ML LAB REPORT

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Week 1:

i)Find s algorithm

```
# This Python 3 environment comes with many helpful analytics libraries ins
talled
# It is defined by the kaggle/python Docker image: https://github.com/kaggl
e/docker-python
# For example, here's several helpful packages to load

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

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will
list all files under the input directory

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that
gets preserved as output when you create a version using "Save & Run All"
# You can also write temporary files to /kaggle/temp/, but they won't be sa
ved outside of the current session
```

```
/kaggle/input/datasetcsv/data.csv
```

```
data = pd.read_csv("/kaggle/input/datasetcsv/data.csv")
print("The entered data is \n")
print(data,"\n")
d = np.array(data)[:,:-1]
print("\n The attributes are: \n",d)
target = np.array(data)[:,-1]
print("\n The target is: ",target)
def training(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)):In
                if val[x] != specific_hypothesis[x]:
                    specific_hypothesis[x] = '?'
                else:
                    pass
    return specific_hypothesis
print("\n The final hypothesis is:",training(d,target))
```

Output:

```
The entered data is

  Weather Temperature Humidity Goes
0  Sunny        Warm     Mild  Yes
1   Rainy        Cold     Mild   No
2  Sunny     Moderate    Nomal  Yes
3  Sunny         Cold    High   Yes


 The attributes are:
 [['Sunny ' 'Warm ' 'Mild']
 ['Rainy' 'Cold' 'Mild']
 ['Sunny ' 'Moderate' 'Nomal']
 ['Sunny ' 'Cold' 'High ']]

 The target is:  ['Yes' 'No' 'Yes' 'Yes']

 The final hypothesis is: ['Sunny ' '?' '?']
```

Week 2:

ii)Candidate elimination algorithm:

```
# This Python 3 environment comes with many helpful analytics libraries ins
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import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will
list all files under the input directory

import os
```

```
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that
gets preserved as output when you create a version using "Save & Run All"
# You can also write temporary files to /kaggle/temp/, but they won't be sa
ved outside of the current session
/kaggle/input/candidatecsv/candidate.csv

data = pd.read_csv("/kaggle/input/candidatecsv/candidate.csv")
print("Entered data is")
print(data)
concepts = np.array(data)[:,:-1]
print("\n The attributes are: \n",d)
target = np.array(data)[:,-1]
print("\n The target is: ",target)

Entered data is
     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

 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']

#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)
     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:

```
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' '?' '?' 'warm' 'same']
['sunny' 'warm' '?' '?' 'warm' 'same']
['sunny' 'warm' '?' '?' 'warm' 'same']
['sunny' 'warm' '?' '?' 'warm' 'same']



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

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

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

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

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

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

Week 3:

3)ID3 algorithm:

```
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_test.csv")


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

Output:

```
bmsce@bmsce-Precision-T1700:~/Documents/LAB - 3 - DECISION TREE$ python ml3.py
The decision tree for the dataset using ID3 algorithm is
('', 'Outlook')
('  ', 'overcast')
('    ', 'yes')
('  ', 'sunny')
('    ', 'Humidity')
('      ', 'high')
('        ', 'no')
('      ', 'normal')
('        ', 'yes')
('  ', 'rain')
('    ', 'Wind')
('      ', 'strong')
('        ', 'no')
('      ', 'weak')
('        ', 'yes')
('The test instance:', ['rain', 'cool', 'normal', 'strong'])
The label for test instance:
no
('The test instance:', ['sunny', 'mild', 'normal', 'strong'])
The label for test instance:
yes
```

Week 4:

iv)Naïve bayes classifier:

```
import pandas as pd

data = pd.read_csv('PlayTennis.csv')
data.head()
```

```
y = list(data['PlayTennis'].values)
```

```
X = data.iloc[:,1:].values
```

```
print(f'Target Values: {y}')
```

```
print(f'Features: \n{X}')
```

```
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']]
```

```
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)}")
```

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

```
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] an
d 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:

```
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
```

