :-

+*In[7]:*+

[source, ipython3]

```
import numpy as np

import pandas as pd
```

+*In[10]:*+

[source, ipython3]

```
# Loading Data from a CSV File

data = pd.DataFrame(data=pd.read_csv(r'C:\Users\Admin\OneDrive\Desktop\6th
sem\ML\lab-ml\lab 2\trainingdata.csv'))

print(data)
```

+*Out[10]:*+

```
    sky airtemp humidity    wind water forecast 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
```

+*In[11]:*+

[source, ipython3]

```
# Separating concept features from Target
concepts = np.array(data.iloc[:,0:-1])
print(concepts)
```

+*Out[11]:*+

```
[['Sunny' 'Warm' 'Normal' 'Strong' 'Warm' 'Same']
 ['Sunny' 'Warm' 'High' 'Strong' 'Warm' 'Same']
 ['Rainy' 'Cold' 'High' 'Strong' 'Warm' 'Change']
 ['Sunny' 'Warm' 'High' 'Strong' 'Cool' 'Change']]
```

+*In[12]:*+

[source, ipython3]

```
# Isolating target into a separate DataFrame
# copying last column to target array
target = np.array(data.iloc[:,-1])
print(target)
```

+*Out[12]:*+

['Yes' 'Yes' 'No' 'Yes']

+*In[13]:*+

[source, ipython3]

```
def learn(concepts, target):

    '''
    learn() function implements the learning method of the Candidate elimination algorithm.
    Arguments:
        concepts - a data frame with all the features
```

```
        target - a data frame with corresponding output values
    '''


    # Initialise S0 with the first instance from concepts
    # .copy() makes sure a new list is created instead of just pointing to the same memory
location
    specific_h = concepts[0].copy()
    print("\nInitialization of specific_h and general_h")
    print(specific_h)
    #h=["#" for i in range(0,5)]
    #print(h)

    general_h = [["?" for i in range(len(specific_h))] for i in range(len(specific_h))]
    print(general_h)
    # The learning iterations
    for i, h in enumerate(concepts):

        # Checking if the hypothesis has a positive target
        if target[i] == "Yes":
            for x in range(len(specific_h)):

                # Change values in S & G only if values change
                if h[x] != specific_h[x]:
                    specific_h[x] = '?'
                    general_h[x][x] = '?'

        # Checking if the hypothesis has a positive target
```

```
        if target[i] == "No":
            for x in range(len(specific_h)):
                # For negative hyposthesis change values only  in G
                if h[x] != specific_h[x]:
                    general_h[x][x] = specific_h[x]
                else:
                    general_h[x][x] = '?'

        print("\nSteps of Candidate Elimination Algorithm",i+1)
        print(specific_h)
        print(general_h)

    # find indices where we have empty rows, meaning those that are unchanged
    indices = [i for i, val in enumerate(general_h) if val == ['?', '?', '?', '?', '?', '?']]
    for i in indices:
        # remove those rows from general_h
        general_h.remove(['?', '?', '?', '?', '?', '?'])
    # Return final values
    return specific_h, general_h
```

+*In[14]:*+

[source, ipython3]

```
s_final, g_final = learn(concepts, target)
```

```
print("\nFinal Specific_h:", s_final, sep="\n")

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

+*Out[14]:*+

```
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', '?', '?', '?', '?']]

+*In[ ]:*+

[source, ipython3]

<u>Output screenshots :-</u>

jupyter Lab-2 Candidate Elimination 1BM19CS159 Last Checkpoint: 5 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3 (ipykernel)

In [7]:
```python
import numpy as np
import pandas as pd
```

In [10]:
```python
# Loading Data from a CSV File
data = pd.DataFrame(data=pd.read_csv(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\lab 2\trainingdata.csv'))
print(data)
```

```
     sky airtemp humidity    wind water forecast 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
```

In [11]:
```python
# Separating concept features from Target
concepts = np.array(data.iloc[:,0:-1])
print(concepts)
```

```
[['Sunny' 'Warm' 'Normal' 'Strong' 'Warm' 'Same']
 ['Sunny' 'Warm' 'High' 'Strong' 'Warm' 'Same']
 ['Rainy' 'Cold' 'High' 'Strong' 'Warm' 'Change']
 ['Sunny' 'Warm' 'High' 'Strong' 'Cool' 'Change']]
```

In [12]:
```python
# Isolating target into a separate DataFrame
# copying last column to target array
target = np.array(data.iloc[:,-1])
print(target)
```

```
['Yes' 'Yes' 'No' 'Yes']
```

jupyter Lab-2 Candidate Elimination 1BM19CS159 Last Checkpoint: 5 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3 (ipykernel)

['Yes' 'Yes' 'No' 'Yes']

In [13]:
```python
def learn(concepts, target):
    '''
    learn() function implements the learning method of the Candidate elimination algorithm.
    Arguments:
        concepts - a data frame with all the features
        target - a data frame with corresponding output values
    '''

    # Initialise S0 with the first instance from concepts
    # .copy() makes sure a new list is created instead of just pointing to the same memory location
    specific_h = concepts[0].copy()
    print("\nInitialization of specific_h and general_h")
    print(specific_h)
    #h=["#" for i in range(0,5)]
    #print(h)

    general_h = [["?" for i in range(len(specific_h))] for i in range(len(specific_h))]
    print(general_h)
    # The learning iterations
    for i, h in enumerate(concepts):

        # Checking if the hypothesis has a positive target
        if target[i] == "Yes":
            for x in range(len(specific_h)):

                # Change values in S & G only if values change
                if h[x] != specific_h[x]:
                    specific_h[x] = '?'
                    general_h[x][x] = '?'

        # Checking if the hypothesis has a positive target
        if target[i] == "No":
            for x in range(len(specific_h)):
                # For negative hypothesis change values only  in G
                if h[x] != specific_h[x]:
                    general_h[x][x] = specific_h[x]
                else:
                    general_h[x][x] = '?'

        print("\nSteps of Candidate Elimination Algorithm",i+1)
```

jupyter Lab-2 Candidate Elimination 1BM19CS159 Last Checkpoint: 6 minutes ago (autosaved)

File Edit View Insert Cell Kernel Widgets Help   Trusted   Python 3 (ipykernel)

```python
    # find indices where we have empty rows, meaning those that are unchanged
    indices = [i for i, val in enumerate(general_h) if val == ['?', '?', '?', '?', '?', '?']]
    for i in indices:
        # remove those rows from general_h
        general_h.remove(['?', '?', '?', '?', '?', '?'])
    # Return final values
    return specific_h, general_h
```

In [14]:
```python
s_final, g_final = learn(concepts, target)
print("\nFinal Specific_h:", s_final, sep="\n")
print("\nFinal General_h:", g_final, sep="\n")
```

```
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', '?', '?', '?', '?']]
```

A1 fx sky

	A	B	C	D	E	F	G	H	I	J
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			
6										
7										
8										
9										

Lab Program -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.

Source code and output :-

+*In[1]:*+

[source, ipython3]

```
import numpy as np

import math

import csv
```

+*In[2]:*+

[source, ipython3]

```
def read_data(filename):

    with open(filename, 'r') as csvfile:

        datareader = csv.reader(csvfile, delimiter=',')

        headers = next(datareader)

        metadata = []

        traindata = []

        for name in headers:

            metadata.append(name)
```

```
        for row in datareader:
            traindata.append(row)

    return (metadata, traindata)
```

+*In[5]:*+

[source, ipython3]

```
class Node:
    def __init__(self, attribute):
        self.attribute = attribute
        self.children = []
        self.answer = ""

    def __str__(self):
        return self.attribute
```

+*In[6]:*+

[source, ipython3]

```
def subtables(data, col, delete):
    dict = {}
```

```
    items = np.unique(data[:, col])
    count = np.zeros((items.shape[0], 1), dtype=np.int32)

    for x in range(items.shape[0]):
        for y in range(data.shape[0]):
            if data[y, col] == items[x]:
                count[x] += 1

    for x in range(items.shape[0]):
        dict[items[x]] = np.empty((int(count[x]), data.shape[1]), dtype="|S32")
        pos = 0
        for y in range(data.shape[0]):
            if data[y, col] == items[x]:
                dict[items[x]][pos] = data[y]
                pos += 1
        if delete:
            dict[items[x]] = np.delete(dict[items[x]], col, 1)

    return items, dict
```

+*In[7]:*+

[source, ipython3]

```
def entropy(S):
```

```
    items = np.unique(S)

    if items.size == 1:
        return 0

    counts = np.zeros((items.shape[0], 1))
    sums = 0

    for x in range(items.shape[0]):
        counts[x] = sum(S == items[x]) / (S.size * 1.0)

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

+*In[8]:*+
[source, ipython3]

```
def gain_ratio(data, col):
    items, dict = subtables(data, col, delete=False)

    total_size = data.shape[0]
    entropies = np.zeros((items.shape[0], 1))
    intrinsic = np.zeros((items.shape[0], 1))
```

```
    for x in range(items.shape[0]):
        ratio = dict[items[x]].shape[0]/(total_size * 1.0)
        entropies[x] = ratio * entropy(dict[items[x]][:, -1])
        intrinsic[x] = ratio * math.log(ratio, 2)

    total_entropy = entropy(data[:, -1])
    iv = -1 * sum(intrinsic)

    for x in range(entropies.shape[0]):
        total_entropy -= entropies[x]

    return total_entropy / iv
```

+*In[9]:*+

[source, ipython3]

```
def create_node(data, metadata):
    if (np.unique(data[:, -1])).shape[0] == 1:
        node = Node("")
        node.answer = np.unique(data[:, -1])[0]
        return node

    gains = np.zeros((data.shape[1] - 1, 1))
```

```
    for col in range(data.shape[1] - 1):
        gains[col] = gain_ratio(data, col)

    split = np.argmax(gains)

    node = Node(metadata[split])
    metadata = np.delete(metadata, split, 0)

    items, dict = subtables(data, split, delete=True)

    for x in range(items.shape[0]):
        child = create_node(dict[items[x]], metadata)
        node.children.append((items[x], child))

    return node
```

+*In[10]:*+

[source, ipython3]

```
def empty(size):
    s = ""
    for x in range(size):
        s += "   "
```

```
    return s


def print_tree(node, level):
    if node.answer != "":
        print(empty(level), node.answer)
        return
    print(empty(level), node.attribute)
    for value, n in node.children:
        print(empty(level + 1), value)
        print_tree(n, level + 2)
```

+*In[11]:*+

[source, ipython3]

