VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

Machine Learning

Submitted by

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

B.M.S. COLLEGE OF ENGINEERING
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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 **Piyush Dubey (1BM19CS221),** 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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Index Sheet

Course Outcomes:

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

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

In [11]:
```
import csv
```

In [12]:
```
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
```

In [13]:
```
if __name__ == "__main__":
    data = []
    h = []

    with open('data.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)
```

```
Data:
['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']

Hypothesis:  ['sunny', 'warm', '?', 'strong', '?', '?']
```

In [ ]:

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

```
import numpy as np
import pandas as pd

data = pd.read_csv('data.csv')
concepts = np.array(data.iloc[:,0:-1])
print("\nInstances are:\n",concepts)
target = np.array(data.iloc[:,-1])
print("\nTarget Values are: ",target)

def learn(concepts, target):
    specific_h = concepts[0].copy()
    print("\nInitialization of specific_h and genearal_h")
    print("\nSpecific Boundary: "0, specific_h)
    general_h = [["?" for i in range(len(specific_h))] for i in range(len(specific_h))]
    print("\nGeneric Boundary: ",general_h)

    for i, h in enumerate(concepts):
        print("\nInstance", i+1 , "is ", h)
        if target[i] == "yes":
            print("Instance is Positive ")
            for x in range(len(specific_h)):
                if h[x]!= specific_h[x]:
                    specific_h[x] ='?'
                    general_h[x][x] ='?'

        if target[i] == "no":
            print("Instance is Negative ")
            for x in range(len(specific_h)):
                if h[x]!= specific_h[x]:
                    general_h[x][x] = specific_h[x]
                else:
                    general_h[x][x] = '?'

        print("Specific Bundary after ", i+1, "Instance is ", specific_h)
        print("Generic Boundary after ", i+1, "Instance is ", general_h)
        print("\n")

    indices = [i for i, val in enumerate(general_h) if val == ['?', '?', '?', '?', '?', '?']]
    for i in indices:
        general_h.remove(['?', '?', '?', '?', '?', '?'])
    return specific_h, general_h

s_final, g_final = learn(concepts, target)

print("Final Specific_h: ", s_final, sep="\n")
print("Final General_h: ", g_final, sep="\n")
```

```
❯ python candidateElimination.py
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']]
Target: ['yes' 'yes' 'no' 'yes']
Initialization of specific_h and general_h
        specific_h: ['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
        general_h: [['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?']]

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

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

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

 Steps of Candidate Elimination Algorithm 4
        specific_h ['sunny' 'warm' '?' 'strong' '?' '?']
        general_h: [['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

```
import pandas as pd
import math
import numpy as np

data = pd.read_csv('id.csv')
features = [feat for feat in data]
features.pop()

class Node:
    def __init__(self):
        self.children = []
        self.value = ""
        self.isLeaf = False
        self.pred = ""

def entropy(examples):
    pos = 0.0
    neg = 0.0
    for _, row in examples.iterrows():
        if row["Answer"] == "yes":
            pos += 1
        else:
            neg += 1
    if pos == 0.0 or neg == 0.0:
        return 0.0
    else:
        p = pos / (pos + neg)
        n = neg / (pos + neg)
        return -(p * math.log(p, 2) + n * math.log(n, 2))

def info_gain(examples, attr):
    uniq = np.unique(examples[attr])
    gain = entropy(examples)
    for u in uniq:
        subdata = examples[examples[attr] == u]
        #print ("\n",subdata)
        sub_e = entropy(subdata)
        gain -= (float(len(subdata)) / float(len(examples))) * sub_e
    return gain

```

```python

def ID3(examples, attrs):
    root = Node()
    max_gain = 0
    max_feat = ""
    for feature in attrs:
        gain = info_gain(examples, feature)
        if gain > max_gain:
            max_gain = gain
            max_feat = feature
    root.value = max_feat
    uniq = np.unique(examples[max_feat])
    for u in uniq:
        subdata = examples[examples[max_feat] == u]
        if entropy(subdata) == 0.0:
            newNode = Node()
            newNode.isLeaf = True
            newNode.value = u
            newNode.pred = np.unique(subdata["Answer"])
            root.children.append(newNode)
        else:
            dummyNode = Node()
            dummyNode.value = u
            new_attrs = attrs.copy()
            new_attrs.remove(max_feat)
            child = ID3(subdata, new_attrs)
            dummyNode.children.append(child)
            root.children.append(dummyNode)
    return root

def printTree(root: Node, depth=0):
    for i in range(depth):
        print("\t", end="")
    print(root.value, end="")
    if root.isLeaf:
        print(" -> ", root.pred)
    print()
    for child in root.children:
        printTree(child, depth + 1)

root = ID3(data, features)
printTree(root)
```

```
Outlook
        overcast -> ['yes']

        rain
                Wind
                        strong -> ['no']

