VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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LAB REPORT on

Machine Learning

Submitted by

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in partial fulfilment for the award of the degree of

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Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "Machine Learning" carried out by **Aruna Ravi K R (1BM19CS225),** who is bonafide student of **B. M. S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2022. The Lab report has been approved as it satisfies the academic requirements in respect of a **Machine Learning - (20CS6PCMAL)** work prescribed for the said degree.

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Course Outcome

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

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

a) Using CSV as input:

```
import csv

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

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

    return h

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

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

Output:

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

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

B) Using user Input:

```
import numpy as np
import pandas as pd

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

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

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

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

def findS(c,t):
    for i, val in enumerate(t):
        if val == "Yes":
            specific_hypothesis = c[i].copy()
            break

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

    return specific_hypothesis

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

Output:

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

Enter the name of  2  attribute

Enter the name of  3  attribute

Ënter the values of  1  row
Enter the values of attributes

Ënter the values of  2  row
Enter the values of attributes

Ënter the values of  3  row
Enter the values of attributes

Enter the target values
Enter the value of  1  target

Enter the value of  2  target

Enter the value of  3  target

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

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

```
import numpy as np
import pandas as pd

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

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

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

#training function to implement candidate_elimination algorithm
def learn(concepts, target):
 specific_h = concepts[0].copy()
 print("\n Initialization of specific_h and general_h")
 print(specific_h)
 general_h = [["?" for i in range(len(specific_h))] for i in
range(len(specific_h))]
 print(general_h)
 for i, h in enumerate(concepts):
    if target[i] == "yes":
       for x in range(len(specific_h)):
          if h[x]!= specific_h[x]:
             specific_h[x] ='?'
             general_h[x][x] ='?'
          #  print(specific_h)
    if target[i] == "no":
       for x in range(len(specific_h)):
          if h[x]!= specific_h[x]:
             general_h[x][x] = specific_h[x]
          else:
             general_h[x][x] = '?'
    print("\n Steps of Candidate Elimination Algorithm",i+1)
    print(specific_h)
    print(general_h)
 indices = [i for i, val in enumerate(general_h) if val ==
['?', '?', '?', '?', '?', '?']]
 for i in indices:
    general_h.remove(['?', '?', '?', '?', '?', '?'])
 return specific_h, general_h
s_final, g_final = learn(concepts, target)

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

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

Output:

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

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

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

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

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

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

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

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

Final Specific_h:
['sunny' 'warm' '?' 'strong' '?' '?']

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

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

a)ID3 :

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

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

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

    counts=[0]*len(attr)
    r=len(data)
    c=len(data[0])
    for x in range(len(attr)):
        for y in range(r):
            if data[y][col]==attr[x]:
                counts[x]+=1

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

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

    counts=[0,0]
    for i in range(2):
```

```
        counts[i]=sum([1 for x in S if attr[i]==x])/(len(S)*1.0)

    sums=0
    for cnt in counts:
        sums+=-1*cnt*math.log(cnt,2)
    return sums

def compute_gain(data,col):
    attr,dic = subtables(data,col,delete=False)

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

    total_entropy=entropy([row[-1] for row in data])
    for x in range(len(attr)):
        ratio[x]=len(dic[attr[x]])/(total_size*1.0)
        entropies[x]=entropy([row[-1] for row in dic[attr[x]]])
        total_entropy-=ratio[x]*entropies[x]
    return total_entropy

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

    n=len(data[0])-1
    gains=[0]*n
    for col in range(n):
        gains[col]=compute_gain(data,col)
    split=gains.index(max(gains))
    node=Node(features[split])
    fea = features[:split]+features[split+1:]


    attr,dic=subtables(data,split,delete=True)

    for x in range(len(attr)):
        child=build_tree(dic[attr[x]],fea)
        node.children.append((attr[x],child))
    return node

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

    print("  "*level,node.attribute)
    for value,n in node.children:
        print("  "*(level+1),value)
```

```
        print_tree(n,level+2)


def classify(node,x_test,features):
    if node.answer!="":
        print(node.answer)
        return
    pos=features.index(node.attribute)
    for value, n in node.children:
        if x_test[pos]==value:
            classify(n,x_test,features)

'''Main program'''
dataset,features=load_csv("id3.csv")
node1=build_tree(dataset,features)

print("The decision tree for the dataset using ID3 algorithm is")
print_tree(node1,0)
testdata,features=load_csv("id3.csv")

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

Output:

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

b) Using SKlearn:

```
import pandas as pd

import numpy as np

from sklearn.datasets import load_iris

data = load_iris()
```

In [2]:

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

In [3]:

```
df.head()
df['Species'] = data.target

#replace this with the actual names

target = np.unique(data.target)

target_names = np.unique(data.target_names)

targets = dict(zip(target, target_names))

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

In [5]:

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

y = df["Species"]
```

In [6]:

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

In [7]:

```
from sklearn.model_selection import train_test_split

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

In [8]:

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

In [9]:

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

In [11]:

```
from sklearn import metrics

import seaborn as sns

import matplotlib.pyplot as plt
```

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

In [12]:

```
confusion_matrix
```

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

```
clf.score(test_x,test_lab)
```

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

Output:

Out[3]:

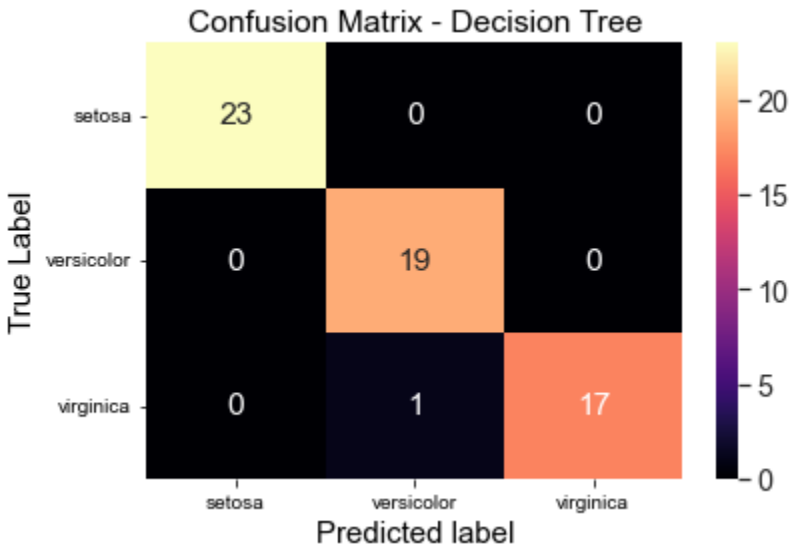
	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
0	5.1	3.5	1.4	0.2
1	4.9	3.0	1.4	0.2
2	4.7	3.2	1.3	0.2
3	4.6	3.1	1.5	0.2
4	5.0	3.6	1.4	0.2

Out[9]:

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

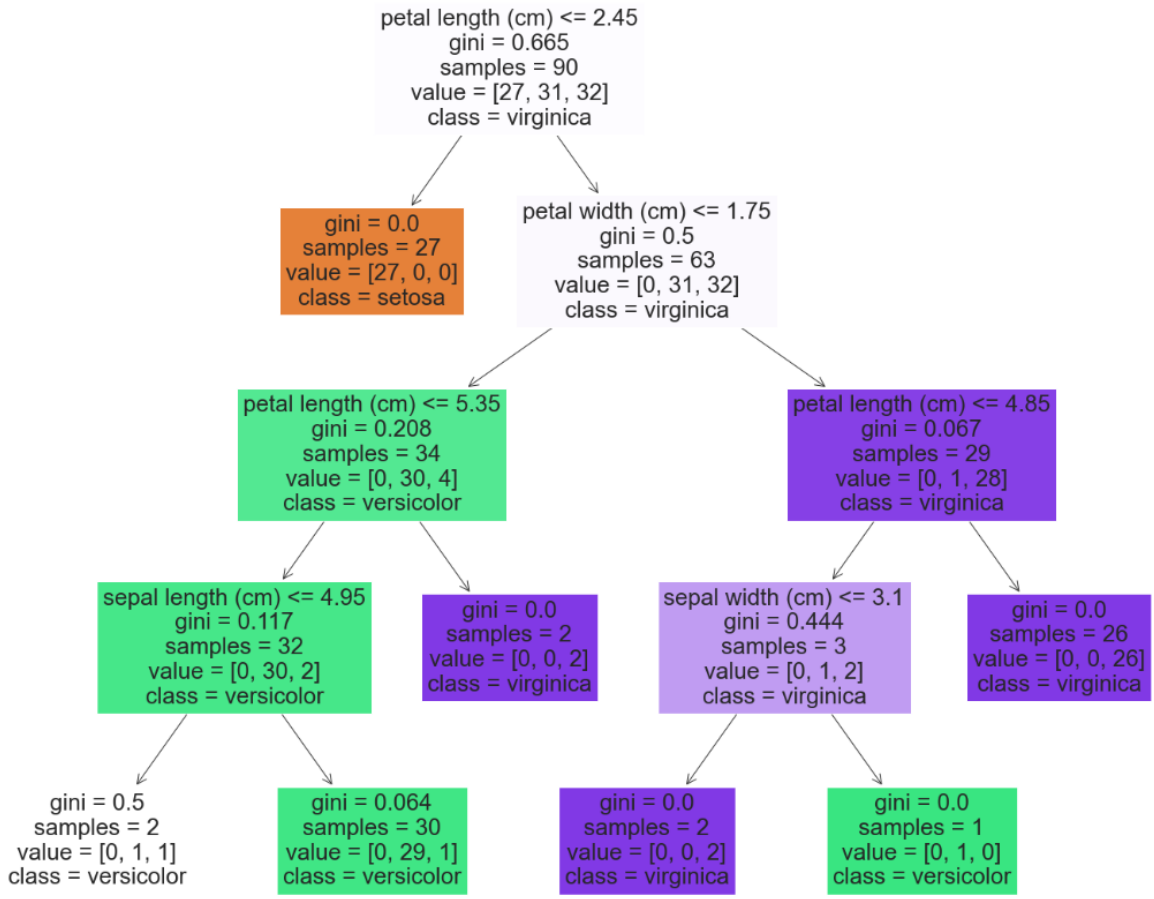
Out[12]:

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




```
In [14]: clf.score(test_x,test_lab)
```

```
Out[14]: 0.9833333333333333
```



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

a) Without using SKlearn:

```
import numpy as np
import pandas as pd

data = pd.read_csv('/content/dataset.csv')
data.head()

y = list(data['PlayTennis'].values)
X = data.iloc[:,1:].values
print(f'Target Values: {y}')
print(f'Features: \n{X}')
y_train = y[:8]
y_val = y[8:]
X_train = X[:8]
X_val = X[8:]
print(f"Number of instances in training set: {len(X_train)}")
print(f"Number of instances in testing set: {len(X_val)}")
class NaiveBayesClassifier:
    def __init__(self, X, y):
        self.X, self.y = X, y
        self.N = len(self.X)
        self.dim = len(self.X[0])
        self.attrs = [[] for _ in range(self.dim)]
        self.output_dom = {}
        self.data = []
        for i in range(len(self.X)):
            for j in range(self.dim):
                if not self.X[i][j] in self.attrs[j]:
                    self.attrs[j].append(self.X[i][j])
            if not self.y[i] in self.output_dom.keys():
                self.output_dom[self.y[i]] = 1
            else:
                self.output_dom[self.y[i]] += 1
            self.data.append([self.X[i], self.y[i]])
    def classify(self, entry):
        solve = None
        max_arg = -1
        for y in self.output_dom.keys():
            prob = self.output_dom[y]/self.N
            for i in range(self.dim):
                cases = [x for x in self.data if x[0][i] == entry[i] and x[1] == y]
                n = len(cases)
                prob *= n/self.N
            if prob > max_arg:
                max_arg = prob
                solve = y
```

```
        return solve
nbc = NaiveBayesClassifier(X_train, y_train)
total_cases = len(y_val)
good = 0
bad = 0
predictions = []
for i in range(total_cases):
    predict = nbc.classify(X_val[i])
    predictions.append(predict)
    if y_val[i] == predict:
        good += 1
    else:
        bad += 1
print('Predicted values:', predictions)
print('Actual values:', y_val)
print()
print('Total number of testing instances in the dataset:', total_cases)
print('Number of correct predictions:', good)
print('Number of wrong predictions:', bad)
print()
print('Accuracy of Bayes Classifier:', good/total_cases)
```

Output:

Out[2]:

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

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

```
Number of instances in training set: 8
Number of instances in testing set: 6

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

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

Accuracy of Bayes Classifier: 0.6666666666666666
```

b)Using SKlearn:

```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import GaussianNB
from sklearn import metrics

df = pd.read_csv("/content/pima_indian.csv")
feature_col_names = ['num_preg', 'glucose_conc', 'diastolic_bp', 'thickness', 'insulin', 'bmi', 'diab_pred', 'age']
predicted_class_names = ['diabetes']
X = df[feature_col_names].values
y = df[predicted_class_names].values
print(df.head)
xtrain,xtest,ytrain,ytest=train_test_split(X,y,test_size=0.33)
print ('\nThe total number of Training Data:',ytrain.shape)
print ('The total number of Test Data:',ytest.shape)
clf = GaussianNB().fit(xtrain,ytrain.ravel())
predicted = clf.predict(xtest)
predictTestData= clf.predict([[6,148,72,35,0,33.6,0.627,50]])
print('\nConfusion matrix')
print(metrics.confusion_matrix(ytest,predicted))
print('\nAccuracy of the classifier:',metrics.accuracy_score(ytest,predicted))
print('The value of Precision:', metrics.precision_score(ytest,predicted))
print('The value of Recall:', metrics.recall_score(ytest,predicted))
print("Predicted Value for individual Test Data:", predictTestData)
```

