ML Lab report

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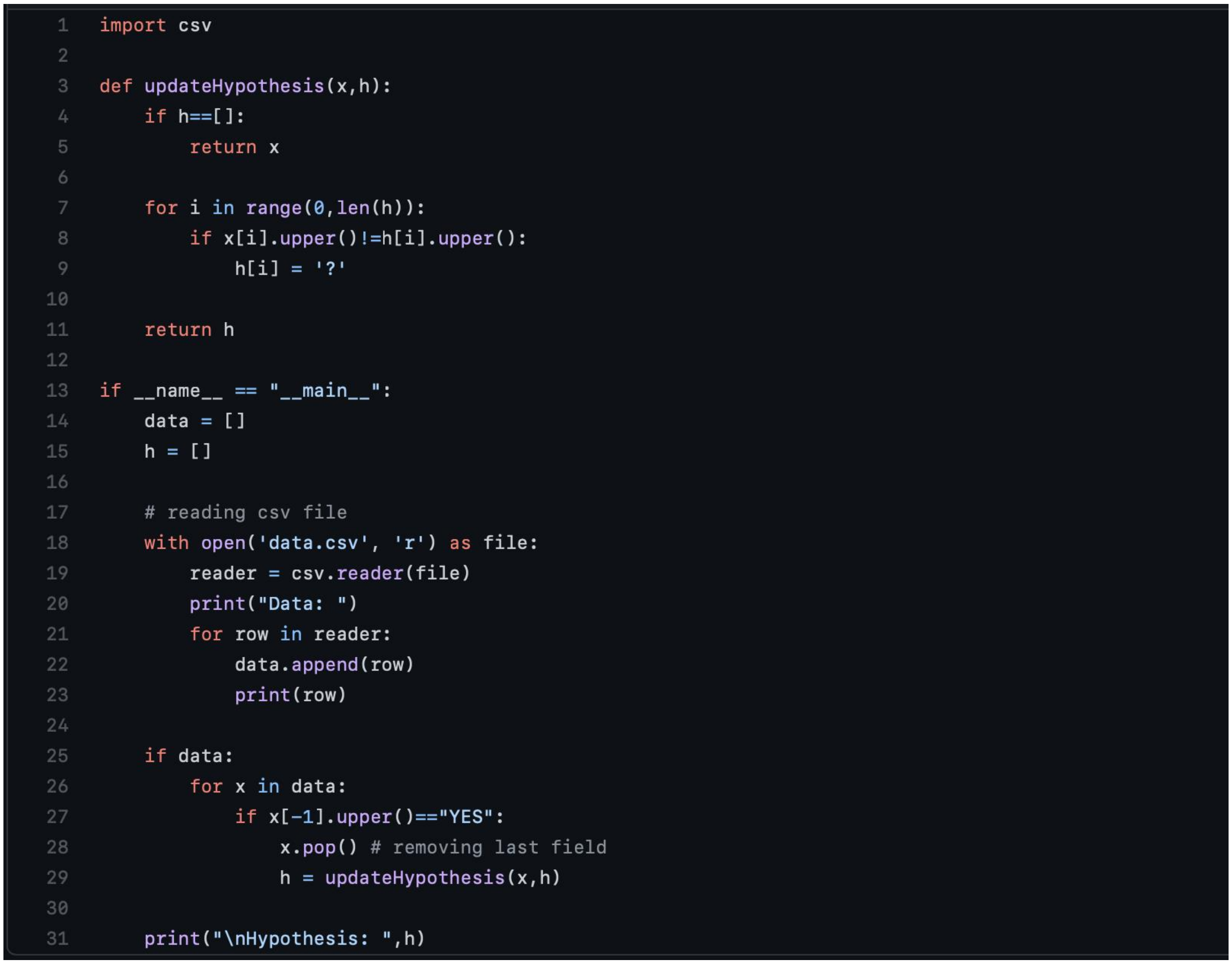
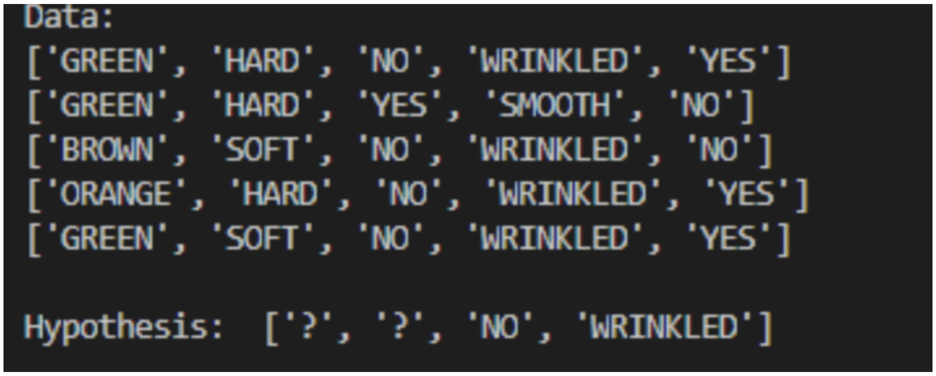
LAB 1

CODE:



```python
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('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)
```