                        weak -> ['yes']

        sunny
                Humidity
                        high -> ['no']

                        normal -> ['yes']
```

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

```python
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import GaussianNB
from sklearn import metrics

df = pd.read_csv("diabetes.csv")
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=0.40)

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

clf = GaussianNB().fit(xtrain,ytrain.ravel())
predicted = clf.predict(xtest)
predictTestData= clf.predict([[6,148,72,35,0,33.6,0.627,50]])

print('\n Confusion matrix')
print(metrics.confusion_matrix(ytest,predicted))

print('\n Accuracy of the classifier is',metrics.accuracy_score(ytest,predicted))

print('\n The value of Precision', metrics.precision_score(ytest,predicted))

print('\n The value of Recall', metrics.recall_score(ytest,predicted))

print("Predicted Value for individual Test Data:", predictTestData)
```

```
<bound method NDFrame.head of      num_preg  glucose_conc  diastolic_bp  thickness  insulin   bmi  \
0           6           148            72         35        0  33.6
1           1            85            66         29        0  26.6
2           8           183            64          0        0  23.3
3           1            89            66         23       94  28.1
4           0           137            40         35      168  43.1
..        ...           ...           ...        ...      ...   ...
140         3           128            78          0        0  21.1
141         5           106            82         30        0  39.5
142         2           108            52         26       63  32.5
143        10           108            66          0        0  32.4
144         4           154            62         31      284  32.8

     diab_pred  age  diabetes
0        0.627   50         1
1        0.351   31         0
2        0.672   32         1
3        0.167   21         0
4        2.288   33         1
..         ...  ...       ...
140      0.268   55         0
141      0.286   38         0
142      0.318   22         0
143      0.272   42         1
144      0.237   23         0

[145 rows x 9 columns]>

 the total number of Training Data : (87, 1)

 the total number of Test Data : (58, 1)

 Confusion matrix
[[30 12]
 [ 8  8]]

 Accuracy of the classifier is 0.6551724137931034

 The value of Precision 0.4

 The value of Recall 0.5
Predicted Value for individual Test Data: [1]
```

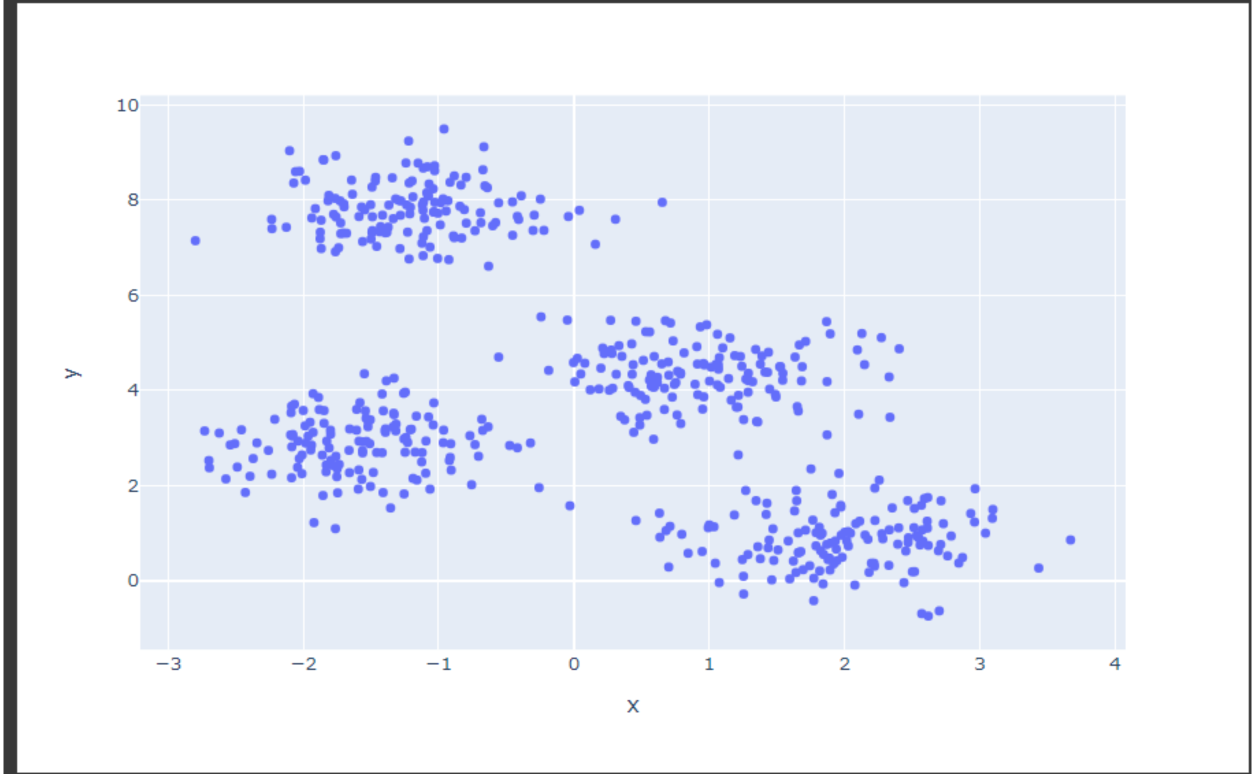
5. Write a program to construct a Bayesian network considering training data. Use this model to make predictions.