Week 5:

v)Bayesian network:

```
# This Python 3 environment comes with many helpful analytics libraries installed  # It is defined by the kaggle/python Docker image: https://github.com/kaggle/docker-python  # For example, here's several helpful packages to load  import numpy as np

# linear algebra

import pandas as pd

import pgmpy as pgmpy from pgmpy.estimators

import MaximumLikelihoodEstimator from pgmpy.models

import BayesianModel from pgmpy.inference

import VariableElimination

import os for dirname, _, filenames in os.walk('/kaggle/input'):

for filename in filenames: print(os.path.join(dirname, filename)) # You can write up to 20GB to the current directory (/kaggle/working/) that gets preserved as output when you create a version using "Save & Run All" # You can also write temporary files to /kaggle/temp/, but they won't be saved outside of the current session
```

```
#read Cleveland Heart Disease data
heartDisease = pd.read_csv("/kaggle/input/bayesiannetwork/heart.csv")
heartDisease = heartDisease.replace('?',np.nan)
#display the data
print('Sample instances from the dataset are given below')
print(heartDisease.head())
```

```
#display the Attributes names and datatyes
print('\n Attributes and datatypes')
print(heartDisease.dtypes)
#Creat Model- Bayesian Network
model = BayesianModel([('age','heartdisease'),('sex','heartdisease'),('
exang','heartdisease'),('cp','heartdisease'),('heartdisease','restecg')
,('heartdisease','chol')])
#Learning CPDs using Maximum Likelihood Estimators
print('\n Learning CPD using Maximum likelihood estimators')
model.fit(heartDisease,estimator=MaximumLikelihoodEstimator)
# Inferencing with Bayesian Network
print('\n Inferencing with Bayesian Network:')
HeartDiseasetest_infer = VariableElimination(model)
#computing the Probability of HeartDisease given restecg
print('\n 1.Probability of HeartDisease given evidence= restecg :1')
q1=HeartDiseasetest_infer.query(variables=['heartdisease'],evidence={'r
estecg':1})
print(q1)
#computing the Probability of HeartDisease given cp
print('\n 2.Probability of HeartDisease given evidence= cp:2 ')
q2=HeartDiseasetest_infer.query(variables=['heartdisease'],evidence={'c
p':2})
print(q2)
```

Output:

```
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

 Learning CPD using Maximum likelihood estimators
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: chol:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: cp:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: sex:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: exang: 100%|██████████| 5/5 [00:00<00:00, 189.65it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00, 132.81it/s]
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: chol:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: restecg:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: sex:   0%|          | 0/5 [00:00<?, ?it/s]
Eliminating: exang: 100%|██████████| 5/5 [00:00<00:00, 230.00it/s]
 Inferencing with Bayesian Network:
1.Probability of HeartDisease given evidence= restecg :1
+-----------------+---------------------+
| 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:2
+-----------------+---------------------+
| heartdisease    |   phi(heartdisease) |
+=================+=====================+
| heartdisease(0) |              0.3610 |
+-----------------+---------------------+
| heartdisease(1) |              0.2159 |
+-----------------+---------------------+
| heartdisease(2) |              0.1373 |
+-----------------+---------------------+
| heartdisease(3) |              0.1537 |
+-----------------+---------------------+
| heartdisease(4) |              0.1321
```

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

WEEK 6:

vi)Inferring from Bayesian model:

```
from pgmpy.models import BayesianModel
```

```
from pgmpy.factors.discrete import TabularCPD
```

```
from pgmpy.inference import VariableElimination
```

```
cancer_model = BayesianModel([('Pollution','Cancer'),
                              ('Smoker','Cancer'),
                              ('Cancer','Xray'),
                              ('Cancer','Dyspnoea')])
print('Bayesian network nodes are:')
print("\t",cancer_model.nodes())
print('Bayesian network edges are:')
print("\t",cancer_model.edges())

cpd_poll = TabularCPD(variable='Pollution',variable_card=2,values=[[0.9
],[0.1]])
cpd_smoke = TabularCPD(variable='Smoker',variable_card=2,values=[[0.3],
[0.7]])
cpd_cancer = TabularCPD(variable='Cancer',variable_card=2,values=[[0.03
,0.05,0.001,0.02],
                                                                  [0.97,
0.95,0.999,0.98]],
                        evidence=['Smoker','Pollution'],
                        evidence_card=[2,2])
cpd_xray = TabularCPD(variable='Xray',variable_card=2,values=[[0.9,0.2]
,[0.1,0.8]],
                      evidence=['Cancer'],evidence_card=[2])
cpd_dysp = TabularCPD(variable='Dyspnoea',variable_card=2,values=[[0.65
,0.3],[0.35,0.7]],
                      evidence=['Cancer'],evidence_card=[2])
```

```
Bayesian network nodes are:
        ['Pollution', 'Cancer', 'Smoker', 'Xray', 'Dyspnoea']
Bayesian network edges are:
        [('Pollution', 'Cancer'), ('Cancer', 'Xray'), ('Cancer', 'Dyspn
oea'), ('Smoker', 'Cancer')]
```

```
cancer_model.add_cpds(cpd_poll,cpd_smoke,cpd_cancer,cpd_xray,cpd_dysp)
print('Model generated by adding cpts(cpds)')
print('Checking correctness of model:',end='')
print(cancer_model.check_model())
```

```
Model generated by adding cpts(cpds)
Checking correctness of model:True
```

```
print('All local depencies are as follows')
```

```
cancer_model.get_independencies()
```

```
All local depencies are as follows
```