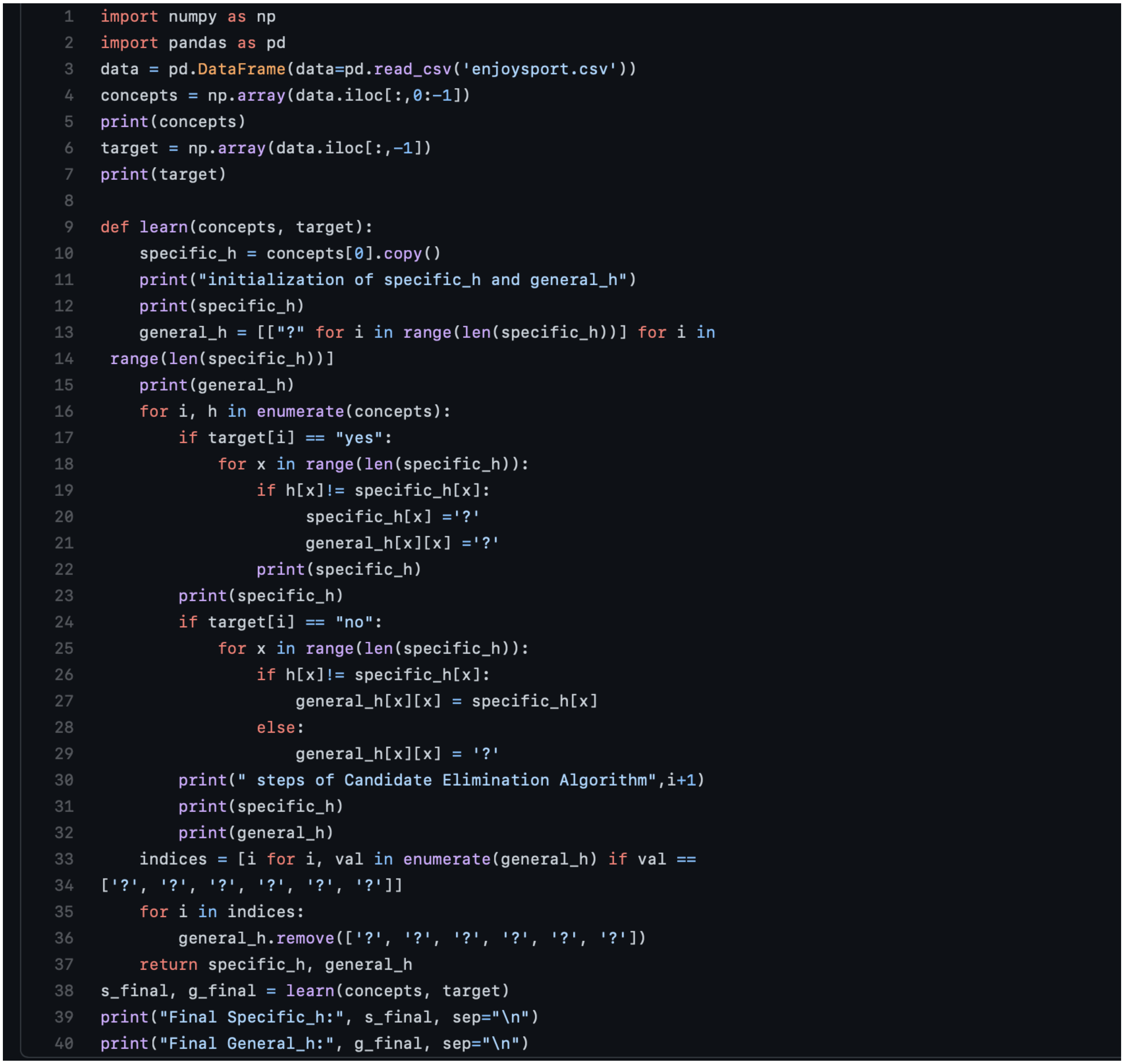
Output:



```
Data:
['GREEN', 'HARD', 'NO', 'WRINKLED', 'YES']
['GREEN', 'HARD', 'YES', 'SMOOTH', 'NO']
['BROWN', 'SOFT', 'NO', 'WRINKLED', 'NO']
['ORANGE', 'HARD', 'NO', 'WRINKLED', 'YES']
['GREEN', 'SOFT', 'NO', 'WRINKLED', 'YES']

Hypothesis:  ['?', '?', 'NO', 'WRINKLED']
```