```python

get_ipython().system('pip install pgmpy')


from pgmpy.models import BayesianModel
from pgmpy.factors.discrete import TabularCPD
from pgmpy.inference import VariableElimination
import numpy as np

#bayesNet = BayesianModel([("M", "R"),("U", "R"),("B", "R"),("R", "S")])
bayesNet.add_node("M")
bayesNet.add_node("U")
bayesNet.add_node("R")
bayesNet.add_node("B")
bayesNet.add_node("S")

bayesNet.add_edge("M", "R")
bayesNet.add_edge("U", "R")
bayesNet.add_edge("B", "R")
bayesNet.add_edge("B", "S")
bayesNet.add_edge("R", "S")

cpd_A = TabularCPD('M', 2, values=[[.95], [.05]])
cpd_U = TabularCPD('U', 2, values=[[.85], [.15]])
cpd_H = TabularCPD('B', 2, values=[[.90], [.10]])

cpd_S = TabularCPD('S', 2, values=[[0.98, .88, .95, .6], [.02, .12, .05, .40]],
                   evidence=['R', 'B'], evidence_card=[2, 2])

cpd_R = TabularCPD('R', 2,
                   values=[[0.96, .86, .94, .82, .24, .15, .10, .05], [.04, .14, .06, .18, .76, .85, .90, .95]],
                   evidence=['M', 'B', 'U'], evidence_card=[2, 2,2])
bayesNet.add_cpds(cpd_A, cpd_U, cpd_H, cpd_S, cpd_R)