```
metadata, traindata = read_data(r"C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 3\id3 training dataset.csv")
data = np.array(traindata)
node = create_node(data, metadata)
print_tree(node, 0)
```

+*Out[11]:*+

```
 Outlook
```

```
  overcast
    b'yes'
  rain
    Wind
      b'strong'
        b'no'
      b'weak'
        b'yes'
  sunny
    Humidity
      b'high'
        b'no'
      b'normal'
        b'yes'
```

+*In[ ]:*+

[source, ipython3]

Output screenshots :-

Jupyter Lab-3 ID3 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help

Trusted | Python 3 (ipykernel)

Run Code

In [1]:
```
import numpy as np
import math
import csv
```

In [2]:
```
def read_data(filename):
    with open(filename, 'r') as csvfile:
        datareader = csv.reader(csvfile, delimiter=',')
        headers = next(datareader)
        metadata = []
        traindata = []
        for name in headers:
            metadata.append(name)
        for row in datareader:
            traindata.append(row)

    return (metadata, traindata)
```

In [5]:
```
class Node:
    def __init__(self, attribute):
        self.attribute = attribute
        self.children = []
        self.answer = ""

    def __str__(self):
        return self.attribute
```

In [6]:
```
def subtables(data, col, delete):
    dict = {}
    items = np.unique(data[:, col])
    count = np.zeros((items.shape[0], 1), dtype=np.int32)

    for x in range(items.shape[0]):
        for y in range(data.shape[0]):
            if data[y, col] == items[x]:
                count[x] += 1

    for x in range(items.shape[0]):
        dict[items[x]] = np.empty((int(count[x]), data.shape[1]), dtype="|S32")
        pos = 0
        for y in range(data.shape[0]):
            if data[y, col] == items[x]:
                dict[items[x]][pos] = data[y]
                pos += 1
        if delete:
```

Jupyter Lab-3 ID3 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3 (ipykernel)

```
            dict[items[x]] = np.delete(dict[items[x]], col, 1)

    return items, dict
```

In [7]:
```
def entropy(S):
    items = np.unique(S)

    if items.size == 1:
        return 0

    counts = np.zeros((items.shape[0], 1))
    sums = 0

    for x in range(items.shape[0]):
        counts[x] = sum(S == items[x]) / (S.size * 1.0)

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

In [8]:
```
def gain_ratio(data, col):
    items, dict = subtables(data, col, delete=False)

    total_size = data.shape[0]
    entropies = np.zeros((items.shape[0], 1))
    intrinsic = np.zeros((items.shape[0], 1))

    for x in range(items.shape[0]):
        ratio = dict[items[x]].shape[0]/(total_size * 1.0)
        entropies[x] = ratio * entropy(dict[items[x]][:, -1])
        intrinsic[x] = ratio * math.log(ratio, 2)

    total_entropy = entropy(data[:, -1])
    iv = -1 * sum(intrinsic)

    for x in range(entropies.shape[0]):
        total_entropy -= entropies[x]

    return total_entropy / iv
```

```
In [9]: def create_node(data, metadata):
            if (np.unique(data[:, -1])).shape[0] == 1:
                node = Node("")
                node.answer = np.unique(data[:, -1])[0]
                return node

            gains = np.zeros((data.shape[1] - 1, 1))

            for col in range(data.shape[1] - 1):
                gains[col] = gain_ratio(data, col)

            split = np.argmax(gains)

            node = Node(metadata[split])
            metadata = np.delete(metadata, split, 0)

            items, dict = subtables(data, split, delete=True)

            for x in range(items.shape[0]):
                child = create_node(dict[items[x]], metadata)
                node.children.append((items[x], child))

            return node
```

jupyter Lab-3 ID3 1BM19CS159 Last Checkpoint: 6 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3 (ipykernel)

Run Code

```
In [10]: def empty(size):
             s = ""
             for x in range(size):
                 s += "   "
             return s

         def print_tree(node, level):
             if node.answer != "":
                 print(empty(level), node.answer)
                 return
             print(empty(level), node.attribute)
             for value, n in node.children:
                 print(empty(level + 1), value)
                 print_tree(n, level + 2)
```

```
In [11]: metadata, traindata = read_data(r"C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 3\id3 training dataset.csv")
         data = np.array(traindata)
         node = create_node(data, metadata)
         print_tree(node, 0)
```

```
 Outlook
    overcast
       b'yes'
    rain
       Wind
          b'strong'
             b'no'
          b'weak'
             b'yes'
    sunny
       Humidity
          b'high'
             b'no'
          b'normal'
             b'yes'
```

```
In [ ]:
```

A1 | f_x Outlook

	A	B	C	D	E	F	G
1	Outlook	Temperat	Humidity	Wind	Answer		
2	sunny	hot	high	weak	no		
3	sunny	hot	high	strong	no		
4	overcast	hot	high	weak	yes		
5	rain	mild	high	weak	yes		
6	rain	cool	normal	weak	yes		
7	rain	cool	normal	strong	no		
8	overcast	cool	normal	strong	yes		
9	sunny	mild	high	weak	no		
10	sunny	cool	normal	weak	yes		
11	rain	mild	normal	weak	yes		
12	sunny	mild	normal	strong	yes		
13	overcast	mild	high	strong	yes		
14	overcast	hot	normal	weak	yes		
15	rain	mild	high	strong	no		
16							
17							

Lab Program -4.a.:-

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

Source code and output :-

```
+*In[1]:*+

[source, ipython3]

----

# import necessary libarities

import pandas as pd

from sklearn import tree

from sklearn.preprocessing import LabelEncoder

from sklearn.naive_bayes import GaussianNB


# load data from CSV

data = pd.read_csv(r"C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 4\Naive Bayesian classifier training dataset.csv")

print("THe first 5 values of data is :\n",data.head())

----


+*Out[1]:*+

----

THe first 5 values of data is :

    Outlook Temperature Humidity  Windy PlayTennis
```

```
0    Sunny       Hot    High  False       No
1    Sunny       Hot    High   True       No
2  Overcast       Hot    High  False      Yes
3    Rainy      Mild    High  False      Yes
4    Rainy      Cool   Normal  False      Yes
```

+*In[2]:*+

[source, ipython3]

```
# obtain Train data and Train output
X = data.iloc[:,:-1]
print("\nThe First 5 values of train data is\n",X.head())
```

+*Out[2]:*+

```
The First 5 values of train data is
    Outlook Temperature Humidity  Windy
0    Sunny       Hot    High  False
1    Sunny       Hot    High   True
2  Overcast       Hot    High  False
3    Rainy      Mild    High  False
```

4   Rainy   Cool   Normal False

+*In[3]:*+

[source, ipython3]

```
y = data.iloc[:,-1]
print("\nThe first 5 values of Train output is\n",y.head())
```

+*Out[3]:*+

```
The first 5 values of Train output is
 0     No
1     No
2    Yes
3    Yes
4    Yes
Name: PlayTennis, dtype: object
```

+*In[4]:*+

[source, ipython3]

```
# Convert then in numbers
le_outlook = LabelEncoder()
X.Outlook = le_outlook.fit_transform(X.Outlook)

le_Temperature = LabelEncoder()
X.Temperature = le_Temperature.fit_transform(X.Temperature)

le_Humidity = LabelEncoder()
X.Humidity = le_Humidity.fit_transform(X.Humidity)

le_Windy = LabelEncoder()
X.Windy = le_Windy.fit_transform(X.Windy)

print("\nNow the Train data is :\n",X.head())
```

+*Out[4]:*+

```
Now the Train data is :
   Outlook  Temperature  Humidity  Windy
0       2           1        0     0
1       2           1        0     1
```

```
2       0           1        0     0
3       1           2        0     0
4       1           0        1     0
```

+*In[5]:*+

[source, ipython3]

```
le_PlayTennis = LabelEncoder()
y = le_PlayTennis.fit_transform(y)
print("\nNow the Train output is\n",y)
```

+*Out[5]:*+

```
Now the Train output is
 [0 0 1 1 1 0 1 0 1 1 1 1 1 0]
```

+*In[6]:*+

[source, ipython3]

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.20)

classifier = GaussianNB()
classifier.fit(X_train,y_train)

from sklearn.metrics import accuracy_score
print("Accuracy is:",accuracy_score(classifier.predict(X_test),y_test))
----
```

+*Out[6]:*+

```
----
Accuracy is: 0.3333333333333333
----
```

+*In[ ]:*+

```
[source, ipython3]
----

----
```

Output screenshots :-

jupyter Lab 4 - Naive bayesian classifier 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help

Not Trusted

Python 3 (ipykernel)

Run Code

In [1]:
```
# import necessary libarities
import pandas as pd
from sklearn import tree
from sklearn.preprocessing import LabelEncoder
from sklearn.naive_bayes import GaussianNB

# load data from CSV
data = pd.read_csv(r"C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 4\Naive Bayesian classifier training dataset.csv")
print("THe first 5 values of data is :\n",data.head())
```

```
THe first 5 values of data is :
    Outlook Temperature Humidity  Windy PlayTennis
0     Sunny         Hot     High  False         No
1     Sunny         Hot     High   True         No
2  Overcast         Hot     High  False        Yes
3     Rainy        Mild     High  False        Yes
4     Rainy        Cool   Normal  False        Yes
```

In [2]:
```
# obtain Train data and Train output
X = data.iloc[:,:-1]
print("\nThe First 5 values of train data is\n",X.head())
```

```

The First 5 values of train data is
    Outlook Temperature Humidity  Windy
0     Sunny         Hot     High  False
1     Sunny         Hot     High   True
2  Overcast         Hot     High  False
3     Rainy        Mild     High  False
4     Rainy        Cool   Normal  False
```

In [3]:
```
y = data.iloc[:,-1]
print("\nThe first 5 values of Train output is\n",y.head())
```

```

The first 5 values of Train output is
 0     No
1     No
2    Yes
3    Yes
4    Yes
Name: PlayTennis, dtype: object
```

jupyter Lab 4 - Naive bayesian classifier 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help

Not Trusted

Python 3 (ipykernel)

Run Code

In [4]:

```
# Convert then in numbers
le_outlook = LabelEncoder()
X.Outlook = le_outlook.fit_transform(X.Outlook)

le_Temperature = LabelEncoder()
X.Temperature = le_Temperature.fit_transform(X.Temperature)

le_Humidity = LabelEncoder()
X.Humidity = le_Humidity.fit_transform(X.Humidity)

le_Windy = LabelEncoder()
X.Windy = le_Windy.fit_transform(X.Windy)

print("\nNow the Train data is :\n",X.head())
```

```
Now the Train data is :
    Outlook  Temperature  Humidity  Windy
0        2            1         0      0
1        2            1         0      1
2        0            1         0      0
3        1            2         0      0
4        1            0         1      0
```

In [5]:

```
le_PlayTennis = LabelEncoder()
y = le_PlayTennis.fit_transform(y)
print("\nNow the Train output is\n",y)
```

```
Now the Train output is
 [0 0 1 1 1 0 1 0 1 1 1 1 1 0]
```

In [6]:

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.20)

classifier = GaussianNB()
classifier.fit(X_train,y_train)

from sklearn.metrics import accuracy_score
print("Accuracy is:",accuracy_score(classifier.predict(X_test),y_test))
```

```
Accuracy is: 0.3333333333333333
```

In [ ]:

Outlook	Temperat	Humidity	Windy	PlayTennis
Sunny	Hot	High	FALSE	No
Sunny	Hot	High	TRUE	No
Overcast	Hot	High	FALSE	Yes
Rainy	Mild	High	FALSE	Yes
Rainy	Cool	Normal	FALSE	Yes
Rainy	Cool	Normal	TRUE	No
Overcast	Cool	Normal	TRUE	Yes
Sunny	Mild	High	FALSE	No
Sunny	Cool	Normal	FALSE	Yes
Rainy	Mild	Normal	FALSE	Yes
Sunny	Mild	Normal	TRUE	Yes
Overcast	Mild	High	TRUE	Yes
Overcast	Hot	Normal	FALSE	Yes
Rainy	Mild	High	TRUE	No

Lab Program -4.b.:-

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 (without packages).

Source code and output :-

```
+*In[1]:*+

[source, ipython3]

----

import math

import csv

import random

----




+*In[2]:*+

[source, ipython3]

----

# This make sures that the dataset is in an ordered format. If we have some arbirary names in that column it difficult to deal with that.


def encode_class(dataset):

  classes=[]

  for i in range(len(dataset)):

    if dataset[i][-1] not in classes:

      classes.append(dataset[i][-1])
```

```
  # Looping across the classes which we have derived above.This will make sure that we have definitive classes (numeric) and not arbitrary
  for i in range(len(classes)):
    # Looping across all rows of dataset
    for j in range(len(dataset)):
      if dataset[j][-1] == classes[i]:
        dataset[j][-1]=i
  return dataset
```

+*In[3]:*+

[source, ipython3]

```
# Splitting the data between training set and testing set. Normally its a general understanding the training:testing=7:3

def train_test_split(dataset,ratio):
  test_num=int(ratio*len(dataset))
  train=list(dataset)
  test=[]
  for i in range(test_num):
    rand=random.randrange(len(train))
    test.append(train.pop(rand))
  return train,test
```

+*In[4]:*+

[source, ipython3]

```
# Now depending on resultant value (last column values), we need to group the rows. It will be useful for calculating mean and std_dev


def groupUnderClass(train):
  dict={}
  for row in train:
    if row[-1] not in dict:
      dict[row[-1]]=[]
    dict[row[-1]].append(row)
  return dict
```

+*In[5]:*+

[source, ipython3]

```
# Standard formulae (just by-heart)


def mean(val):
  return sum(val)/float(len(val)) #Obvious


def stdDev(val):
```

```
  avg=mean(val)
  variance=sum([pow(x-avg,2) for x in val])/float(len(val)-1) # Especially this one
  return math.sqrt(variance)
```

+*In[6]:*+

[source, ipython3]

```
# We will calculte the mean and std dev with respect to each attribute. Important while calculating gaussian probablity


def meanStdDev(instances):
  info=[(mean(x),stdDev(x)) for x in zip(*instances)] # Here we are taking complete column's values of all instances.
  del info[-1]
  return info
```

+*In[7]:*+

[source, ipython3]

```
# As explained earlier why e need to group. We will be calculating the mean and std dev with respect each class.
```

```
def MeanAndStdDevForClass(train):
  info={}
  dictionary=groupUnderClass(train)
  # print(dictionary)
  for key,value in dictionary.items():
    # dictionary[key]=meanStdDev(value)
    info[key]=meanStdDev(value) #Here value stands for a complete group.
  return info
```

+*In[8]:*+

[source, ipython3]

```
# Its a formula by heart (no choice)

def calculateGaussianProbablity(x,mean,std_dev):
  expo = math.exp(-(math.pow(x - mean, 2) / (2 * math.pow(std_dev, 2))))
  return (1 / (math.sqrt(2 * math.pi) * std_dev)) * expo
```

+*In[9]:*+

[source, ipython3]

After calculating mean and std dev w.r.t training data now its time to check if the logic will work on testing data

```
def calculateClassProbablities(info,ele):
  probablities={}
  for key,summaries in info.items(): # Info contains the groupName (key) and list of (mean,std_dev) for each attribute of that group
    probablities[key]=1
    for i in range(len(summaries)): #Loop across all attributes
      mean,std_dev=summaries[i]
      x=ele[i] # Testing data's one instance's attribute value.
      probablities[key] *= calculateGaussianProbablity(x, mean, std_dev)
  return probablities
```

+*In[10]:*+

[source, ipython3]

```
def predict(info,ele):
  probablities=calculateClassProbablities(info,ele) # returns a dictionary of probablities for each group
  bestLabel,bestProb=None,-1
  # Consider group name whichever gives you the highest probablities for this instance of testing data
```

```
  for key,prob in probablities.items():
    if bestLabel==None or prob>bestProb:
      bestProb=prob
      bestLabel=key
  return bestLabel
```

+*In[11]:*+

[source, ipython3]

```
# Loop across testing data and store the predicted result from our model in the list.

def getPredictions(info,test):
  predictions=[]
  for ele in test:
    result=predict(info,ele) # This will give you the group to which it will belong.
    predictions.append(result)
  return predictions
```

+*In[12]:*+

[source, ipython3]

```
----
def check_accuracy(predictions,test):
  count=0
  for i in range(len(test)):
    if predictions[i]==test[i][-1]:
      count+=1
  return count/float(len(test))*100
----
```

+*In[13]:*+

[source, ipython3]

```
----
filename=r"C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 4\pima-indians-diabetes.csv"
dataset=csv.reader(open(filename))
dataset=list(dataset)
dataset=encode_class(dataset)
for i in range(len(dataset)):
  dataset[i]=[float(x) for x in dataset[i]]

ratio=0.3
print(len(dataset))
train,test=train_test_split(dataset,ratio)
info=MeanAndStdDevForClass(train)

predictions=getPredictions(info,test)
```

accuracy=check_accuracy(predictions,test)

accuracy

+*Out[13]:*+

768

75.21739130434783----

+*In[ ]:*+

[source, ipython3]

<u>Output screenshots :-</u>

jupyter Lab-4(b) Naive Bayesian Classifier (without packages) 1BM19CS159 Last Checkpoint: 3 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help

Trusted

Python 3 (ipykernel)

Run Code

In [1]:
```
import math
import csv
import random
```

In [2]:
```
# This make sures that the dataset is in an ordered format. If we have some arbirary names in that column it difficult to deal wi

def encode_class(dataset):
  classes=[]
  for i in range(len(dataset)):
    if dataset[i][-1] not in classes:
      classes.append(dataset[i][-1])

  # Looping across the classes which we have derived above.This will make sure that we have definitive classes (numeric) and not
  for i in range(len(classes)):
    # Looping across all rows of dataset
    for j in range(len(dataset)):
      if dataset[j][-1] == classes[i]:
        dataset[j][-1]=i
  return dataset
```

In [3]:
```
# Splitting the data between training set and testing set. Normally its a general understanding the training:testing=7:3

def train_test_split(dataset,ratio):
  test_num=int(ratio*len(dataset))
  train=list(dataset)
  test=[]
  for i in range(test_num):
    rand=random.randrange(len(train))
    test.append(train.pop(rand))
  return train,test
```

In [4]:
```
# Now depending on resultant value (last column values), we need to group the rows. It will be usefult for calculating mean and s

def groupUnderClass(train):
  dict={}
  for row in train:
    if row[-1] not in dict:
      dict[row[-1]]=[]
    dict[row[-1]].append(row)
  return dict
```

jupyter Lab-4(b) Naive Bayesian Classifier (without packages) 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3 (ipykernel)

In [5]:
```
# Standard formulae (just by-heart)

def mean(val):
  return sum(val)/float(len(val)) #Obvious

def stdDev(val):
  avg=mean(val)
  variance=sum([pow(x-avg,2) for x in val])/float(len(val)-1) # Especially this one
  return math.sqrt(variance)
```

In [6]:
```
# We will calculte the mean and std dev with respect to each attribute. Important while calculating gaussian probablity

def meanStdDev(instances):
  info=[(mean(x),stdDev(x)) for x in zip(*instances)] # Here we are taking complete column's values of all instances.
  del info[-1]
  return info
```

In [7]:
```
# As explained earlier why e need to group. We will be calculating the mean and std dev with respect each class.

def MeanAndStdDevForClass(train):
  info={}
  dictionary=groupUnderClass(train)
  # print(dictionary)
  for key,value in dictionary.items():
    # dictionary[key]=meanStdDev(value)
    info[key]=meanStdDev(value) #Here value stands for a complete group.
  return info
```

In [8]:
```
# Its a formula by heart (no choice)

def calculateGaussianProbablity(x,mean,std_dev):
  expo = math.exp(-(math.pow(x - mean, 2) / (2 * math.pow(std_dev, 2))))
  return (1 / (math.sqrt(2 * math.pi) * std_dev)) * expo
```

jupyter Lab-4(b) Naive Bayesian Classifier (without packages) 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help   Trusted   Python 3 (ipykernel)