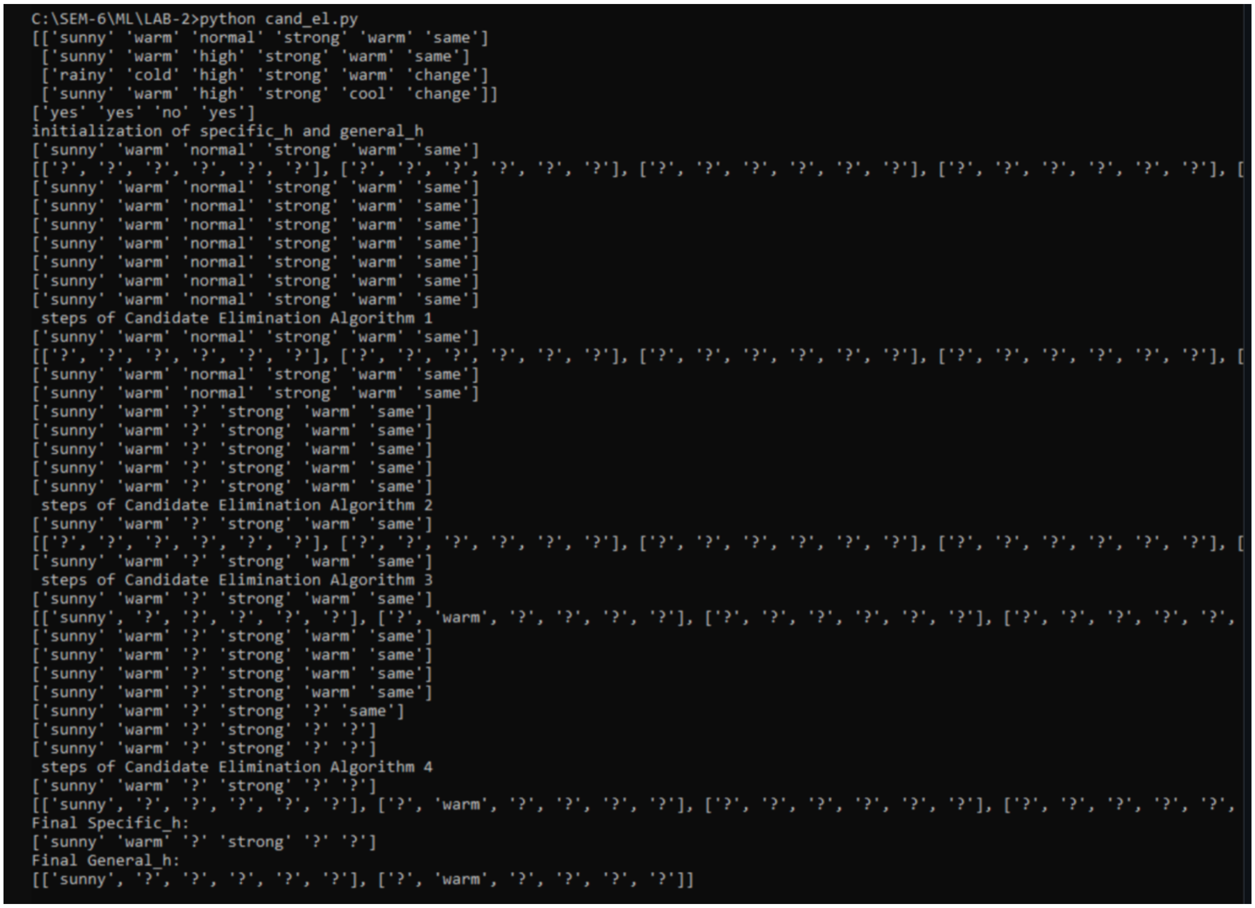
LAB 2

Code:



```
import numpy as np
import pandas as pd
data = pd.DataFrame(data=pd.read_csv('enjoysport.csv'))
concepts = np.array(data.iloc[:,0:-1])
print(concepts)
target = np.array(data.iloc[:,-1])
print(target)

def learn(concepts, target):
    specific_h = concepts[0].copy()
    print("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)
        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(" 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)
print("Final Specific_h:", s_final, sep="\n")
print("Final General_h:", g_final, sep="\n")
```

Output:



```
C:\SEM-6\ML\LAB-2>python cand_el.py
[['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
 ['sunny' 'warm' 'high' 'strong' 'warm' 'same']
 ['rainy' 'cold' 'high' 'strong' 'warm' 'change']
 ['sunny' 'warm' 'high' 'strong' 'cool' 'change']]
['yes' 'yes' 'no' 'yes']
initialization of specific_h and general_h
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], [
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
 steps of Candidate Elimination Algorithm 1
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], [
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
['sunny' 'warm' 'normal' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' 'warm' 'same']
 steps of Candidate Elimination Algorithm 2
['sunny' 'warm' '?' 'strong' 'warm' 'same']
[['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], [
['sunny' 'warm' '?' 'strong' 'warm' 'same']
 steps of Candidate Elimination Algorithm 3
['sunny' 'warm' '?' 'strong' 'warm' 'same']
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?',
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' 'warm' 'same']
['sunny' 'warm' '?' 'strong' '?' 'same']
['sunny' 'warm' '?' 'strong' '?' '?']
['sunny' 'warm' '?' 'strong' '?' '?']
 steps of Candidate Elimination Algorithm 4
['sunny' 'warm' '?' 'strong' '?' '?']
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?'], ['?', '?', '?', '?', '?', '?'], ['?', '?', '?', '?', '?',
Final Specific_h:
['sunny' 'warm' '?' 'strong' '?' '?']
Final General_h:
[['sunny', '?', '?', '?', '?', '?'], ['?', 'warm', '?', '?', '?', '?']]
```

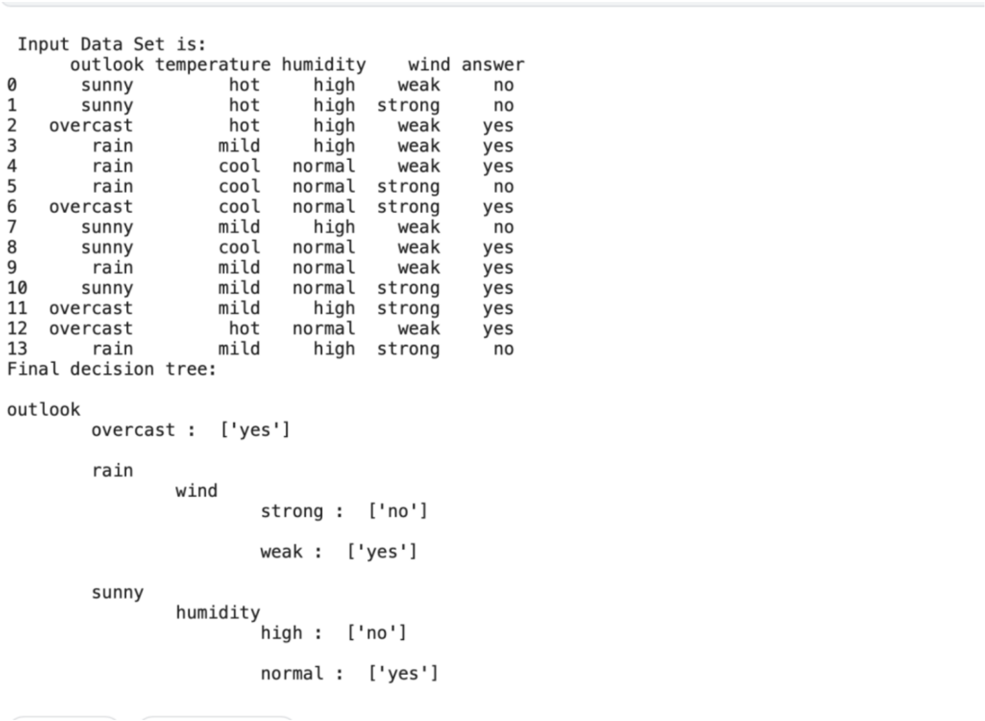
Lab 3:

code:

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



data=pd.read_csv("../input/dataset-id3/dataset.csv")
print("\n Input Data Set is:\n", data)
features = [f for f in data]
features.remove("answer")



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


def find_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 = find_entropy(examples)
   for u in uniq:
       subdata = examples[examples[attr] == u]
       sub_e = find_entropy(subdata)
       gain -= (float(len(subdata)) / float(len(examples))) * sub_e
   return gain



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 find_entropy(subdata) == 0.0:
         newNode = Node()
         newNode.isLeaf = True
         newNode.value = u
         newNode.pred = np.unique(subdata["answer"])
         root.children.append(newNode)
     else:
         tempNode = Node()
         tempNode.value = u
         new_attrs = attrs.copy()
         new_attrs.remove(max_feat)
         child = id3(subdata, new_attrs)
         tempNode.children.append(child)
         root.children.append(tempNode)
 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)
print("Final decision tree:\n")
printTree(root)
```

Output:



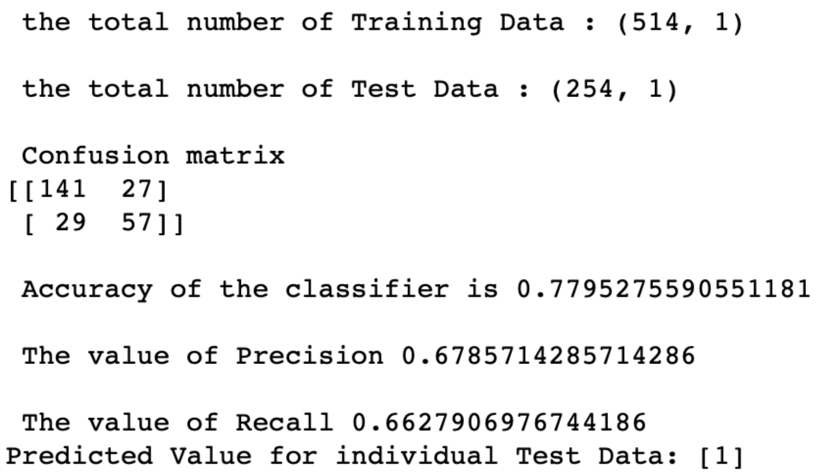
```
 Input Data Set is:
      outlook temperature humidity    wind answer
0      sunny         hot     high    weak     no
1      sunny         hot     high  strong     no
2   overcast         hot     high    weak    yes
3       rain        mild     high    weak    yes
4       rain        cool   normal    weak    yes
5       rain        cool   normal  strong     no
6   overcast        cool   normal  strong    yes
7      sunny        mild     high    weak     no
8      sunny        cool   normal    weak    yes
9       rain        mild   normal    weak    yes
10     sunny        mild   normal  strong    yes
11  overcast        mild     high  strong    yes
12  overcast         hot   normal    weak    yes
13      rain        mild     high  strong     no
Final decision tree:

outlook
        overcast :  ['yes']

        rain
                wind
                        strong :  ['no']

                        weak :  ['yes']

        sunny
                humidity
                        high :  ['no']

                        normal :  ['yes']
```

Lab 4:

code:

```
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("/Users/suman/Downloads/pima_indian.csv")
feature_col_names = ['num_preg', 'glucose_conc', 'diastolic_bp', 'thickness', 'insulin', 'bmi',
'diab_pred', 'age']
predicted_class_names = ['diabetes']

X = df[feature_col_names].values # these are factors for the prediction
y = df[predicted_class_names].values # this is what we want to predict

#splitting the dataset into train and test data

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

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


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

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

#printing Confusion matrix, accuracy, Precision and Recall

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

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

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

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

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

Output:



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

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

  Confusion matrix
 [[141  27]
  [ 29  57]]

  Accuracy of the classifier is 0.7795275590551181

  The value of Precision 0.6785714285714286

  The value of Recall 0.6627906976744186
 Predicted Value for individual Test Data: [1]
```

Lab 5:

Code:

```
import numpy as np
import pandas as pd
import csv
!pip install pgmpy
from pgmpy.estimators import MaximumLikelihoodEstimator
from pgmpy.models import BayesianModel
from pgmpy.inference import VariableElimination
```