bayesNet.check_model()
print("Model is correct.")
```

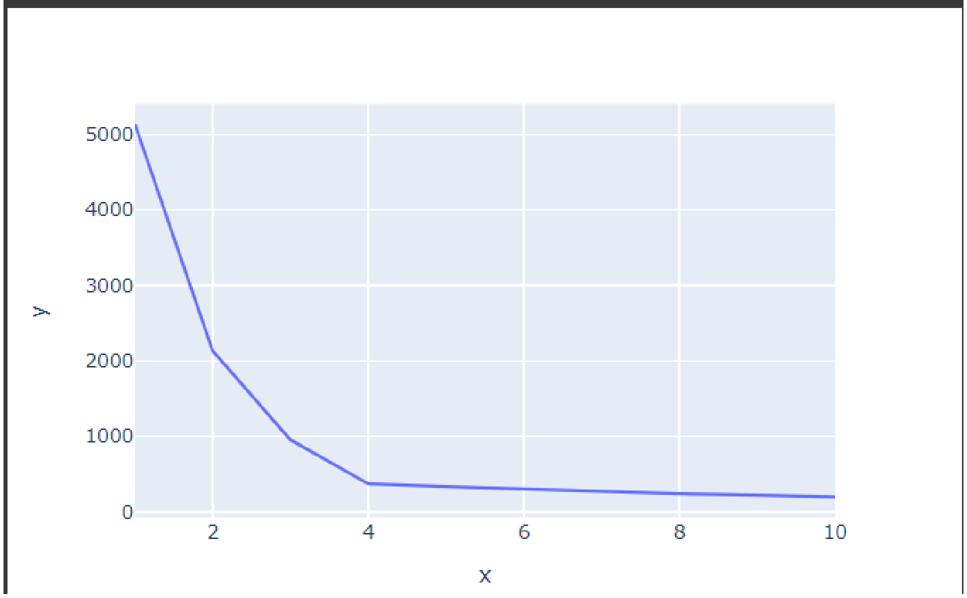
```
Model is correct.
/usr/local/lib/python3.7/dist-packages/pgmpy/models/BayesianModel.py:10: FutureWarning: BayesianModel has been renamed to BayesianNetwork. Please use BayesianNetwork class, BayesianModel will be removed in
  FutureWarning,
Finding Elimination Order: : 0%  0/3 [00:00<?, ?it/s]
Eliminating: M: 100%  3/3 [00:00<00:00, 43.94it/s]
R +------+----------+
| R    |   phi(R) |
+======+==========+
| R(0) |   0.9062 |
+------+----------+
| R(1) |   0.0938 |
+------+----------+
Finding Elimination Order: : 100%  2/2 [00:00<00:00, 18.53it/s]
Eliminating: B: 100%  2/2 [00:00<00:00, 32.17it/s]
R| M +------+----------+
| R    |   phi(R) |
+======+==========+
| R(0) |   0.2131 |
+------+----------+
| R(1) |   0.7869 |
+------+----------+
Finding Elimination Order: : 100%  3/3 [00:00<00:00, 17.63it/s]
Eliminating: M: 100%  3/3 [00:00<00:00, 43.05it/s]
S| B +------+----------+
| S    |   phi(S) |
+======+==========+
| S(0) |   0.8465 |
+------+----------+
| S(1) |   0.1535 |
+------+----------+
<TabularCPD representing P(R:2 | M:2, B:2, U:2) at 0x7f578998c6d0>
```

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

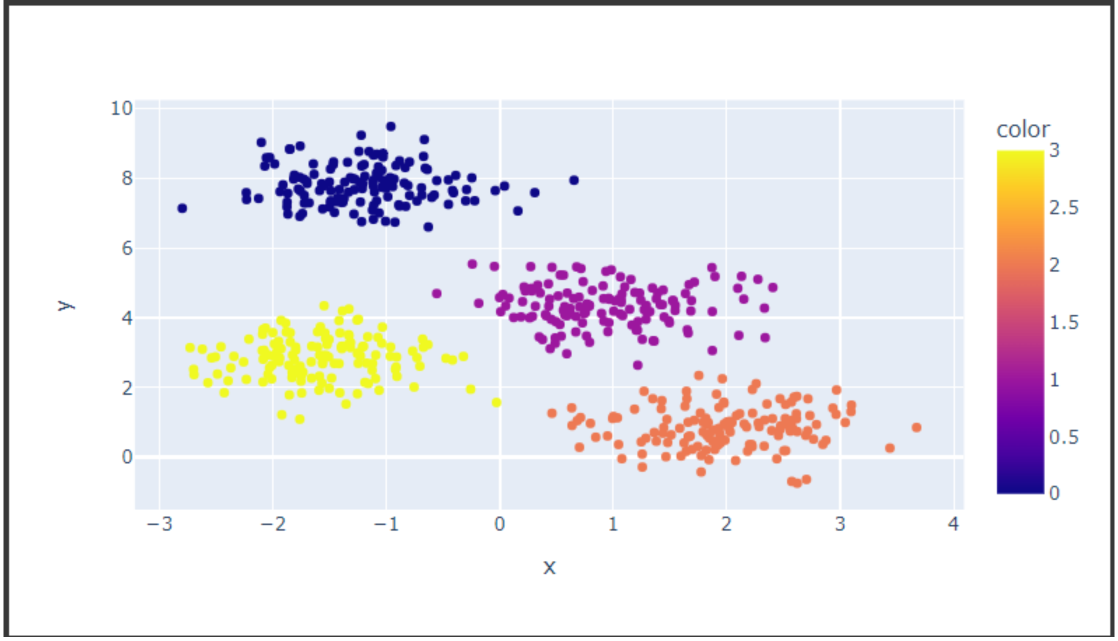
```
import matplotlib.pyplot as plt
import numpy as np
from sklearn.cluster import KMeans
from sklearn.datasets import make_blobs
X, y_true = make_blobs(n_samples=550, centers=4, cluster_std=0.60, random_state=0)
import plotly.express as px
fig = px.scatter(x =X[:, 0], y =X[:, 1],width=800,height=500)
fig.show()
```



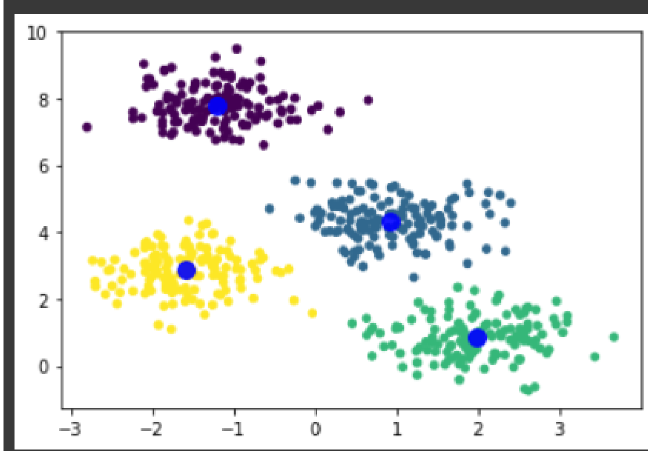
```
cost =[]
for i in range(1, 11):
  KM = KMeans(n_clusters = i, max_iter = 500)
  KM.fit(X)

  cost.append(KM.inertia_)