Run   Code

```
  return (1 / (math.sqrt(2 * math.pi) * std_dev)) * expo
```

In [9]:
```
# After calculating mean and std dev w.r.t training data now its time to check if the logic will work on testing data


def calculateClassProbablities(info,ele):
  probablities={}
  for key,summaries in info.items(): # Info contains the groupName (key) and list of (mean,std_dev) for each attribute of that gr
    probablities[key]=1
    for i in range(len(summaries)): #Loop across all attributes
      mean,std_dev=summaries[i]
      x=ele[i] # Testing data's one instance's attribute value.
      probablities[key] *= calculateGaussianProbablity(x, mean, std_dev)
  return probablities
```

In [10]:
```
def predict(info,ele):
  probablities=calculateClassProbablities(info,ele) # returns a dictionary of probablities for each group
  bestLabel,bestProb=None,-1
  # Consider group name whichever gives you the highest probablities for this instance of testing data
  for key,prob in probablities.items():
    if bestLabel==None or prob>bestProb:
      bestProb=prob
      bestLabel=key
  return bestLabel
```

In [11]:
```
# Loop across testing data and store the predicted result from our model in the list.

def getPredictions(info,test):
  predictions=[]
  for ele in test:
    result=predict(info,ele) # This will give you the group to which it will belong.
    predictions.append(result)
  return predictions
```

In [12]:
```
def check_accuracy(predictions,test):
  count=0
  for i in range(len(test)):
    if predictions[i]==test[i][-1]:
      count+=1
  return count/float(len(test))*100
```

Jupyter Lab-4(b) Naive Bayesian Classifier (without packages) 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3 (ipykernel)

```
In [11]: # Loop across testing data and store the predicted result from our model in the list.

def getPredictions(info,test):
  predictions=[]
  for ele in test:
    result=predict(info,ele) # This will give you the group to which it will belong.
    predictions.append(result)
  return predictions
```

```
In [12]: def check_accuracy(predictions,test):
  count=0
  for i in range(len(test)):
    if predictions[i]==test[i][-1]:
      count+=1
  return count/float(len(test))*100
```

```
In [13]: filename=r"C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 4\pima-indians-diabetes.csv"
dataset=csv.reader(open(filename))
dataset=list(dataset)
dataset=encode_class(dataset)
for i in range(len(dataset)):
  dataset[i]=[float(x) for x in dataset[i]]

ratio=0.3
print(len(dataset))
train,test=train_test_split(dataset,ratio)
info=MeanAndStdDevForClass(train)

predictions=getPredictions(info,test)
accuracy=check_accuracy(predictions,test)
accuracy
```

```
768
```

```
Out[13]: 75.21739130434783
```

```
In [ ]:
```

Pregnancies	Glucose	BloodPressure	BloodThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
6	148	72	35	0	33.6	0.627	50	1
1	85	66	29	0	26.6	0.351	31	0
8	183	64	0	0	23.3	0.672	32	1
1	89	66	23	94	28.1	0.167	21	0
0	137	40	35	168	43.1	2.288	33	1
5	116	74	0	0	25.6	0.201	30	0
3	78	50	32	88	31	0.248	26	1
10	115	0	0	0	35.3	0.134	29	0
2	197	70	45	543	30.5	0.158	53	1
8	125	96	0	0	0	0.232	54	1
4	110	92	0	0	37.6	0.191	30	0
10	168	74	0	0	38	0.537	34	1
10	139	80	0	0	27.1	1.441	57	0
1	189	60	23	846	30.1	0.398	59	1
5	166	72	19	175	25.8	0.587	51	1
7	100	0	0	0	30	0.484	32	1
0	118	84	47	230	45.8	0.551	31	1
7	107	74	0	0	29.6	0.254	31	1
1	103	30	38	83	43.3	0.183	33	0
1	115	70	30	96	34.6	0.529	32	1
3	126	88	41	235	39.3	0.704	27	0
8	99	84	0	0	35.4	0.388	50	0
7	196	90	0	0	39.8	0.451	41	1
9	119	80	35	0	29	0.263	29	1
11	143	94	33	146	36.6	0.254	51	1
10	125	70	26	115	31.1	0.205	41	1
7	147	76	0	0	39.4	0.257	43	1

Lab Program -5.:-

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

Source code and output :-

+*In[1]:*+

[source, ipython3]

```
import numpy as np

import matplotlib.pyplot as plt

import pandas as pd
```

+*In[11]:*+

[source, ipython3]

```
dataset = pd.read_csv(r"C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 5\Lr-Salary Dataset.csv")

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

y = dataset.iloc[:, 1].values
```

+*In[13]:*+

[source, ipython3]

----

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)

+*In[14]:*+

[source, ipython3]

Fitting Simple Linear Regression to the Training set

from sklearn.linear_model import LinearRegression

regressor = LinearRegression()

regressor.fit(X_train, y_train)

+*Out[14]:*+

----LinearRegression()----

+*In[15]:*+

[source, ipython3]

Predicting the Test set results

y_pred = regressor.predict(X_test)

+*In[19]:*+

[source, ipython3]

```
# 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()
```

+*Out[19]:*+

```
![png](output_5_0.png)
```

+*In[17]:*+

[source, ipython3]

```
# 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()
```

+*Out[17]:*+

```
![png](output_6_0.png)
```

+*In[ ]:*+

[source, ipython3]


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

Output screenshots :-

jupyter Lab-5 Linear regression 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

File Edit View Insert Cell Kernel Widgets Help | Not Trusted | Python 3 (ipykernel)

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

In [11]:
```
dataset = pd.read_csv(r"C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 5\Lr-Salary Dataset.csv")
X = dataset.iloc[:, :-1].values
y = dataset.iloc[:, 1].values
```

In [13]:
```
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)
```

In [14]:
```
# Fitting Simple Linear Regression to the Training set
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train, y_train)
```

Out[14]:
```
LinearRegression()
```

In [15]:
```
# Predicting the Test set results
y_pred = regressor.predict(X_test)
```

jupyter Lab-5 Linear regression 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

File Edit View Insert Cell Kernel Widgets Help | Not Trusted | Python 3 (ipykernel)

```
y_pred = regressor.predict(X_test)
```

In [19]:
```
# 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()
```

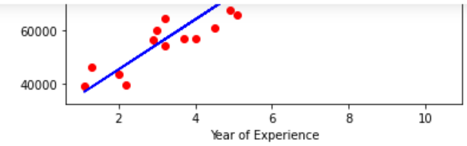
jupyter Lab-5 Linear regression 1BM19CS159 Last Checkpoint: 4 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help

Not Trusted | Python 3 (ipykernel)

Run Code



In [17]:

```
# 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()
```

In [ ]:

format.

A1 | Year

	A	B	C
1	YearsExperience	Salary	
2	1.1	39343	
3	1.3	46205	
4	1.5	37731	
5	2	43525	
6	2.2	39891	
7	2.9	56642	
8	3	60150	
9	3.2	54445	
10	3.2	64445	
11	3.7	57189	
12	3.9	63218	
13	4	55794	
14	4	56957	
15	4.1	57081	
16	4.5	61111	
17	4.9	67938	
18	5.1	66029	
19	5.3	83088	
20	5.9	81363	
21	6	93940	
22	6.8	91738	
23	7.1	98273	
24	7.9	101302	
25	8.2	113812	

Lr-Salary Dataset

Lab Program -6 :-

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

Source code and output :-

+*In[1]:*+

[source, ipython3]

!pip install pgmpy

+*Out[1]:*+

Defaulting to user installation because normal site-packages is not writeable

Collecting pgmpy

  Downloading pgmpy-0.1.18-py3-none-any.whl (1.9 MB)

Requirement already satisfied: scipy in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.7.3)

Requirement already satisfied: pyparsing in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (3.0.4)

Requirement already satisfied: pandas in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.4.2)

Collecting torch

  Downloading torch-1.11.0-cp39-cp39-win_amd64.whl (157.9 MB)

Requirement already satisfied: scikit-learn in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.0.2)

Requirement already satisfied: numpy in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.21.5)

Requirement already satisfied: tqdm in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (4.64.0)

Requirement already satisfied: networkx in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (2.7.1)

Requirement already satisfied: joblib in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.1.0)

Requirement already satisfied: statsmodels in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (0.13.2)

Requirement already satisfied: python-dateutil>=2.8.1 in c:\programdata\anaconda3\lib\site-packages (from pandas->pgmpy) (2.8.2)

Requirement already satisfied: pytz>=2020.1 in c:\programdata\anaconda3\lib\site-packages (from pandas->pgmpy) (2021.3)

Requirement already satisfied: six>=1.5 in c:\programdata\anaconda3\lib\site-packages (from python-dateutil>=2.8.1->pandas->pgmpy) (1.16.0)

Requirement already satisfied: threadpoolctl>=2.0.0 in c:\programdata\anaconda3\lib\site-packages (from scikit-learn->pgmpy) (2.2.0)

Requirement already satisfied: patsy>=0.5.2 in c:\programdata\anaconda3\lib\site-packages (from statsmodels->pgmpy) (0.5.2)

Requirement already satisfied: packaging>=21.3 in c:\programdata\anaconda3\lib\site-packages (from statsmodels->pgmpy) (21.3)

Requirement already satisfied: typing-extensions in c:\programdata\anaconda3\lib\site-packages (from torch->pgmpy) (4.1.1)

Requirement already satisfied: colorama in c:\programdata\anaconda3\lib\site-packages (from tqdm->pgmpy) (0.4.4)

Installing collected packages: torch, pgmpy

Successfully installed pgmpy-0.1.18 torch-1.11.0

WARNING: The scripts convert-caffe2-to-onnx.exe, convert-onnx-to-caffe2.exe and torchrun.exe are installed in 'C:\Users\Admin\AppData\Roaming\Python\Python39\Scripts' which is not on PATH.

Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.