Out[10]:

```
(Pollution ⊥ Smoker)
(Pollution ⊥ Dyspnoea, Xray | Cancer)
(Pollution ⊥ Xray | Dyspnoea, Cancer)
(Pollution ⊥ Dyspnoea | Cancer, Xray)
(Pollution ⊥ Dyspnoea, Xray | Cancer, Smoker)
(Pollution ⊥ Xray | Dyspnoea, Cancer, Smoker)
(Pollution ⊥ Dyspnoea | Cancer, Xray, Smoker)
(Smoker ⊥ Pollution)
(Smoker ⊥ Dyspnoea, Xray | Cancer)
(Smoker ⊥ Xray | Dyspnoea, Cancer)
(Smoker ⊥ Dyspnoea, Xray | Pollution, Cancer)
(Smoker ⊥ Dyspnoea | Cancer, Xray)
(Smoker ⊥ Xray | Dyspnoea, Pollution, Cancer)
(Smoker ⊥ Dyspnoea | Pollution, Cancer, Xray)
(Xray ⊥ Dyspnoea, Pollution, Smoker | Cancer)
(Xray ⊥ Pollution, Smoker | Dyspnoea, Cancer)
(Xray ⊥ Dyspnoea, Smoker | Pollution, Cancer)
(Xray ⊥ Dyspnoea, Pollution | Cancer, Smoker)
(Xray ⊥ Smoker | Dyspnoea, Pollution, Cancer)
(Xray ⊥ Pollution | Dyspnoea, Cancer, Smoker)
(Xray ⊥ Dyspnoea | Pollution, Cancer, Smoker)
(Dyspnoea ⊥ Pollution, Xray, Smoker | Cancer)
(Dyspnoea ⊥ Xray, Smoker | Pollution, Cancer)
(Dyspnoea ⊥ Pollution, Smoker | Cancer, Xray)
(Dyspnoea ⊥ Pollution, Xray | Cancer, Smoker)
(Dyspnoea ⊥ Smoker | Pollution, Cancer, Xray)
(Dyspnoea ⊥ Xray | Pollution, Cancer, Smoker)
(Dyspnoea ⊥ Pollution | Cancer, Xray, Smoker)
```

```
print('Displaying  CPDs')
print(cancer_model.get_cpds('Pollution'))
print(cancer_model.get_cpds('Smoker'))
print(cancer_model.get_cpds('Cancer'))
print(cancer_model.get_cpds('Xray'))
print(cancer_model.get_cpds('Dyspnoea'))
```

```
Displaying  CPDs
+--------------+-----+
| Pollution(0) | 0.9 |
+--------------+-----+
| Pollution(1) | 0.1 |
+--------------+-----+
+-----------+-----+
| Smoker(0) | 0.3 |
+-----------+-----+
| Smoker(1) | 0.7 |
+-----------+-----+
+-----------+--------------+--------------+--------------+-------------
-+
```

```
| Smoker    | Smoker(0)    | Smoker(0)    | Smoker(1)    | Smoker(1)
|
+-----------+--------------+--------------+--------------+-------------
-+
| Pollution | Pollution(0) | Pollution(1) | Pollution(0) | Pollution(1)
|
+-----------+--------------+--------------+--------------+-------------
-+
| Cancer(0) | 0.03         | 0.05         | 0.001        | 0.02
|
+-----------+--------------+--------------+--------------+-------------
-+
| Cancer(1) | 0.97         | 0.95         | 0.999        | 0.98
|
+-----------+--------------+--------------+--------------+-------------
-+
+---------+----------+-----------+
| Cancer  | Cancer(0) | Cancer(1) |
+---------+----------+-----------+
| Xray(0) | 0.9       | 0.2       |
+---------+----------+-----------+
| Xray(1) | 0.1       | 0.8       |
+---------+----------+-----------+
+-------------+----------+-----------+
| Cancer      | Cancer(0) | Cancer(1) |
+-------------+----------+-----------+
| Dyspnoea(0) | 0.65      | 0.3       |
+-------------+----------+-----------+
| Dyspnoea(1) | 0.35      | 0.7       |
+-------------+----------+-----------+
```

```
cancer_infer=VariableElimination(cancer_model)
print('\n Inferencing with bayesian network')
print("\n Probability of Cancer given smoker")
q=cancer_infer.query(variables=['Cancer'],evidence={'Smoker':1})
print(q)

print("\n Probability of Cancer given smoker,pollution")
q=cancer_infer.query(variables=['Cancer'],evidence={'Smoker':1,'Polluti
on':1})
print(q)
```