# plot the cost against K values
fig = px.line(x=range(1, 11), y=cost, width=600, height=400)
fig.show()
```



```
kmeans = KMeans(n_clusters=4)
kmeans.fit(X)
y_kmeans = kmeans.predict(X)
fig = px.scatter(x =X[:, 0], y = X[:, 1], color=y_kmeans, width=700,height=400)
trace = px.scatter(x =X[:, 0], y = X[:, 1],  width=700,height=400)
fig.show()
```




```
plt.scatter(X[:, 0], X[:, 1], c=y_kmeans, s=20)
centers = kmeans.cluster_centers_
plt.scatter(centers[:, 0], centers[:, 1], c='blue', s=100, alpha=0.9);
plt.show()
```



```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn import datasets
iris = datasets.load_iris()
df = pd.DataFrame(iris.data)
df['class']=iris.target
df.columns=['sepal_len', 'sepal_wid', 'petal_len', 'petal_wid', 'class']
df.info()
```

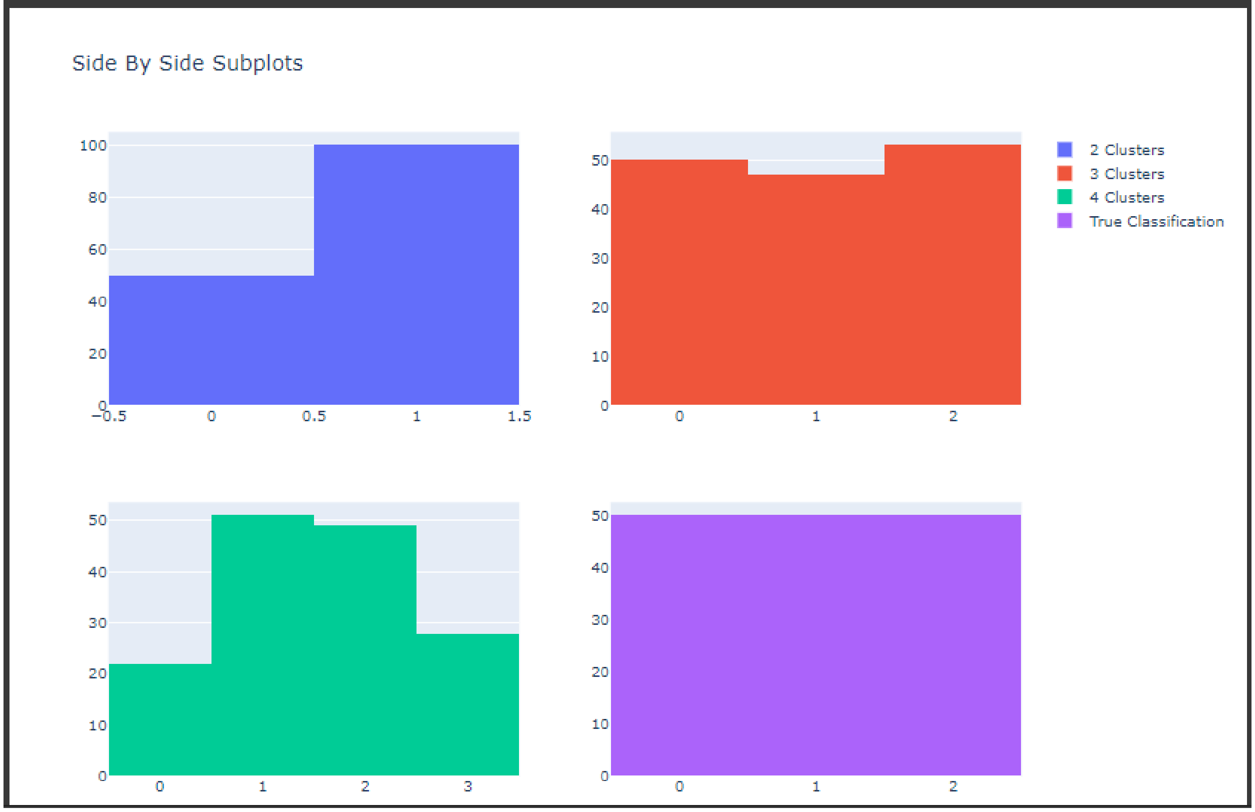
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 5 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   sepal_len  150 non-null    float64
 1   sepal_wid  150 non-null    float64
 2   petal_len  150 non-null    float64
 3   petal_wid  150 non-null    float64
 4   class      150 non-null    int64
dtypes: float64(4), int64(1)
memory usage: 6.0 KB
```

```python
px.histogram(df, x ='class', color='class')
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
X = df.iloc[:,0:4].values
scaled_x = scaler.fit_transform(X)
model = KMeans(n_clusters=3,init='k-means++',random_state=0)
labels = model.fit_predict(scaled_x)
```


```python
px.histogram(df, x ='class', color='class')
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
X = df.iloc[:,0:4].values
scaled_x = scaler.fit_transform(X)
model = KMeans(n_clusters=3,init='k-means++',random_state=0)
labels = model.fit_predict(scaled_x)
```


```python
import plotly.graph_objects as go
fig = go.Figure()

 # Add trace
fig.add_trace(go.Histogram(x=labels,name="Predicted Labels"))
fig.add_trace(go.Histogram(x=df['class'],name="True Labels"))

# Overlay both histograms
fig.update_layout(barmode='overlay')
# Reduce opacity to see both histograms
fig.update_traces(opacity=0.75)
fig.show()
```

```
labels =[]
for i in range(2, 5):
  model = KMeans(n_clusters = i, max_iter = 500)
  model.fit(scaled_x)
  labels.append(model.fit_predict(scaled_x))
from plotly.subplots import make_subplots
import plotly.graph_objects as go
fig = make_subplots(rows=2, cols=2)
for i in range(0, 3):
    fig.add_trace(go.Histogram(x=labels[i],name="{} Clusters".format(i+2)),
              row=(i//2 + 1), col=(i%2 + 1))
fig.add_trace(go.Histogram(x=df['class'],name="True Classification"),
              row=(2), col=(2))
fig.update_layout(height=700, width=1000, title_text="Side By Side Subplots")

fig.show()
```