+*In[1]:*+

[source, ipython3]

----

import numpy as np

import pandas as pd

import csv

import pgmpy

```
from pgmpy.estimators import MaximumLikelihoodEstimator

from pgmpy.models import BayesianModel

from pgmpy.inference import VariableElimination
```

+*In[6]:*+

[source, ipython3]

```
#read Cleveland Heart Disease data

heartDisease = pd.read_csv(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 6\heart.csv')

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

+*In[7]:*+

[source, ipython3]

```
#display the data

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

print(heartDisease.head())
```

+*Out[7]:*+

```
Sample instances from the dataset are given below

   Unnamed: 0   age  sex   cp  trestbps   chol  fbs  restecg  thalach  exang  \

0        NaN  63.0  1.0  1.0     145.0  233.0  1.0      2.0    150.0    0.0
```

```
1       NaN  67.0  1.0  4.0    160.0  286.0  0.0    2.0   108.0   1.0

2       NaN  67.0  1.0  4.0    120.0  229.0  0.0    2.0   129.0   1.0

3       NaN  37.0  1.0  3.0    130.0  250.0  0.0    0.0   187.0   0.0

4       NaN  41.0  0.0  2.0    130.0  204.0  0.0    2.0   172.0   0.0


  ...  slope  ca thal heartdisease  Unnamed: 15  Unnamed: 16  Unnamed: 17  \

0 ...    3.0   0   6        0.0        NaN        NaN        NaN

1 ...    2.0   3   3        2.0        NaN        NaN        NaN

2 ...    2.0   2   7        1.0        NaN        NaN        NaN

3 ...    3.0   0   3        0.0        NaN        NaN        NaN

4 ...    1.0   0   3        0.0        NaN        NaN        NaN


  Unnamed: 18  Unnamed: 19  Unnamed: 20

0        NaN        NaN        NaN

1        NaN        NaN        NaN

2        NaN        NaN        NaN

3        NaN        NaN        NaN

4        NaN        NaN        NaN


[5 rows x 21 columns]

----
```

+*In[8]:*+

[source, ipython3]

```
#display the Attributes names and datatyes

print('\n Attributes and datatypes')

print(heartDisease.dtypes)
```

+*Out[8]:*+

```
 Attributes and datatypes
Unnamed: 0      float64
age             float64
sex             float64
cp              float64
trestbps        float64
chol            float64
fbs             float64
restecg         float64
thalach         float64
exang           float64
oldpeak         float64
slope           float64
ca               object
thal             object
heartdisease    float64
Unnamed: 15     float64
Unnamed: 16     float64
Unnamed: 17     float64
Unnamed: 18     float64
Unnamed: 19     float64
Unnamed: 20     float64
dtype: object
```

+*In[9]:*+

[source, ipython3]

#Creat Model-Bayesian Network

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

+*Out[9]:*+

C:\Users\Admin\AppData\Roaming\Python\Python39\site-packages\pgmpy\models\BayesianModel.py:8: FutureWarning: BayesianModel has been renamed to BayesianNetwork. Please use BayesianNetwork class, BayesianModel will be removed in future.

  warnings.warn(

+*In[10]:*+

[source, ipython3]

#Learning CPDs using Maximum Likelihood Estimators

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

model.fit(heartDisease,estimator=MaximumLikelihoodEstimator)

+*Out[10]:*+

 Learning CPD using Maximum likelihood estimators

+*In[11]:*+

[source, ipython3]

```
#Inferencing with Bayesian Network
print('\n Inferencing with Bayesian Network:')
HeartDiseasetest_infer = VariableElimination(model)
```

+*Out[11]:*+

 Inferencing with Bayesian Network:

+*In[12]:*+

[source, ipython3]

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

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

print(q1)

+*Out[12]:*+

1.Probability of HeartDisease given evidence= restecg :1

```
 0%|          | 0/4 [00:00<?, ?it/s]  0%|          | 0/4 [00:00<?, ?it/s]
+-------------------+---------------------+
| heartdisease      |   phi(heartdisease) |
+===================+=====================+
| heartdisease(0.0) |              0.2000 |
+-------------------+---------------------+
| heartdisease(1.0) |              0.2000 |
+-------------------+---------------------+
| heartdisease(2.0) |              0.2000 |
+-------------------+---------------------+
| heartdisease(3.0) |              0.2000 |
+-------------------+---------------------+
| heartdisease(4.0) |              0.2000 |
+-------------------+---------------------+
```

+*In[14]:*+

[source, ipython3]

```
#computing the Probability of HeartDisease given cp

print('\n 2.Probability of HeartDisease given evidence= cp:2 ')

q2=HeartDiseasetest_infer.query(variables=['heartdisease'],evidence={'cp':2})

print(q2)
```

+*Out[14]:*+

```
 2.Probability of HeartDisease given evidence= cp:2

  0%|          | 0/3 [00:00<?, ?it/s]  0%|          | 0/3 [00:00<?, ?it/s]

+------------------+--------------------+

| heartdisease     |   phi(heartdisease) |

+==================+=====================+

| heartdisease(0.0) |           0.2000 |

+------------------+--------------------+

| heartdisease(1.0) |           0.2000 |

+------------------+--------------------+

| heartdisease(2.0) |           0.2000 |

+------------------+--------------------+

| heartdisease(3.0) |           0.2000 |

+------------------+--------------------+

| heartdisease(4.0) |           0.2000 |

+------------------+--------------------+
```

+*In[ ]:*+

[source, ipython3]

----

jupyter Lab-6 Bayesian Network (heart dataset) 1BM19CS159 Last Checkpoint: 6 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help

Trusted | Python 3 (ipykernel)

Run Code

In [1]:
```
!pip install pgmpy
```

```
Defaulting to user installation because normal site-packages is not writeable
Collecting pgmpy
  Downloading pgmpy-0.1.18-py3-none-any.whl (1.9 MB)
Requirement already satisfied: scipy in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.7.3)
Requirement already satisfied: pyparsing in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (3.0.4)
Requirement already satisfied: pandas in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.4.2)
Collecting torch
  Downloading torch-1.11.0-cp39-cp39-win_amd64.whl (157.9 MB)
Requirement already satisfied: scikit-learn in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.0.2)
Requirement already satisfied: numpy in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.21.5)
Requirement already satisfied: tqdm in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (4.64.0)
Requirement already satisfied: networkx in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (2.7.1)
Requirement already satisfied: joblib in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (1.1.0)
Requirement already satisfied: statsmodels in c:\programdata\anaconda3\lib\site-packages (from pgmpy) (0.13.2)
Requirement already satisfied: python-dateutil>=2.8.1 in c:\programdata\anaconda3\lib\site-packages (from pandas->pgmpy) (2.8.
2)
Requirement already satisfied: pytz>=2020.1 in c:\programdata\anaconda3\lib\site-packages (from pandas->pgmpy) (2021.3)
Requirement already satisfied: six>=1.5 in c:\programdata\anaconda3\lib\site-packages (from python-dateutil>=2.8.1->pandas->pgm
py) (1.16.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\programdata\anaconda3\lib\site-packages (from scikit-learn->pgmpy)
(2.2.0)
Requirement already satisfied: patsy>=0.5.2 in c:\programdata\anaconda3\lib\site-packages (from statsmodels->pgmpy) (0.5.2)
Requirement already satisfied: packaging>=21.3 in c:\programdata\anaconda3\lib\site-packages (from statsmodels->pgmpy) (21.3)
Requirement already satisfied: typing-extensions in c:\programdata\anaconda3\lib\site-packages (from torch->pgmpy) (4.1.1)
Requirement already satisfied: colorama in c:\programdata\anaconda3\lib\site-packages (from tqdm->pgmpy) (0.4.4)
Installing collected packages: torch, pgmpy
Successfully installed pgmpy-0.1.18 torch-1.11.0
```

```
  WARNING: The scripts convert-caffe2-to-onnx.exe, convert-onnx-to-caffe2.exe and torchrun.exe are installed in 'C:\Users\Admin
\AppData\Roaming\Python\Python39\Scripts' which is not on PATH.
  Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
```

In [1]:
```
import numpy as np
import pandas as pd
import csv
import pgmpy
from pgmpy.estimators import MaximumLikelihoodEstimator
from pgmpy.models import BayesianModel
from pgmpy.inference import VariableElimination
```

jupyter Lab-6 Bayesian Network (heart dataset) 1BM19CS159 Last Checkpoint: 7 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help   Trusted   Python 3 (ipykernel)

Run   Code

```
from pgmpy.estimators import MaximumLikelihoodEstimator
from pgmpy.models import BayesianModel
from pgmpy.inference import VariableElimination
```

In [6]:
```
#read Cleveland Heart Disease data
heartDisease = pd.read_csv(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 6\heart.csv')
heartDisease = heartDisease.replace('?',np.nan)
```

In [7]:
```
#display the data
print('Sample instances from the dataset are given below')
print(heartDisease.head())
```

```
Sample instances from the dataset are given below
   Unnamed: 0   age  sex   cp  trestbps   chol  fbs  restecg  thalach  exang  \
0         NaN  63.0  1.0  1.0     145.0  233.0  1.0      2.0    150.0    0.0
1         NaN  67.0  1.0  4.0     160.0  286.0  0.0      2.0    108.0    1.0
2         NaN  67.0  1.0  4.0     120.0  229.0  0.0      2.0    129.0    1.0
3         NaN  37.0  1.0  3.0     130.0  250.0  0.0      0.0    187.0    0.0
4         NaN  41.0  0.0  2.0     130.0  204.0  0.0      2.0    172.0    0.0

   ...  slope  ca thal heartdisease  Unnamed: 15  Unnamed: 16  Unnamed: 17  \
0  ...    3.0   0    6          0.0          NaN          NaN          NaN
1  ...    2.0   3    3          2.0          NaN          NaN          NaN
2  ...    2.0   2    7          1.0          NaN          NaN          NaN
3  ...    3.0   0    3          0.0          NaN          NaN          NaN
4  ...    1.0   0    3          0.0          NaN          NaN          NaN

   Unnamed: 18  Unnamed: 19  Unnamed: 20
0          NaN          NaN          NaN
1          NaN          NaN          NaN
2          NaN          NaN          NaN
3          NaN          NaN          NaN
4          NaN          NaN          NaN

[5 rows x 21 columns]
```

jupyter Lab-6 Bayesian Network (heart dataset) 1BM19CS159 Last Checkpoint: 8 minutes ago (autosaved)

Logout

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3 (ipykernel)

In [8]:
```
#display the Attributes names and datatyes
print('\n Attributes and datatypes')
print(heartDisease.dtypes)
```

```
 Attributes and datatypes
Unnamed: 0      float64
age             float64
sex             float64
cp              float64
trestbps        float64
chol            float64
fbs             float64
restecg         float64
thalach         float64
exang           float64
oldpeak         float64
slope           float64
ca               object
thal             object
heartdisease    float64
Unnamed: 15     float64
Unnamed: 16     float64
Unnamed: 17     float64
Unnamed: 18     float64
Unnamed: 19     float64
Unnamed: 20     float64
dtype: object
```

In [9]:
```
#Creat Model-Bayesian Network
model =  BayesianModel([('age','heartdisease'),('sex','heartdisease'),('exang','heartdisease'),('cp','heartdisease'),('heartdisea
```