Output:

```
<bound method NDFrame.head of      num_preg  glucose_conc  diastolic_bp  ...  diab_pred  age  diabetes
0           6           148            72  ...      0.627   50         1
1           1            85            66  ...      0.351   31         0
2           8           183            64  ...      0.672   32         1
3           1            89            66  ...      0.167   21         0
4           0           137            40  ...      2.288   33         1
..        ...           ...           ...  ...        ...  ...       ...
763        10           101            76  ...      0.171   63         0
764         2           122            70  ...      0.340   27         0
765         5           121            72  ...      0.245   30         0
766         1           126            60  ...      0.349   47         1
767         1            93            70  ...      0.315   23         0

[768 rows x 9 columns]>

The total number of Training Data: (514, 1)
The total number of Test Data: (254, 1)

Confusion matrix
[[156  16]
 [ 35  47]]

Accuracy of the classifier: 0.7992125984251969
The value of Precision: 0.746031746031746
The value of Recall: 0.573170731707317
Predicted Value for individual Test Data: [1]
```

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

a)Using SKlearn:

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

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

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

# Fitting Simple Linear Regression to the Training set
from sklearn.linear_model import LinearRegression
regressor = LinearRegression()
regressor.fit(X_train, y_train)

# Visualizing the Training set results
viz_train = plt
viz_train.scatter(X_train, y_train, color='red')
viz_train.plot(X_train, regressor.predict(X_train), color='blue')
viz_train.title('Salary VS Experience (Training set)')
viz_train.xlabel('Year of Experience')
viz_train.ylabel('Salary')
viz_train.show()
# Visualizing the Test set results
viz_test = plt
viz_test.scatter(X_test, y_test, color='red')
viz_test.plot(X_train, regressor.predict(X_train), color='blue')
viz_test.title('Salary VS Experience (Test set)')
viz_test.xlabel('Year of Experience')
viz_test.ylabel('Salary')
viz_test.show()
# Predicting the Test set results
y_pred = regressor.predict(X_test)
print(y_pred)
```

Output:

```
Out[4]: LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

In [8]:
```
# Predicting the Test set results
y_pred = regressor.predict(X_test)
print(y_pred)
```

```
[ 40835.10590871 123079.39940819  65134.55626083  63265.36777221
 115602.64545369 108125.8914992  116537.23969801  64199.96201652
  76349.68719258 100649.1375447 ]
```

b) Without using SKlearn:

```
import pandas as pd
import numpy as np

class LR():
    def __init__(self):
        self.w = []
    def fit(self, X, y):
        self.w = np.linalg.solve(X.T@X, X.T@y)
    def predict(self, X):
        return X@self.w
    def score(self, X, y):
        SS_reg = np.sum((X@self.w - y)**2)
        SS_tot = np.sum((y - np.mean(y))**2)
        return (1 - (SS_reg/SS_tot))


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

fetch_california_housing

data, labels = fetch_california_housing(return_X_y = True)

data.shape, labels.shape

one = np.ones(data.shape[0])
data = np.column_stack((one, data))

X_train,X_test, y_train, y_test = train_test_split(data, labels, train_size = 0.75, random_state = 42)

lro = LR()
lro.fit(X_train, y_train)

lro.w

lro.predict(X_test)


lro.score(X_test, y_test)
```

Output:

```
data.shape, labels.shape
```

```
((20640, 9), (20640,))
```

```
lro.w
```

```
array([-3.70278276e+01,  4.47600069e-01,  9.56752596e-03, -1.24755956e-01,
        7.94471254e-01, -1.43902596e-06, -3.44307993e-03, -4.18555257e-01,
       -4.33405135e-01])
```

```
lro.predict(X_test)
```

```
array([0.72412832, 1.76677807, 2.71151581, ..., 1.72382152, 2.34689276,
       3.52917352])
```

```
lro.score(X_test, y_test)
```

```
0.5910509795491321
```