Output:

```
Finding Elimination Order: :   0%|          | 0/3 [00:00<?, ?it/s]
  0%|          | 0/3 [00:00<?, ?it/s]
Eliminating: Dyspnoea:   0%|          | 0/3 [00:00<?, ?it/s]
Eliminating: Pollution:   0%|          | 0/3 [00:00<?, ?it/s]
Eliminating: Xray: 100%|██████████| 3/3 [00:00<00:00, 359.52it/s]

  0%|          | 0/2 [00:00<?, ?it/s]
Finding Elimination Order: :   0%|          | 0/2 [00:00<?, ?it/s]

  0%|          | 0/2 [00:00<?, ?it/s]
```

```
Eliminating: Dyspnoea:   0%|          | 0/2 [00:00<?, ?it/s]

Eliminating: Xray: 100%|██████████| 2/2 [00:00<00:00, 333.49it/s]A
 Inferencing with bayesian network

 Probability of Cancer given smoker
+-----------+---------------+
| Cancer    |   phi(Cancer) |
+===========+===============+
| Cancer(0) |        0.0029 |
+-----------+---------------+
| Cancer(1) |        0.9971 |
+-----------+---------------+
Probability of Cancer given smoker,pollution
+-----------+---------------+
| Cancer    |   phi(Cancer) |
+===========+===============+
| Cancer(0) |        0.0200 |
+-----------+---------------+
| Cancer(1) |        0.9800 |
+-----------+---------------+
```

Week 7 – K means

```
import math;
import sys;
import pandas as pd
import numpy as np
from random import choice
from matplotlib import pyplot
from random import shuffle, uniform;



def ReadData(fileName):
    f = open(fileName,'r')
    lines = f.read().splitlines()
    f.close()

    items = []

    for i in range(1,len(lines)):
        line = lines[i].split(',')
        itemFeatures = []

        for j in range(len(line)-1):
            v = float(line[j])
            itemFeatures.append(v)
        items.append(itemFeatures)

    shuffle(items)
```

```
def FindColMinMax(items):
    n = len(items[0])
    minima = [float('inf') for i in range(n)]
    maxima = [float('-inf') -1 for i in range(n)]

    for item in items:
        for f in range(len(item)):
            if(item[f] < minima[f]):
                minima[f] = item[f]

            if(item[f] > maxima[f]):
                maxima[f] = item[f]

    return minima,maxima

def EuclideanDistance(x,y):
    S = 0
    for i in range(len(x)):
        S += math.pow(x[i]-y[i],2)

    return math.sqrt(S)

def InitializeMeans(items,k,cMin,cMax):
    f = len(items[0])
    means = [[0 for i in range(f)] for j in range(k)]

    for mean in means:
        for i in range(len(mean)):
            mean[i] = uniform(cMin[i]+1,cMax[i]-1)
            return means


    return items

def UpdateMean(n,mean,item):
    for i in range(len(mean)):
        m = mean[i]
        m = (m*(n-1)+item[i])/float(n)
        mean[i] = round(m,3)

    return mean


def FindClusters(means,items):
    clusters = [[] for i in range(len(means))]

    for item in items:
        index = Classify(means,item)
        clusters[index].append(item)

    return clusters
def Classify(means,item):

    minimum = float('inf');
    index = -1

    for i in range(len(means)):
        dis = EuclideanDistance(item,means[i])
```