```
C:\Users\Admin\AppData\Roaming\Python\Python39\site-packages\pgmpy\models\BayesianModel.py:8: FutureWarning: BayesianModel has
been renamed to BayesianNetwork. Please use BayesianNetwork class, BayesianModel will be removed in future.
  warnings.warn(
```

In [10]:
```
#Learning CPDs using Maximum Likelihood Estimators
print('\n Learning CPD using Maximum likelihood estimators')
model.fit(heartDisease,estimator=MaximumLikelihoodEstimator)
```

```
 Learning CPD using Maximum likelihood estimators
```

In [11]:
```
#Inferencing with Bayesian Network
print('\n Inferencing with Bayesian Network:')
HeartDiseasetest_infer = VariableElimination(model)
```

```
 Inferencing with Bayesian Network:
```

In [12]:
```
#computing the Probability of HeartDisease given restecg
print('\n 1.Probability of HeartDisease given evidence= restecg :1')
q1=HeartDiseasetest_infer.query(variables=['heartdisease'],evidence={'restecg':1})
print(q1)
```

```
 1.Probability of HeartDisease given evidence= restecg :1
```

Finding Elimination Order: : 100% 4/4 [00:00<00:00, 142.85it/s]

Eliminating: exang: 100% 4/4 [00:00<00:00, 129.02it/s]

```
+-------------------+---------------------+
| heartdisease      |   phi(heartdisease) |
+===================+=====================+
| heartdisease(0.0) |              0.2000 |
+-------------------+---------------------+
| heartdisease(1.0) |              0.2000 |
+-------------------+---------------------+
| heartdisease(2.0) |              0.2000 |
+-------------------+---------------------+
| heartdisease(3.0) |              0.2000 |
+-------------------+---------------------+
| heartdisease(4.0) |              0.2000 |
+-------------------+---------------------+
```

In [14]:
```python
#computing the Probability of HeartDisease given cp
print('\n 2.Probability of HeartDisease given evidence= cp:2 ')
q2=HeartDiseasetest_infer.query(variables=['heartdisease'],evidence={'cp':2})
print(q2)
```

```
 2.Probability of HeartDisease given evidence= cp:2

Finding Elimination Order: : 0%          0/3 [00:00<?, ?it/s]

Eliminating: exang: 100%          3/3 [00:00<00:00, 157.74it/s]

+-----------------+---------------------+
| heartdisease    |   phi(heartdisease) |
+=================+=====================+
| heartdisease(0.0) |            0.2000 |
+-----------------+---------------------+
| heartdisease(1.0) |            0.2000 |
+-----------------+---------------------+
| heartdisease(2.0) |            0.2000 |
+-----------------+---------------------+
| heartdisease(3.0) |            0.2000 |
+-----------------+---------------------+
| heartdisease(4.0) |            0.2000 |
+-----------------+---------------------+
```

In [ ]:

A	B	C	D	E	F	G	H	I	J	K	L	M
	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca
	63	1	1	145	233	1	2	150	0	2.3	3	
	67	1	4	160	286	0	2	108	1	1.5	2	
	67	1	4	120	229	0	2	129	1	2.6	2	
	37	1	3	130	250	0	0	187	0	3.5	3	
	41	0	2	130	204	0	2	172	0	1.4	1	
	56	1	2	120	236	0	0	178	0	0.8	1	
	62	0	4	140	268	0	2	160	0	3.6	3	
	57	0	4	120	354	0	0	163	1	0.6	1	
	63	1	4	130	254	0	2	147	0	1.4	2	
	53	1	4	140	203	1	2	155	1	3.1	3	
	57	1	4	140	192	0	0	148	0	0.4	2	
	56	0	2	140	294	0	2	153	0	1.3	2	
	56	1	3	130	256	1	2	142	1	0.6	2	
	44	1	2	120	263	0	0	173	0	0	1	
	52	1	3	172	199	1	0	162	0	0.5	1	
	57	1	3	150	168	0	0	174	0	1.6	1	
	48	1	2	110	229	0	0	168	0	1	3	
	54	1	4	140	239	0	0	160	0	1.2	1	
	48	0	3	130	275	0	0	139	0	0.2	1	
	49	1	2	130	266	0	0	171	0	0.6	1	
	64	1	1	110	211	0	2	144	1	1.8	2	
	58	0	1	150	283	1	2	162	0	1	1	
	58	1	2	120	284	0	2	160	0	1.8	2	

Lab Program -7 :-

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

Source code and output :-

```
#!/usr/bin/env python

# coding: utf-8


# In[18]:



import pandas as pd

import matplotlib

import numpy as np

import matplotlib.pyplot as plt

from sklearn.cluster import KMeans

from sklearn.preprocessing import MinMaxScaler

from matplotlib import pyplot as plt

get_ipython().run_line_magic('matplotlib', 'inline')



# In[19]:



df = pd.read_csv(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 7\income.csv')

df.head(10)



# In[20]:
```

```
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)


# In[21]:


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


# In[22]:


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
```

In[23]:

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

Therefore, the elbow point is 3

In[24]:

```
km = KMeans(n_clusters=3)
km
```

In[25]:

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

In[26]:

```
df['cluster'] = y_predict
df.head()
```

```
# In[27]:

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

# In[28]:

df1 = df[df.cluster == 1]
df1

# In[29]:

df2 = df[df.cluster == 2]
df2

# In[30]:

km.cluster_centers_

# In[34]:
```

```
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.legend((p1, p2, p3, c),
        ('Cluster 1', 'Cluster 2', 'Cluster 3', 'Centroid'))
```

	A	B	C	D
1	Name	Age	Income($)	
2	Rob	27	70000	
3	Michael	29	90000	
4	Mohan	29	61000	
5	Ismail	28	60000	
6	Kory	42	150000	
7	Gautam	39	155000	
8	David	41	160000	
9	Andrea	38	162000	
10	Brad	36	156000	
11	Angelina	35	130000	
12	Donald	37	137000	
13	Tom	26	45000	
14	Arnold	27	48000	
15	Jared	28	51000	
16	Stark	29	49500	
17	Ranbir	32	53000	
18	Dipika	40	65000	
19	Priyanka	41	63000	
20	Nick	43	64000	
21	Alia	39	80000	
22	Sid	41	82000	
23	Abdul	39	58000	

```
# In[ ]:
```

jupyter Lab-7 K-Means cluster (income) 1BM19CS159 Last Checkpoint: 5 minutes ago (autosaved)

File Edit View Insert Cell Kernel Widgets Help No kernel Trusted Python 3 (ipykern

In [18]:
```
import pandas as pd
import matplotlib
import numpy as np
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
from sklearn.preprocessing import MinMaxScaler
from matplotlib import pyplot as plt
%matplotlib inline
```

In [19]:
```
df = pd.read_csv(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 7\income.csv')
df.head(10)
```

Out[19]:

	Name	Age	Income($)
0	Rob	27	70000
1	Michael	29	90000
2	Mohan	29	61000
3	Ismail	28	60000
4	Kory	42	150000
5	Gautam	39	155000
6	David	41	160000
7	Andrea	38	162000
8	Brad	36	156000
9	Angelina	35	130000

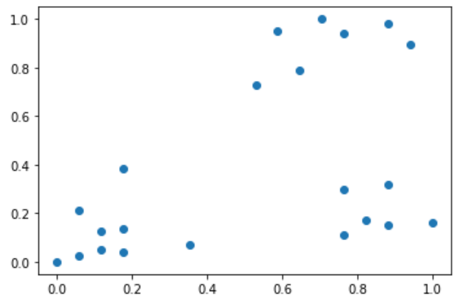
In [20]:
```
scaler = MinMaxScaler()
scaler.fit(df[['Age']])
df[['Age']] = scaler.transform(df[['Age']])

scaler.fit(df[['Income($)']])
df[['Income($)']] = scaler.transform(df[['Income($)']])
df.head(10)
```

Out[20]:

	Name	Age	Income($)
0	Rob	0.058824	0.213675
1	Michael	0.176471	0.384615

In [21]:
```python
plt.scatter(df['Age'], df['Income($)'])
```

Out[21]: `<matplotlib.collections.PathCollection at 0x298b0f99760>`



In [22]:
```python
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
```

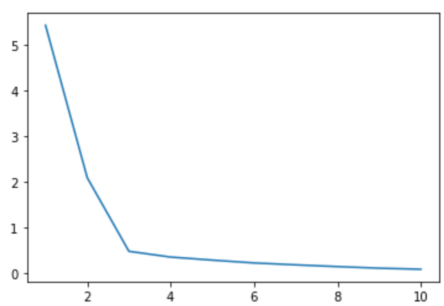
```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1036: UserWarning: KMeans is known to have a memory leak
on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the environment variable OM
P_NUM_THREADS=1.
  warnings.warn(
```

Out[22]:
```
[5.434011511988178,
 2.0911363886990775,
 0.4750783498553096,
 0.34910470944195654,
 0.2818479744366238,
 0.22020960864009398,
 0.17840674931327938,
 0.1397684499538816,
 0.10497488680620909,
 0.08139933135681814]
```

In [23]:
```python
plt.xlabel = 'Number of Clusters'
```

In [23]:
```python
plt.xlabel = 'Number of Clusters'
plt.ylabel = 'Sum of Squared Errors'
plt.plot(k_range, sse)
```

Out[23]: `[<matplotlib.lines.Line2D at 0x298b1fc7eb0>]`



Therefore, the elbow point is 3

In [24]:
```python
km = KMeans(n_clusters=3)
km
```

Out[24]: `KMeans(n_clusters=3)`

In [25]:
```python
y_predict = km.fit_predict(df[['Age', 'Income($)']])
y_predict
```

Out[25]: `array([0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 2, 2, 2, 2, 2, 2])`

In [26]:
```python
df['cluster'] = y_predict
df.head()
```

In [28]:
```python
df1 = df[df.cluster == 1]
df1
```

Out[28]:

	Name	Age	Income($)	cluster
4	Kory	0.941176	0.897436	1
5	Gautam	0.764706	0.940171	1
6	David	0.882353	0.982906	1
7	Andrea	0.705882	1.000000	1
8	Brad	0.588235	0.948718	1
9	Angelina	0.529412	0.726496	1
10	Donald	0.647059	0.786325	1

In [29]:
```python
df2 = df[df.cluster == 2]
df2
```

Out[29]:

	Name	Age	Income($)	cluster
16	Dipika	0.823529	0.170940	2
17	Priyanka	0.882353	0.153846	2
18	Nick	1.000000	0.162393	2
19	Alia	0.764706	0.299145	2
20	Sid	0.882353	0.316239	2
21	Abdul	0.764706	0.111111	2

In [30]:
```python
km.cluster_centers_
```

Out[30]:
```
array([[0.1372549 , 0.11633428],
       [0.72268908, 0.8974359 ],
       [0.85294118, 0.2022792 ]])
```

In [34]:
```python
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')
```


| 21 | Abdul | 0.764706 | 0.111111 | 2 |

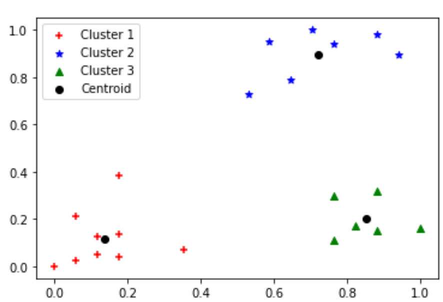
In [30]: km.cluster_centers_

Out[30]: array([[0.1372549 , 0.11633428],
       [0.72268908, 0.8974359],
       [0.85294118, 0.2022792]])

In [34]:
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')