```
Collecting pgmpy
  Downloading pgmpy-0.1.14-py3-none-any.whl (331 kB)
     |████████████████████████████████| 331 kB 3.0 MB/s
Requirement already satisfied: pandas in /opt/conda/lib/python3.7/site-packages (from pgmpy) (1.2.3)
Requirement already satisfied: scikit-learn in /opt/conda/lib/python3.7/site-packages (from pgmpy) (0.24.1)
Requirement already satisfied: scipy in /opt/conda/lib/python3.7/site-packages (from pgmpy) (1.5.4)
Requirement already satisfied: torch in /opt/conda/lib/python3.7/site-packages (from pgmpy) (1.7.0)
Requirement already satisfied: tqdm in /opt/conda/lib/python3.7/site-packages (from pgmpy) (4.59.0)
Requirement already satisfied: joblib in /opt/conda/lib/python3.7/site-packages (from pgmpy) (1.0.1)
Requirement already satisfied: pyparsing in /opt/conda/lib/python3.7/site-packages (from pgmpy) (2.4.7)
Requirement already satisfied: statsmodels in /opt/conda/lib/python3.7/site-packages (from pgmpy) (0.12.2)
Requirement already satisfied: networkx in /opt/conda/lib/python3.7/site-packages (from pgmpy) (2.5)
Requirement already satisfied: numpy in /opt/conda/lib/python3.7/site-packages (from pgmpy) (1.19.5)
Requirement already satisfied: decorator>=4.3.0 in /opt/conda/lib/python3.7/site-packages (from networkx->pgmpy) (4.4.2)
Requirement already satisfied: python-dateutil>=2.7.3 in /opt/conda/lib/python3.7/site-packages (from pandas->pgmpy) (2.8.1)
Requirement already satisfied: pytz>=2017.3 in /opt/conda/lib/python3.7/site-packages (from pandas->pgmpy) (2021.1)
Requirement already satisfied: six>=1.5 in /opt/conda/lib/python3.7/site-packages (from python-dateutil>=2.7.3->pandas->pgmpy) (1.15.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in /opt/conda/lib/python3.7/site-packages (from scikit-learn->pgmpy) (2.1.0)
Requirement already satisfied: patsy>=0.5 in /opt/conda/lib/python3.7/site-packages (from statsmodels->pgmpy) (0.5.1)
Requirement already satisfied: future in /opt/conda/lib/python3.7/site-packages (from torch->pgmpy) (0.18.2)
Requirement already satisfied: typing_extensions in /opt/conda/lib/python3.7/site-packages (from torch->pgmpy) (3.7.4.3)
Requirement already satisfied: dataclasses in /opt/conda/lib/python3.7/site-packages (from torch->pgmpy) (0.6)
Installing collected packages: pgmpy
Successfully installed pgmpy-0.1.14
```

In [2]:

```
heartDisease = pd.read_csv('../input/heartdisease/heart.csv')
heartDisease = heartDisease.replace('?',np.nan)

print('Sample instances from the dataset are given below')
print(heartDisease.head())
print('\n Attributes and datatypes')
print(heartDisease.dtypes)
```

```
Sample instances from the dataset are given below
   age  sex  cp  trestbps  chol  fbs  restecg  thalach  exang  oldpeak  slope  \
0   63    1   1       145   233    1        2      150      0      2.3      3
1   67    1   4       160   286    0        2      108      1      1.5      2
2   67    1   4       120   229    0        2      129      1      2.6      2
3   37    1   3       130   250    0        0      187      0      3.5      3
4   41    0   2       130   204    0        2      172      0      1.4      1

  ca thal  heartdisease
0  0    6             0
```

```
1  3    3            2
2  2    7            1
3  0    3            0
4  0    3            0

 Attributes and datatypes
age              int64
sex              int64
cp               int64
trestbps         int64
chol             int64
fbs              int64
restecg          int64
thalach          int64
exang            int64
oldpeak        float64
slope            int64
ca              object
thal            object
heartdisease     int64
dtype: object
```

In [3]:

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

In [4]:

```
print('\nLearning CPD using Maximum likelihood estimators')
model.fit(heartDisease,estimator=MaximumLikelihoodEstimator)

print('\nInferencing with Bayesian Network:')
HeartDiseasetest_infer = VariableElimination(model)
```

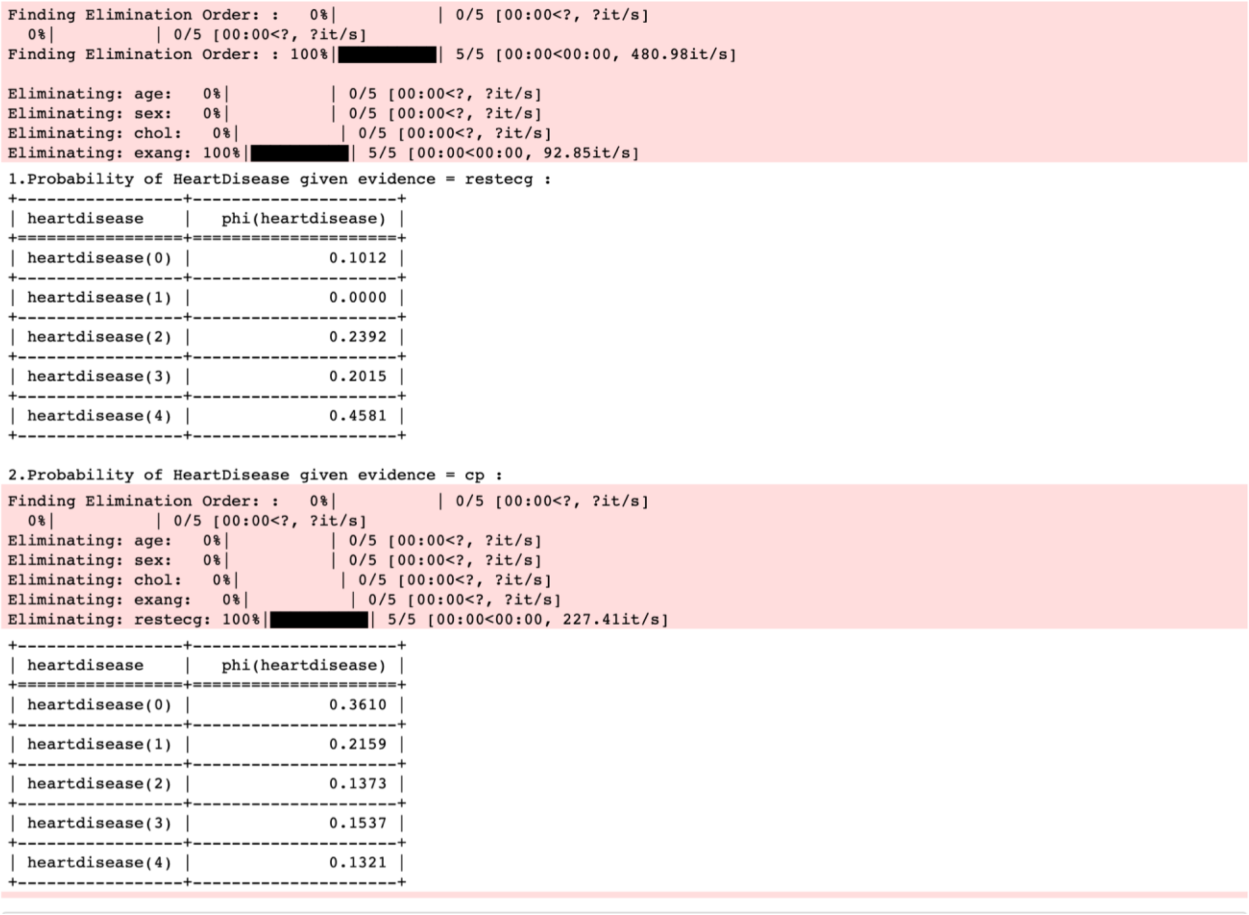
```
Learning CPD using Maximum likelihood estimators