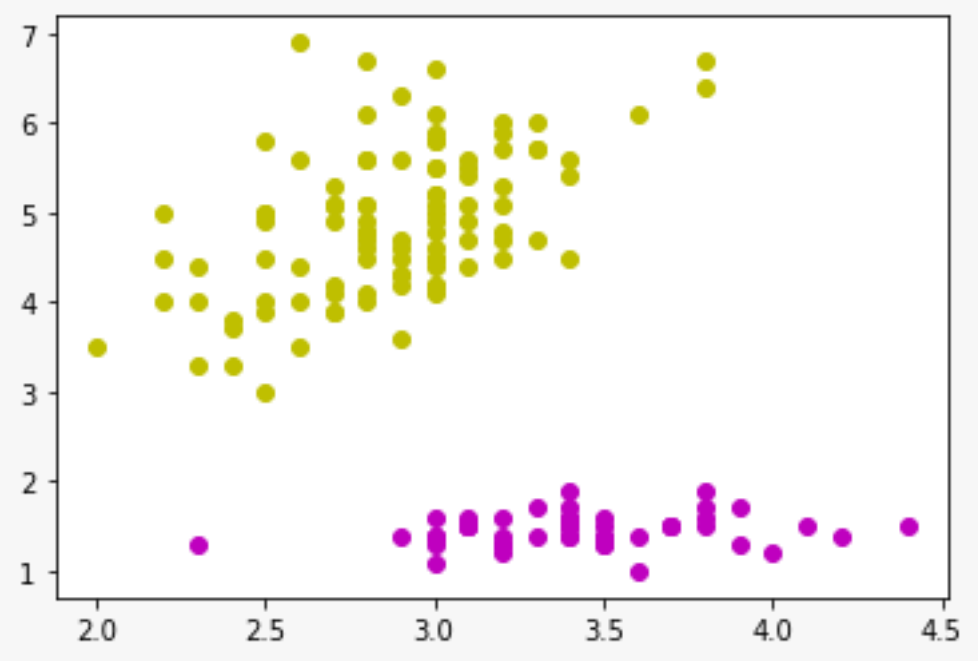
```
if(dis < minimum):
            minimum = dis
            index = i

    return index

def CalculateMeans(k,items,maxIterations=100000):
    cMin, cMax = FindColMinMax(items)

    means = InitializeMeans(items,k,cMin,cMax)

    clusterSizes = [0 for i in range(len(means))]

    belongsTo = [0 for i in range(len(items))]

    for e in range(maxIterations):
        noChange = True;
        for i in range(len(items)):
            item = items[i];
            index = Classify(means,item)
            clusterSizes[index] += 1
            cSize = clusterSizes[index]
            means[index] = UpdateMean(cSize,means[index],item)
            if(index != belongsTo[i]):
                noChange = False
            belongsTo[i] = index

        if (noChange):
            break

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

    return X

def PlotClusters(clusters):
    n = len(clusters)
    X = [[] for i in range(n)]

    for i in range(n):
        cluster = clusters[i]
        for item in cluster:
            X[i].append(item)
            colors = ['r','b','g','c','m','y']

    for x in X:
        c = choice(colors)
        colors.remove(c)

        Xa = []
        Xb = []
```

```
        for item in x:
            Xa.append(item[0])
            Xb.append(item[1])

pyplot.plot(Xa,Xb,'o',color=c)

    pyplot.show()


def main():
    items = ReadData('../input/iriscsv/Iris.csv')
    k = 3
    items = CutToTwoFeatures(items,2,3)
    print(items)
    means = CalculateMeans(k,items)
    print("\nMeans = ", means)

    clusters = FindClusters(means,items)

    PlotClusters(clusters)
    newItem = [1.5,0.2]
    print(Classify(means,newItem))
if __name__ == "__main__":
    main()
```