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

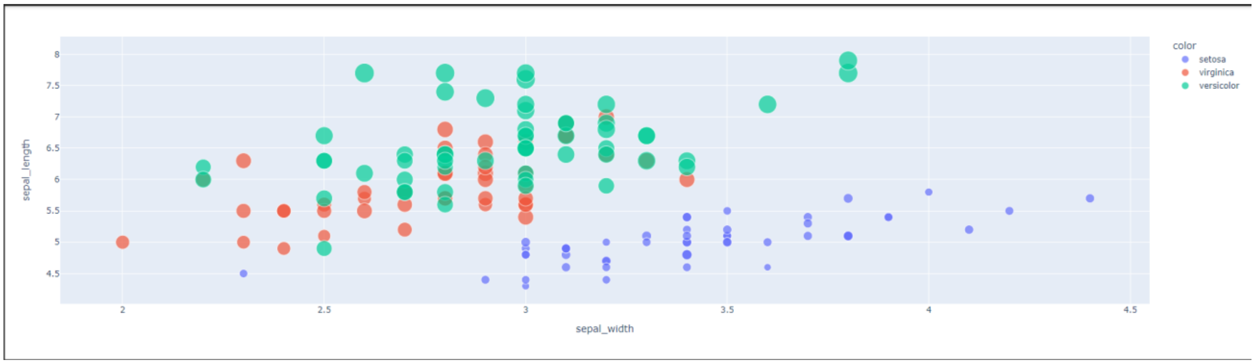
```
import pandas as pd
import plotly.express as px
from sklearn.metrics import confusion_matrix
df = px.data.iris()
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 6 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   sepal_length  150 non-null    float64
 1   sepal_width   150 non-null    float64
 2   petal_length  150 non-null    float64
 3   petal_width   150 non-null    float64
 4   species       150 non-null    object 
 5   species_id    150 non-null    int64  
dtypes: float64(4), int64(1), object(1)
memory usage: 7.2+ KB
```

```
from sklearn.mixture import GaussianMixture
from sklearn.model_selection import train_test_split as tts
X = df.iloc[:,0:4].values
gm = GaussianMixture(n_components=3, random_state=0).fit(X)
gm.means_
```

```
array([[5.006     , 3.418     , 1.464     , 0.244     ],
       [6.54639415, 2.94946365, 5.48364578, 1.98726565],
       [5.9170732 , 2.77804839, 4.20540364, 1.29848217]])
```

```
def feature(x):
    species = ['setosa','versicolor','virginica']
    return species[x]

pred = gm.predict(X)
pred_features = list(map(feature,pred))
fig1 = px.scatter(df, x="sepal_width", y="sepal_length", color=pred_features,
                 size='petal_length', hover_data=['petal_width'])
fig1.show()
```



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

In [27]:
```
import numpy as np
import matplotlib.pyplot as mtp
import pandas as pd
```