```python
plt.legend((p1, p2, p3, c),
           ('Cluster 1', 'Cluster 2', 'Cluster 3', 'Centroid'))
```

Out[34]: <matplotlib.legend.Legend at 0x298b47d5970>



In [ ]:

Lab Program -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.

<u>Source code and output :-</u>

```
+*In[1]:*+

[source, ipython3]

----

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))

+*Out[1]:*+

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: 0.35333333333333333

The Confusion matrix of EM: [[5 0 45]

 [2 48 0]

 [0 50 0]]

```
![png](output_0_1.png)
```

+*In[ ]:*+

[source, ipython3]

----

jupyter Lab-8 Compare EM and K-means 1BM19CS159 Last Checkpoint: a minute ago (autosaved)

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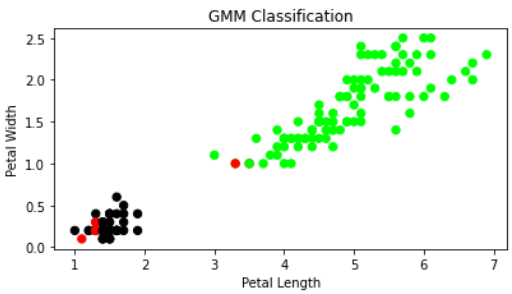
Trusted | Python 3 (ipykernel)

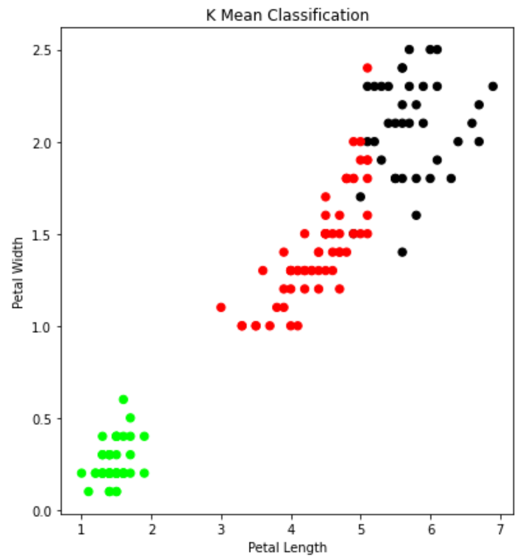
Run Code

In [1]:
```
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)
```

```
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))
```

```
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:  0.35333333333333333
The Confusion matrix of EM:  [[ 5  0 45]
 [ 2 48  0]
 [ 0 50  0]]
```





In [ ]:

Lab Program -9:-

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

Source code and output :-

+*In[1]:*+

[source, ipython3]

```
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))
----
```

+*Out[1]:*+

```
----
sepal-length sepal-width petal-length petal-width
[[5.1 3.5 1.4 0.2]
 [4.9 3.  1.4 0.2]
 [4.7 3.2 1.3 0.2]
 [4.6 3.1 1.5 0.2]
 [5.  3.6 1.4 0.2]
 [5.4 3.9 1.7 0.4]
 [4.6 3.4 1.4 0.3]
 [5.  3.4 1.5 0.2]
```

```
[4.4 2.9 1.4 0.2]
[4.9 3.1 1.5 0.1]
[5.4 3.7 1.5 0.2]
[4.8 3.4 1.6 0.2]
[4.8 3.  1.4 0.1]
[4.3 3.  1.1 0.1]
[5.8 4.  1.2 0.2]
[5.7 4.4 1.5 0.4]
[5.4 3.9 1.3 0.4]
[5.1 3.5 1.4 0.3]
[5.7 3.8 1.7 0.3]
[5.1 3.8 1.5 0.3]
[5.4 3.4 1.7 0.2]
[5.1 3.7 1.5 0.4]
[4.6 3.6 1.  0.2]
[5.1 3.3 1.7 0.5]
[4.8 3.4 1.9 0.2]
[5.  3.  1.6 0.2]
[5.  3.4 1.6 0.4]
[5.2 3.5 1.5 0.2]
[5.2 3.4 1.4 0.2]
[4.7 3.2 1.6 0.2]
[4.8 3.1 1.6 0.2]
[5.4 3.4 1.5 0.4]
[5.2 4.1 1.5 0.1]
[5.5 4.2 1.4 0.2]
```

```
[4.9 3.1 1.5 0.2]
[5.  3.2 1.2 0.2]
[5.5 3.5 1.3 0.2]
[4.9 3.6 1.4 0.1]
[4.4 3.  1.3 0.2]
[5.1 3.4 1.5 0.2]
[5.  3.5 1.3 0.3]
[4.5 2.3 1.3 0.3]
[4.4 3.2 1.3 0.2]
[5.  3.5 1.6 0.6]
[5.1 3.8 1.9 0.4]
[4.8 3.  1.4 0.3]
[5.1 3.8 1.6 0.2]
[4.6 3.2 1.4 0.2]
[5.3 3.7 1.5 0.2]
[5.  3.3 1.4 0.2]
[7.  3.2 4.7 1.4]
[6.4 3.2 4.5 1.5]
[6.9 3.1 4.9 1.5]
[5.5 2.3 4.  1.3]
[6.5 2.8 4.6 1.5]
[5.7 2.8 4.5 1.3]
[6.3 3.3 4.7 1.6]
[4.9 2.4 3.3 1. ]
[6.6 2.9 4.6 1.3]
[5.2 2.7 3.9 1.4]
```

```
[5.  2.  3.5 1. ]
[5.9 3.  4.2 1.5]
[6.  2.2 4.  1. ]
[6.1 2.9 4.7 1.4]
[5.6 2.9 3.6 1.3]
[6.7 3.1 4.4 1.4]
[5.6 3.  4.5 1.5]
[5.8 2.7 4.1 1. ]
[6.2 2.2 4.5 1.5]
[5.6 2.5 3.9 1.1]
[5.9 3.2 4.8 1.8]
[6.1 2.8 4.  1.3]
[6.3 2.5 4.9 1.5]
[6.1 2.8 4.7 1.2]
[6.4 2.9 4.3 1.3]
[6.6 3.  4.4 1.4]
[6.8 2.8 4.8 1.4]
[6.7 3.  5.  1.7]
[6.  2.9 4.5 1.5]
[5.7 2.6 3.5 1. ]
[5.5 2.4 3.8 1.1]
[5.5 2.4 3.7 1. ]
[5.8 2.7 3.9 1.2]
[6.  2.7 5.1 1.6]
[5.4 3.  4.5 1.5]
[6.  3.4 4.5 1.6]
```

[6.7 3.1 4.7 1.5]

[6.3 2.3 4.4 1.3]

[5.6 3. 4.1 1.3]

[5.5 2.5 4. 1.3]

[5.5 2.6 4.4 1.2]

[6.1 3. 4.6 1.4]

[5.8 2.6 4. 1.2]

[5. 2.3 3.3 1.]

[5.6 2.7 4.2 1.3]

[5.7 3. 4.2 1.2]

[5.7 2.9 4.2 1.3]

[6.2 2.9 4.3 1.3]

[5.1 2.5 3. 1.1]

[5.7 2.8 4.1 1.3]

[6.3 3.3 6. 2.5]

[5.8 2.7 5.1 1.9]

[7.1 3. 5.9 2.1]

[6.3 2.9 5.6 1.8]

[6.5 3. 5.8 2.2]

[7.6 3. 6.6 2.1]

[4.9 2.5 4.5 1.7]

[7.3 2.9 6.3 1.8]

[6.7 2.5 5.8 1.8]

[7.2 3.6 6.1 2.5]

[6.5 3.2 5.1 2.]

[6.4 2.7 5.3 1.9]

[6.8 3. 5.5 2.1]

[5.7 2.5 5. 2.]

[5.8 2.8 5.1 2.4]

[6.4 3.2 5.3 2.3]

[6.5 3. 5.5 1.8]

[7.7 3.8 6.7 2.2]

[7.7 2.6 6.9 2.3]

[6. 2.2 5. 1.5]

[6.9 3.2 5.7 2.3]

[5.6 2.8 4.9 2.]

[7.7 2.8 6.7 2.]

[6.3 2.7 4.9 1.8]

[6.7 3.3 5.7 2.1]

[7.2 3.2 6. 1.8]

[6.2 2.8 4.8 1.8]

[6.1 3. 4.9 1.8]

[6.4 2.8 5.6 2.1]

[7.2 3. 5.8 1.6]

[7.4 2.8 6.1 1.9]

[7.9 3.8 6.4 2.]