output:

```
[[2.5, 5.8], [3.2, 5.9], [2.9, 6.3], [3.0, 4.5], [2.3, 4.4], [2.9,
4.3], [2.9, 4.3], [3.5, 1.6], [3.0, 5.2], [3.0, 4.2], [3.2, 5.1], [3.1,
5.4], [3.1, 4.4], [3.1, 4.9], [3.2, 1.6], [3.0, 5.2], [3.8, 1.9], [3.1,
1.5], [3.1, 5.1], [3.7, 1.5], [3.1, 1.5], [3.3, 5.7], [3.3, 6.0], [3.8,
1.5], [3.0, 6.6], [3.0, 1.3], [3.8, 6.7], [3.0, 4.1], [2.8, 4.8], [3.1,
1.6], [4.4, 1.5], [2.2, 4.5], [3.5, 1.5], [3.0, 1.4], [3.3, 1.7], [3.1,
5.5], [3.4, 1.4], [2.7, 5.1], [2.4, 3.3], [3.8, 1.7], [3.0, 4.5], [3.8,
1.6], [2.9, 4.2], [2.8, 4.0], [2.7, 4.2], [2.9, 1.4], [4.2, 1.4], [2.5,
5.0], [3.0, 5.8], [3.0, 6.1], [2.9, 4.5], [3.1, 5.6], [3.0, 4.9], [3.2,
6.0], [3.4, 1.5], [3.7, 1.5], [2.5, 3.0], [3.1, 4.7], [3.1, 1.5], [2.8,
5.6], [3.0, 5.5], [3.4, 1.4], [2.9, 4.7], [3.2, 4.8], [2.7, 3.9], [2.0,
3.5], [3.2, 4.7], [3.0, 4.8], [2.8, 4.6], [3.2, 1.3], [2.7, 3.9], [3.2,
5.7], [2.6, 4.0], [2.3, 1.3], [3.4, 1.6], [3.0, 1.4], [3.2, 1.4], [2.8,
4.1], [2.3, 3.3], [3.4, 1.6], [2.8, 6.1], [3.5, 1.4], [4.1, 1.5], [3.0,
1.6], [3.5, 1.3], [3.7, 1.5], [2.6, 6.9], [2.4, 3.7], [2.5, 5.0], [2.8,
4.5], [2.2, 5.0], [3.6, 1.0], [3.4, 1.9], [2.8, 5.1], [3.0, 4.6], [2.5,
3.9], [2.7, 4.1], [2.9, 3.6], [3.4, 5.6], [3.2, 1.3], [2.8, 4.7], [2.5,
4.0], [3.2, 5.3], [3.4, 1.5], [3.0, 1.1], [3.3, 1.4], [3.9, 1.7], [2.8,
5.6], [3.0, 5.5], [2.4, 3.8], [2.9, 4.6], [2.6, 5.6], [3.5, 1.3], [3.8,
6.4], [2.7, 4.9], [3.0, 4.2], [3.9, 1.3], [2.3, 4.0], [2.7, 5.1], [2.8,
4.9], [2.2, 4.0], [3.0, 5.8], [2.5, 4.9], [3.0, 5.9], [3.4, 5.4], [3.4,
1.5], [3.3, 5.7], [3.5, 1.4], [2.7, 5.1], [3.6, 1.4], [3.0, 1.4], [3.4,
1.7], [2.8, 6.7], [3.2, 1.2], [4.0, 1.2], [2.8, 5.1], [3.0, 5.0], [2.5,
4.5], [2.8, 4.8], [2.6, 3.5], [3.0, 4.4], [3.1, 1.5], [3.3, 4.7], [3.2,
```

```
4.5], [3.6, 6.1], [3.0, 5.1], [2.7, 5.3], [2.6, 4.4], [2.9, 5.6], [3.4,
4.5]] Means = [[2.909, 4.662], [3.413, 1.452], [0, 0]]
```



Week-8:

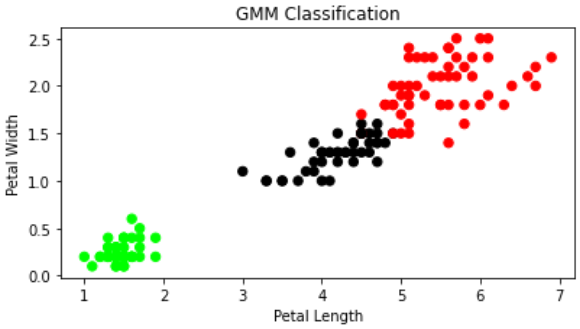
8)Em ALGORITHM USING K-MEANS :