Inferencing with Bayesian Network:
```

In [5]:

```
print('\n1.Probability of HeartDisease given evidence = restecg :')
q1=HeartDiseasetest_infer.query(variables=['heartdisease'],evidence={'restecg':1})
print(q1)

print('\n2.Probability of HeartDisease given evidence = cp :')
q2=HeartDiseasetest_infer.query(variables=['heartdisease'],evidence={'cp':2})
```

```
print(q2)
```

Output:



```
Finding Elimination Order: :   0%|          | 0/5 [00:00<?, ?it/s]
  0%|          | 0/5 [00:00<?, ?it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00, 480.98it/s]

Eliminating: age:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: sex:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: chol:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: exang: 100%|██████████| 5/5 [00:00<00:00, 92.85it/s]
1.Probability of HeartDisease given evidence = restecg :
+-----------------+---------------------+
| heartdisease    |   phi(heartdisease) |
+=================+=====================+
| heartdisease(0) |              0.1012 |
+-----------------+---------------------+
| heartdisease(1) |              0.0000 |
+-----------------+---------------------+
| heartdisease(2) |              0.2392 |
+-----------------+---------------------+
| heartdisease(3) |              0.2015 |
+-----------------+---------------------+
| heartdisease(4) |              0.4581 |
+-----------------+---------------------+

2.Probability of HeartDisease given evidence = cp :
Finding Elimination Order: :   0%|          | 0/5 [00:00<?, ?it/s]
  0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: age:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: sex:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: chol:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: exang:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: restecg: 100%|██████████| 5/5 [00:00<00:00, 227.41it/s]
+-----------------+---------------------+
| heartdisease    |   phi(heartdisease) |
+=================+=====================+
| heartdisease(0) |              0.3610 |
+-----------------+---------------------+
| heartdisease(1) |              0.2159 |
+-----------------+---------------------+
| heartdisease(2) |              0.1373 |
+-----------------+---------------------+
| heartdisease(3) |              0.1537 |
+-----------------+---------------------+
| heartdisease(4) |              0.1321 |
+-----------------+---------------------+
```

Lab 6:

Code:

```
!pip install pgmpy
```

```
Collecting pgmpy
  Downloading pgmpy-0.1.14-py3-none-any.whl (331 kB)
     |████████████████████████████████| 331 kB 892 kB/s eta 0:00:01
Collecting torch
  Downloading torch-1.8.1-cp38-none-macosx_10_9_x86_64.whl (119.6 MB)
     |████████████████████████████████| 119.6 MB 13.9 MB/s eta 0:00:01
Requirement already satisfied: scipy in /opt/anaconda3/lib/python3.8/site-packages (from pgmpy) (1.5.0)
Requirement already satisfied: scikit-learn in /opt/anaconda3/lib/python3.8/site-packages (from pgmpy) (0.23.1)
Requirement already satisfied: pandas in /opt/anaconda3/lib/python3.8/site-packages (from pgmpy) (1.0.5)
Requirement already satisfied: numpy in /opt/anaconda3/lib/python3.8/site-packages (from pgmpy) (1.18.5)
Requirement already satisfied: statsmodels in /opt/anaconda3/lib/python3.8/site-packages (from pgmpy) (0.11.1)
Requirement already satisfied: pyparsing in /opt/anaconda3/lib/python3.8/site-packages (from pgmpy) (2.4.7)
Requirement already satisfied: joblib in /opt/anaconda3/lib/python3.8/site-packages (from pgmpy) (0.16.0)
Requirement already satisfied: networkx in /opt/anaconda3/lib/python3.8/site-packages (from pgmpy) (2.4)
Requirement already satisfied: tqdm in /opt/anaconda3/lib/python3.8/site-packages (from pgmpy) (4.47.0)
Requirement already satisfied: typing-extensions in /opt/anaconda3/lib/python3.8/site-packages (from torch->pgmpy) (3.7.4.2)
Requirement already satisfied: threadpoolctl>=2.0.0 in /opt/anaconda3/lib/python3.8/site-packages (from scikit-learn->pgmpy) (2.1.0)
Requirement already satisfied: pytz>=2017.2 in /opt/anaconda3/lib/python3.8/site-packages (from pandas->pgmpy) (2020.1)
Requirement already satisfied: python-dateutil>=2.6.1 in /opt/anaconda3/lib/python3.8/site-packages (from pandas->pgmpy) (2.8.1)
Requirement already satisfied: patsy>=0.5 in /opt/anaconda3/lib/python3.8/site-packages (from statsmodels->pgmpy) (0.5.1)
Requirement already satisfied: decorator>=4.3.0 in /opt/anaconda3/lib/python3.8/site-packages (from networkx->pgmpy) (4.4.2)
Requirement already satisfied: six>=1.5 in /opt/anaconda3/lib/python3.8/site-packages (from python-dateutil>=2.6.1->pandas->pgmpy) (1.15.0)
Installing collected packages: torch, pgmpy
Successfully installed pgmpy-0.1.14 torch-1.8.1
```