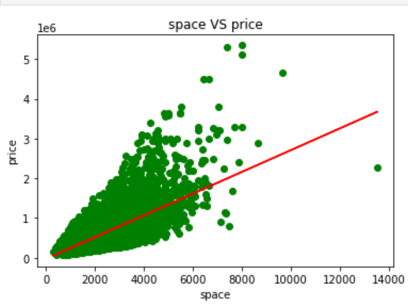
In [28]:
```
dataset = pd.read_csv("kc_house_data.csv")
```

In [29]:
```
space=dataset['sqft_living']
price=dataset['price']

x = np.array(space).reshape(-1, 1)
y = np.array(price)
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 [30]:
```
from sklearn.linear_model import LinearRegression
regressor= LinearRegression()
regressor.fit(x_train, y_train)
```

Out[30]: LinearRegression()

In [31]:
```
y_pred= regressor.predict(x_test)
x_pred= regressor.predict(x_train)
mtp.scatter(x_train, y_train, color="green")
mtp.plot(x_train, x_pred, color="red")
mtp.title("space VS price")
mtp.xlabel("space")
mtp.ylabel("price")
mtp.show()
```



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

```
import pandas as pd
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import train_test_split as tts
from mlxtend.plotting import plot_decision_regions
import matplotlib.pyplot as plt
import seaborn as sns
```

```
df = pd.read_csv("https://raw.githubusercontent.com/Derek-Stanley/6A_ML/main/LAB%208/iris.csv")
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 6 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Id             150 non-null    int64
 1   SepalLengthCm  150 non-null    float64
 2   SepalWidthCm   150 non-null    float64
 3   PetalLengthCm  150 non-null    float64
 4   PetalWidthCm   150 non-null    float64
 5   Species        150 non-null    object
dtypes: float64(4), int64(1), object(1)
memory usage: 7.2+ KB
```

```
X = df.iloc[:,[1,2,3,4]].values
y = df.iloc[:,5].values
X_train, X_test, y_train, y_test = tts(X,y,test_size=0.3)
```

```
import math,numpy as np
math.sqrt(len(df))
```

```
12.24744871391589
```

```
model = KNeighborsClassifier(n_neighbors = 13, metric = 'euclidean')
model.fit(X_train,y_train)
```

```
KNeighborsClassifier(metric='euclidean', n_neighbors=13)
```

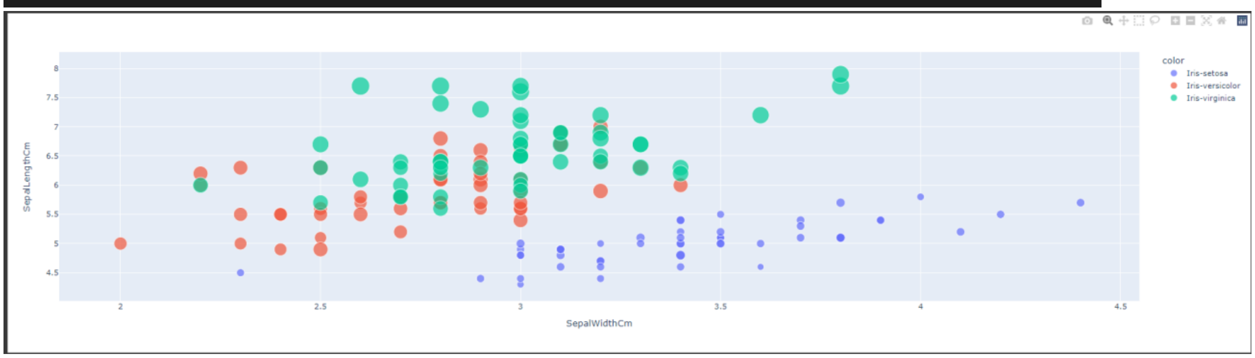
```
y_pred = model.predict(X_test)
```

```python
y_pred = model.predict(X_test)
```

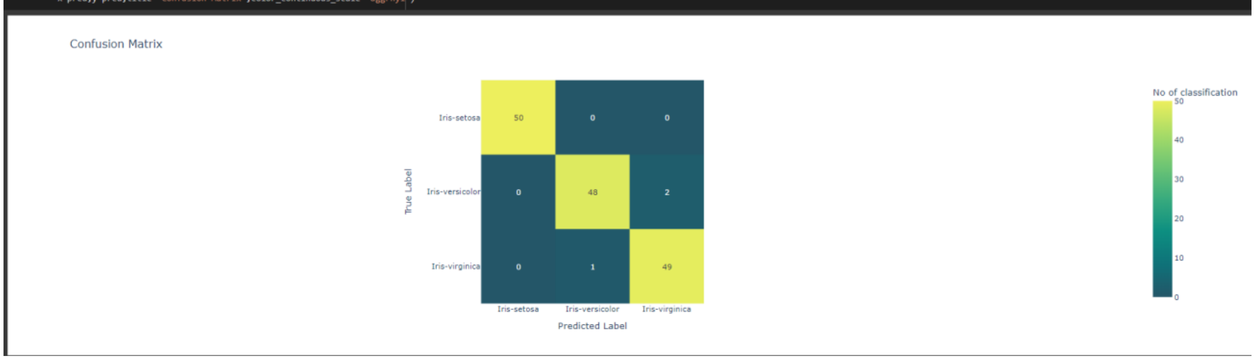
```python
from sklearn.metrics import classification_report, confusion_matrix
print('Accuracy Metrics')
print(classification_report(y_test,y_pred))
```