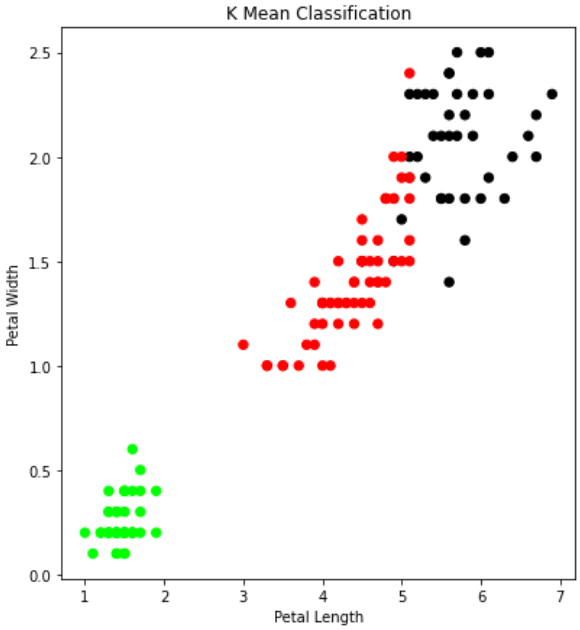
```
import matplotlib.pyplot as plt
from sklearn import datasets
from sklearn.cluster import KMeans
import sklearn.metrics as sm
import pandas as pd
import numpy as np

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.label
s_))
print('The Confusion matrixof K-Mean: ',sm.confusion_matrix(y, model.la
bels_))


from sklearn import preprocessing
scaler = preprocessing.StandardScaler()
scaler.fit(X)
xsa = scaler.transform(X)
xs = pd.DataFrame(xsa, columns = X.columns)
#xs.sample(5)

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

y_gmm = gmm.predict(xs)
#y_cluster_gmm

plt.subplot(2, 2, 3)
plt.scatter(X.Petal_Length, X.Petal_Width, c=colormap[y_gmm], s=40)
plt.title('GMM Classification')
plt.xlabel('Petal Length')
plt.ylabel('Petal Width')
print('The accuracy score of EM: ',sm.accuracy_score(y, y_gmm))
print('The Confusion matrix of EM: ',sm.confusion_matrix(y, y_gmm))
```

Output:

```
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:  0.0
The Confusion matrix of EM:  [[ 0 50  0]
 [ 5  0 45]
 [50  0  0]]
```





9)KNN CLASSIFIER :

```
import math
data = []
with open('../input/habermans-survival-data-set/haberman.csv', 'r') as
f:
    for line in f.readlines():
        atributes = line.strip('\n').split(',')
        data.append([int(x) for x in atributes])
def info_dataset(data, verbose=True):
    label1, label2 = 0, 0
    data_size = len(data)
    for datum in data:
        if datum[-1] == 1:
            label1 += 1
        else:
            label2 += 1
    if verbose:
        print('Total of samples: %d' % data_size)
        print('Total label 1: %d' % label1)
        print('Total label 2: %d' % label2)
    return [len(data), label1, label2]
```

```
info_dataset(data)
```

```
p = 0.6 _, label1, label2 = info_dataset(data,False)
```

```
train_set, test_set = [], []
max_label1, max_label2 = int(p * label1), int(p * label2)
total_label1, total_label2 = 0, 0
for sample in data:
    if (total_label1 + total_label2) < (max_label1 + max_label2):
        train_set.append(sample)
        if sample[-1] == 1 and total_label1 < max_label1:
            total_label1 += 1
        else:
```

```
            total_label2 += 1
    else:
        test_set.append(sample)
def euclidian_dist(p1, p2):
    dim, sum_ = len(p1), 0
    for index in range(dim - 1):
        sum_ += math.pow(p1[index] - p2[index], 2)
    return math.sqrt(sum_)
def knn(train_set, new_sample, K):
    dists, train_size = {}, len(train_set)

    for i in range(train_size):
        d = euclidian_dist(train_set[i], new_sample)
        dists[i] = d

    k_neighbors = sorted(dists, key=dists.get)[:K]

    qty_label1, qty_label2 = 0, 0
    for index in k_neighbors:
        if train_set[index][-1] == 1:
            qty_label1 += 1
        else:
            qty_label2 += 1

    if qty_label1 > qty_label2:
        return 1
    else:
        return 2
print(test_set[0])
print(knn(train_set, test_set[0], 12))
```

Output:

```
Train set size: 183

Test set size: 123

Correct predicitons: 93

Accuracy: 50.82%
```

10)Linear regression:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline

dataset = pd.read_csv('../input/linearlab/house_data.csv')

Y = dataset[['price']]