[6.4 2.8 5.6 2.2]

[6.3 2.8 5.1 1.5]

[6.1 2.6 5.6 1.4]

[7.7 3. 6.1 2.3]

[6.3 3.4 5.6 2.4]

[6.4 3.1 5.5 1.8]

```
 [6.  3.  4.8 1.8]
 [6.9 3.1 5.4 2.1]
 [6.7 3.1 5.6 2.4]
 [6.9 3.1 5.1 2.3]
 [5.8 2.7 5.1 1.9]
 [6.8 3.2 5.9 2.3]
 [6.7 3.3 5.7 2.5]
 [6.7 3.  5.2 2.3]
 [6.3 2.5 5.  1.9]
 [6.5 3.  5.2 2. ]
 [6.2 3.4 5.4 2.3]
 [5.9 3.  5.1 1.8]]
class: 0-Iris-Setosa, 1- Iris-Versicolour, 2- Iris-Virginica
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2]
Confusion Matrix
[[12  0  0]
 [ 0 14  0]
 [ 0  0 19]]
Accuracy Metrics
             precision    recall  f1-score   support

          0       1.00      1.00      1.00        12
```

```
           1       1.00      1.00      1.00        14
           2       1.00      1.00      1.00        19

    accuracy                           1.00        45
   macro avg       1.00      1.00      1.00        45
weighted avg       1.00      1.00      1.00        45
```

+*In[ ]:*+
[source, ipython3]

In [1]:
```
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))
```

```
sepal-length sepal-width petal-length petal-width
[[5.1 3.5 1.4 0.2]
 [4.9 3.  1.4 0.2]
 [4.7 3.2 1.3 0.2]
 [4.6 3.1 1.5 0.2]
 [5.  3.6 1.4 0.2]
 [5.4 3.9 1.7 0.4]
 [4.6 3.4 1.4 0.3]
 [5.  3.4 1.5 0.2]
 [4.4 2.9 1.4 0.2]
 [4.9 3.1 1.5 0.1]
 [5.4 3.7 1.5 0.2]
 [4.8 3.4 1.6 0.2]
 [4.8 3.  1.4 0.1]
 [4.3 3.  1.1 0.1]
```

```
 [6.5 3.  5.2 2. ]
 [6.2 3.4 5.4 2.3]
 [5.9 3.  5.1 1.8]]
class: 0-Iris-Setosa, 1- Iris-Versicolour, 2- Iris-Virginica
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2]
Confusion Matrix
[[12  0  0]
 [ 0 14  0]
 [ 0  0 19]]
Accuracy Metrics
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        12
           1       1.00      1.00      1.00        14
           2       1.00      1.00      1.00        19

    accuracy                           1.00        45
   macro avg       1.00      1.00      1.00        45
weighted avg       1.00      1.00      1.00        45
```

Lab Program -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.

Source code and output :-

```
+*In[2]:*+
[source, ipython3]
----
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]

 # 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)]]))
plt.title('K Mean Classification')
plt.xlabel('Petal Length')
```

+*Out[2]:*+

```
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 :
 [-2.88440998 -2.97461063 -2.97639127 -2.9042727  -3.1194782  -3.06506157
 -2.8349021  -2.90676221 -2.92454458]
 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')
![png](output_0_2.png)
```

+*In[3]:*+

[source, ipython3]

```
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))) # eye - identity matrix
    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) #argsort - index of the smallest
    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();

# load data points
data = pd.read_csv(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 10\tips.csv')
bill = np.array(data.total_bill) # We use only Bill amount and Tips data
tip = np.array(data.tip)

mbill = np.mat(bill) # .mat will convert nd array is converted in 2D array
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

# increase k to get smooth curves
```

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

+*Out[3]:*+

`![png](output_1_0.png)`

+*In[ ]:*+

[source, ipython3]

----

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

tips

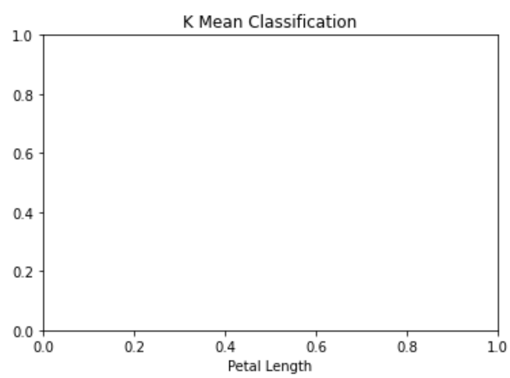
In [2]:

```
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]

 # 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
```

```
    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 :
 [-2.88440998 -2.97461063 -2.97639127 -2.9042727  -3.1194782  -3.06506157
 -2.8349021  -2.90676221 -2.92454458]
 Xo Domain Space(10 Samples) :
 [-2.97993311 -2.95986622 -2.93979933 -2.91973244 -2.89966555 -2.87959866
 -2.85953177 -2.83946488 -2.81939799]
```

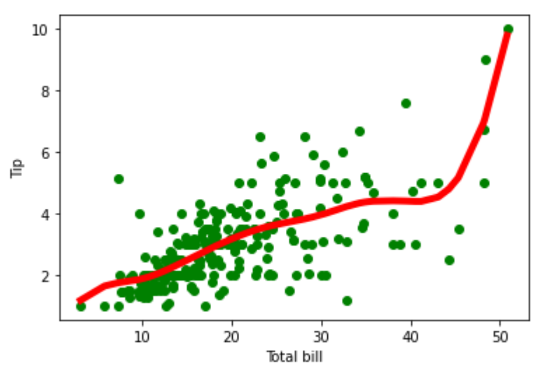
Out[2]: Text(0.5, 0, 'Petal Length')

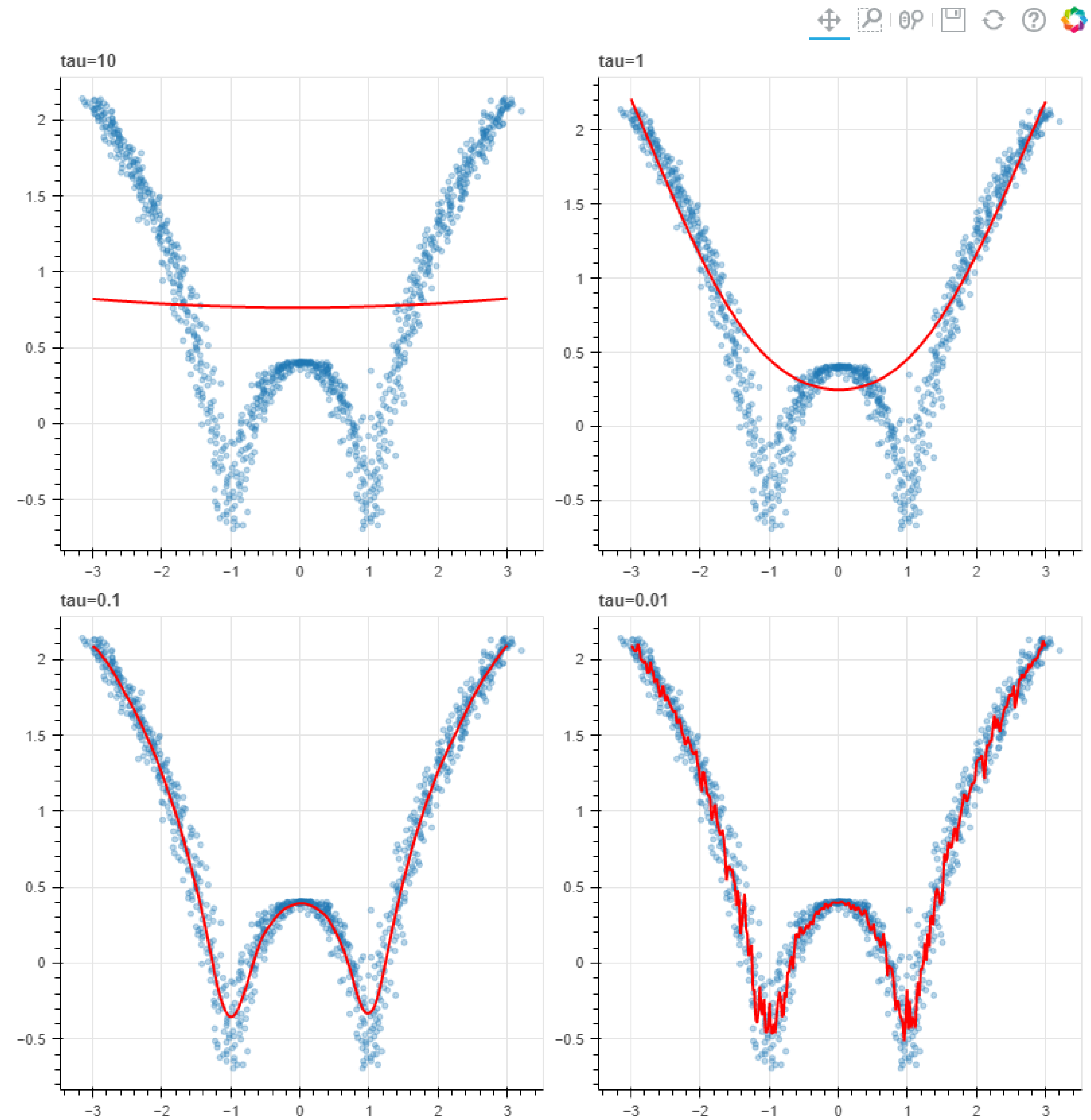


```
In [3]: import matplotlib.pyplot as plt
import pandas as pd
import numpy as np

def kernel(point,xmat, k):
    m,n = np.shape(xmat)
    weights = np.mat(np.eye((m))) # eye - identity matrix
    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) #argsort - index of the smallest
    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();

# load data points
data = pd.read_csv(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 10\tips.csv')
bill = np.array(data.total_bill) # We use only Bill amount and Tips data
tip = np.array(data.tip)

mbill = np.mat(bill) # .mat will convert nd array is converted in 2D array
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
```


```
    plt.ylabel('Tip')
    plt.show();

# load data points
data = pd.read_csv(r'C:\Users\Admin\OneDrive\Desktop\6th sem\ML\lab-ml\Lab 10\tips.csv')
bill = np.array(data.total_bill) # We use only Bill amount and Tips data
tip = np.array(data.tip)

mbill = np.mat(bill) # .mat will convert nd array is converted in 2D array
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
```


```
# increase k to get smooth curves
ypred = localWeightRegression(X,mtip,3)
graphPlot(X,ypred)
```




tau=10
tau=1
tau=0.1
tau=0.01