```
Accuracy Metrics
                 precision    recall  f1-score   support

    Iris-setosa       1.00      1.00      1.00        15
Iris-versicolor       1.00      1.00      1.00        16
 Iris-virginica       1.00      1.00      1.00        14

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

```python
import plotly.express as px
pred = model.predict(X)
fig1 = px.scatter(df, x="SepalWidthCm", y="SepalLengthCm", color=pred,
                  size='PetalLengthCm', hover_data=['PetalWidthCm'])
fig1.show()
```




```python
cm = confusion_matrix(df['Species'], pred, labels=pred)
px.imshow(cm,text_auto=True,labels=dict(x="Predicted Label", y="True Label", color="No of classification"),
        x=pred,y=pred,title="Confusion Matrix",color_continuous_scale="aggrnyl")
```



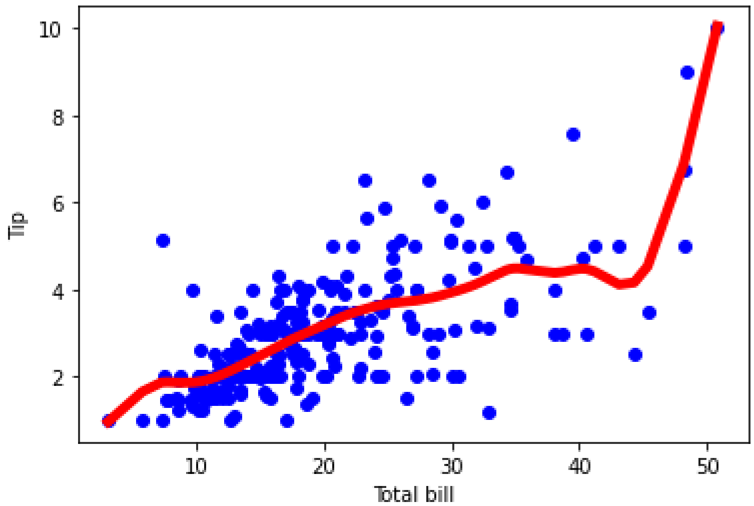
10. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.

```
from numpy import *
from os import listdir
import matplotlib
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np1
import numpy.linalg as np
import seaborn as sn
from scipy.stats.stats import pearsonr
```

```
data = sn.load_dataset('tips')
```

```
def kernel(point,xmat, k):
    m,n = np1.shape(xmat)
    weights = np1.mat(np1.eye((m)))
    for j in range(m):
        diff = point - X[j]
        weights[j,j] = np1.exp(diff*diff.T/(-2.0*k**2))
    return weights


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

def localWeightRegression(xmat,ymat,k):
    m,n = np1.shape(xmat)
    ypred = np1.zeros(m)

    for i in range(m):
        ypred[i] = xmat[i]*localWeight(xmat[i],xmat,ymat,k)
    return ypred
```

```
#load data points

bill = np1.array(data.total_bill)
tip = np1.array(data.tip)
#preparing and add 1 in bill
mbill = np1.mat(bill)
mtip = np1.mat(tip)
# mat is used to convert to n dimesiona to 2 dimensional array form
m= np1.shape(mbill)[1] # print(m) 244 data is stored in m
one = np1.mat(np1.ones(m))
X= np1.hstack((one.T,mbill.T)) # create a stack of bill from ONE
# print(X)
#set k here
ypred = localWeightRegression(X,mtip,2)
SortIndex = X[:,1].argsort(0)
xsort = X[SortIndex][:,0]
fig = plt.figure()
ax = fig.add_subplot(1,1,1)
ax.scatter(bill,tip, color='blue')
ax.plot(xsort[:,1],ypred[SortIndex], color = 'red', linewidth=5)
plt.xlabel('Total bill')
plt.ylabel('Tip')
plt.show();
```



10
8
6
4
2
Tip
10
20
30
40
50
Total bill