```
In [2]:
```

```
import numpy as np
import pandas as pd
import csv
from pgmpy.estimators import MaximumLikelihoodEstimator
from pgmpy.models import BayesianModel
from pgmpy.inference import VariableElimination
```

In [18]:

```
heartDisease = pd.read_csv('/Users/abhishikatkumarsoni/Downloads/heart_Disease-2.csv')
heartDisease = heartDisease.replace('?',np.nan)

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

print('\n Attributes and datatypes')
print(heartDisease.dtypes)
```

```
Sample instances from the dataset are given below
   age  sex  cp  trestbps  chol  fbs  restecg  thalach  exang  oldpeak  slope  \
0   63    1   3       145   233    1        0      150      0      2.3      0
1   37    1   2       130   250    0        1      187      0      3.5      0
2   41    0   1       130   204    0        0      172      0      1.4      2
3   56    1   1       120   236    0        1      178      0      0.8      2
4   57    0   0       120   354    0        1      163      1      0.6      2

   ca  thal  target
0   0     1       1
1   0     2       1
2   0     2       1
3   0     2       1
4   0     2       1

 Attributes and datatypes
age           int64
sex           int64
cp            int64
trestbps      int64
chol          int64
fbs           int64
restecg       int64
thalach       int64
exang         int64
oldpeak     float64
slope         int64
ca            int64
```

```
thal          int64
target        int64
dtype: object
```

In [20]:

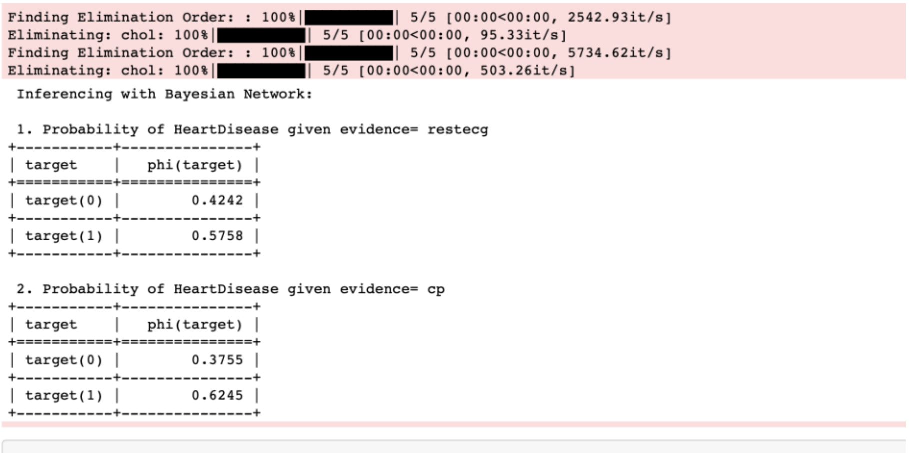
```
model=
BayesianModel([('age','target'),('sex','target'),('exang','target'),('cp','target'),('target','restecg'),('target','chol')])
print('\nLearning CPD using Maximum likelihood estimators')
model.fit(heartDisease,estimator=MaximumLikelihoodEstimator)
```

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

In [22]:

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

print('\n 1. Probability of HeartDisease given evidence= restecg')
q1=HeartDiseasetest_infer.query(variables=['target'],evidence={'restecg':1})
print(q1)

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

Output:



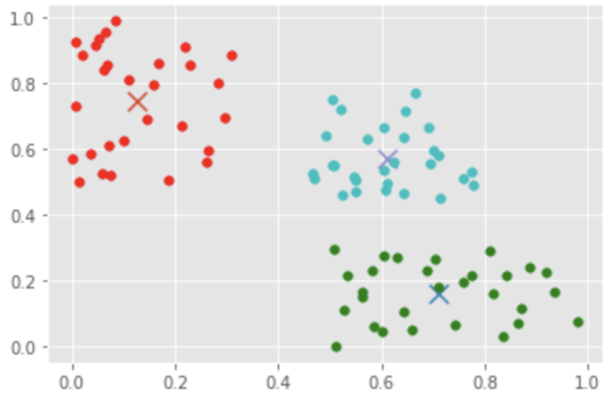
```
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00, 2542.93it/s]
Eliminating: chol: 100%|██████████| 5/5 [00:00<00:00, 95.33it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00, 5734.62it/s]
Eliminating: chol: 100%|██████████| 5/5 [00:00<00:00, 503.26it/s]
 Inferencing with Bayesian Network:

 1. Probability of HeartDisease given evidence= restecg
+-----------+---------------+
| target    |   phi(target) |
+===========+===============+
| target(0) |        0.4242 |
+-----------+---------------+
| target(1) |        0.5758 |
+-----------+---------------+

 2. Probability of HeartDisease given evidence= cp
+-----------+---------------+
| target    |   phi(target) |
+===========+===============+
| target(0) |        0.3755 |
+-----------+---------------+
| target(1) |        0.6245 |
+-----------+---------------+
```

Lab 7:

Code:

```python
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import style
import pandas as pd

style.use('ggplot')

class K_Means:
    def __init__(self, k =3, tolerance = 0.0001, max_iterations = 500):
        self.k = k
        self.tolerance = tolerance
        self.max_iterations = max_iterations

    def fit(self, data):

        self.centroids = {}

        #initialize the centroids, the first 'k' elements in the dataset will be our initial centroids
        for i in range(self.k):
            self.centroids[i] = data[i]
        #begin iterations
        for i in range(self.max_iterations):
            self.classes = {}
            for i in range(self.k):
                self.classes[i] = []

            #find the distance between the point and cluster; choose the nearest centroid
            for features in data:
                distances = [np.linalg.norm(features - self.centroids[centroid]) for centroid in self.centroids]
                classification = distances.index(min(distances))
                self.classes[classification].append(features)

            previous = dict(self.centroids)
            #average the cluster datapoints to re-calculate the centroids
            for classification in self.classes:
                self.centroids[classification] = np.average(self.classes[classification], axis = 0)

            isOptimal = True

            for centroid in self.centroids:

                original_centroid = previous[centroid]
                curr = self.centroids[centroid]

                if np.sum((curr - original_centroid)/original_centroid * 100.0) > self.tolerance:
                    isOptimal = False
            #break out of the main loop if the results are optimal, ie. the centroids don't change their positions much(more than our tolerance)
            if isOptimal:
                break

    def pred(self, data):
        distances = [np.linalg.norm(data - self.centroids[centroid]) for centroid in self.centroids]
        classification = distances.index(min(distances))
        return classification

def main():

    df = pd.read_csv('data.csv')
    df = df[['one', 'two']]
    dataset = df.astype(float).values.tolist()

    X = df.values #returns a numpy array

    km = K_Means(3)
    km.fit(X)

        # Plotting starts here
    colors = 10*["r", "g", "c", "b", "k"]
    for centroid in km.centroids:
        plt.scatter(km.centroids[centroid][0], km.centroids[centroid][1], s = 130, marker = "x")

    for classification in km.classes:
        color = colors[classification]
        for features in km.classes[classification]:
            plt.scatter(features[0], features[1], color = color,s = 30)

    plt.show()


main()
```

Output:



Lab 8:

Code:

```
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
```

In [2]:

```
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']
```

In [3]:

```
model = KMeans(n_clusters=3)
model.fit(X)


plt.figure(figsize=(14,7))

colormap = np.array(['red', 'lime', 'black'])
```

```
<Figure size 1008x504 with 0 Axes>
```

In [4]:

```python
# 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')
```

Out[4]:

```
Text(0, 0.5, 'Petal Width')
```

In [13]:

```python
# 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')
```

Out[13]:

```
Text(0, 0.5, 'Petal Width')
```

In [14]:

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

```
The accuracy score of K-Mean:  0.8933333333333333
The Confusion matrixof K-Mean:
 [[50  0  0]
 [ 0 48  2]
 [ 0 14 36]]
```

In [7]:

```python
from sklearn import preprocessing
scaler = preprocessing.StandardScaler()
scaler.fit(X)
```

```
xsa = scaler.transform(X)
xs = pd.DataFrame(xsa, columns = X.columns)
#xs.sample(5)
```

In [8]:

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

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

In [10]:

```
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')
```

Out[10]:

```
Text(0, 0.5, 'Petal Width')
```

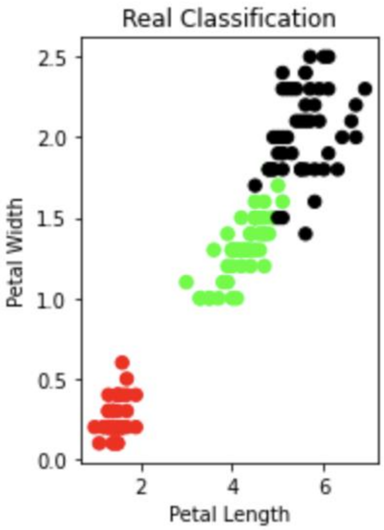
In [12]:

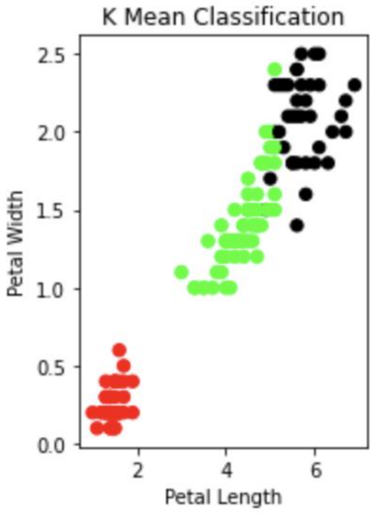
```
print('The accuracy score of EM: ',sm.accuracy_score(y, y_gmm))
print('The Confusion matrix of EM:\n',sm.confusion_matrix(y, y_gmm))
```

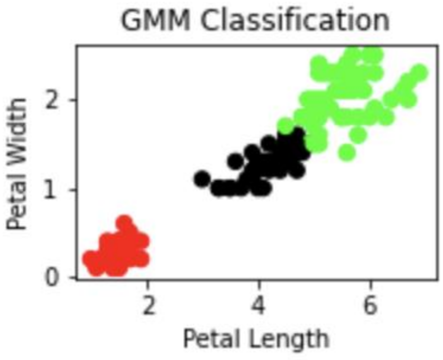
```
The accuracy score of EM:  0.36666666666666664
The Confusion matrix of EM:
 [[50  0  0]
 [ 0  5 45]
 [ 0 50  0]]
```

In [ ]:

Output:


Real Classification
2.5
2.0
1.5
1.0
0.5
0.0
Petal Width
2
4
6
Petal Length


K Mean Classification
2.5
2.0
1.5
1.0
0.5
0.0
Petal Width
2
4
6
Petal Length


GMM Classification
2
1
0
Petal Width
2
4
6
Petal Length