X = dataset.drop(['price', 'id', 'date'],  axis=1)

x = X[['sqft_living']]
```

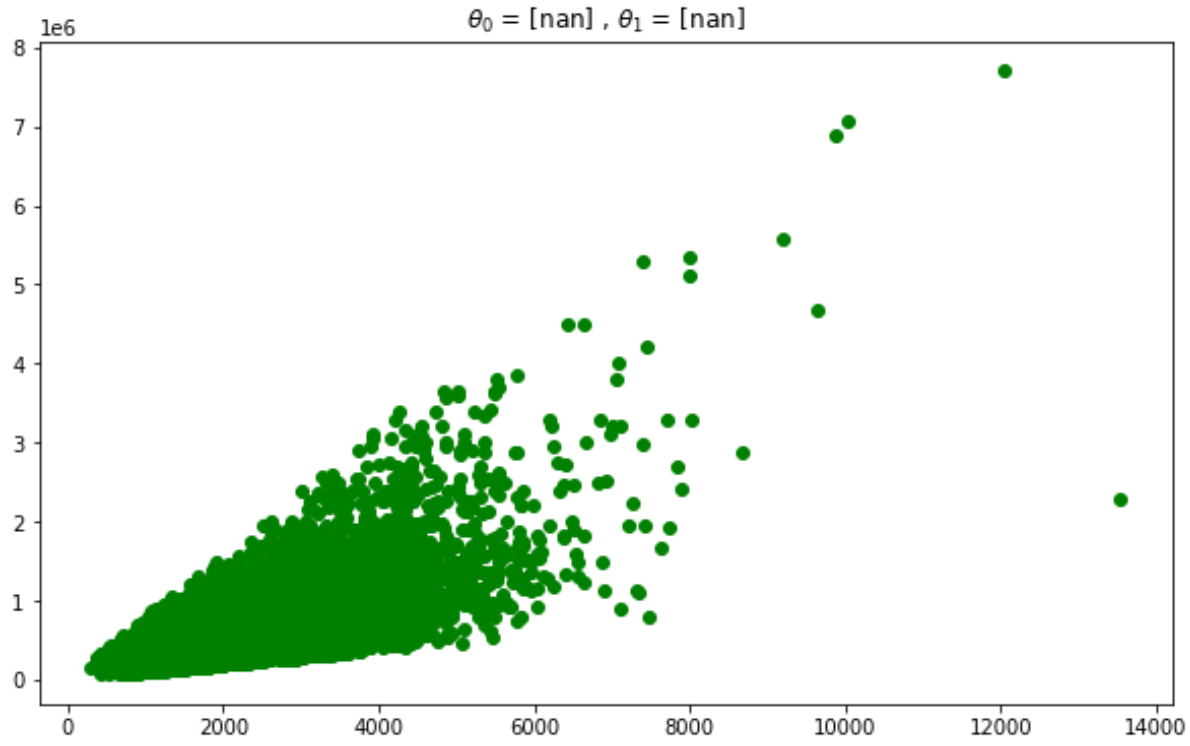
```
y = Y

xg = x.values.reshape(-1,1)
yg = y.values.reshape(-1,1)
xg = np.concatenate((np.ones(len(x)).reshape(-1,1), x), axis=1)

def computeCost(x, y, theta):
    m = len(y)
    h_x = x.dot(theta)
    j = np.sum(np.square(h_x - y))*(1/(2*m))
    return j
def gradientDescent(x, y, theta, alpha, iteration):
    print('Running Gradient Descent...')
    j_hist = []
    m = len(y)
    for i in range(iteration):
        j_hist.append(computeCost(x, y, theta))
        h_x = x.dot(theta)
theta = theta - ((alpha/m) *((np.dot(x.T, (h_x-y) ))))
        #theta[0] = theta[0] - ((alpha/m) *(np.sum((h_x-y))))
    return theta, j_hist

theta = np.zeros((2,1))
iteration = 2000
alpha = 0.001

theta, cost = gradientDescent(xg, yg, theta, alpha, iteration)
print('Theta found by Gradient Descent: slope = {} and intercept {}'.fo
rmat(theta[1], theta[0]))

theta.shape

plt.figure(figsize=(10,6))
plt.title('$\\theta_0$ = {} , $\\theta_1$ = {}'.format(theta[0], theta[
1]))
plt.scatter(x,y, marker='o', color='g')
plt.plot(x,np.dot(x.values, theta.T))
plt.show()

plt.plot(cost)
plt.xlabel('No. of iterations')
plt.ylabel('Cost')
```

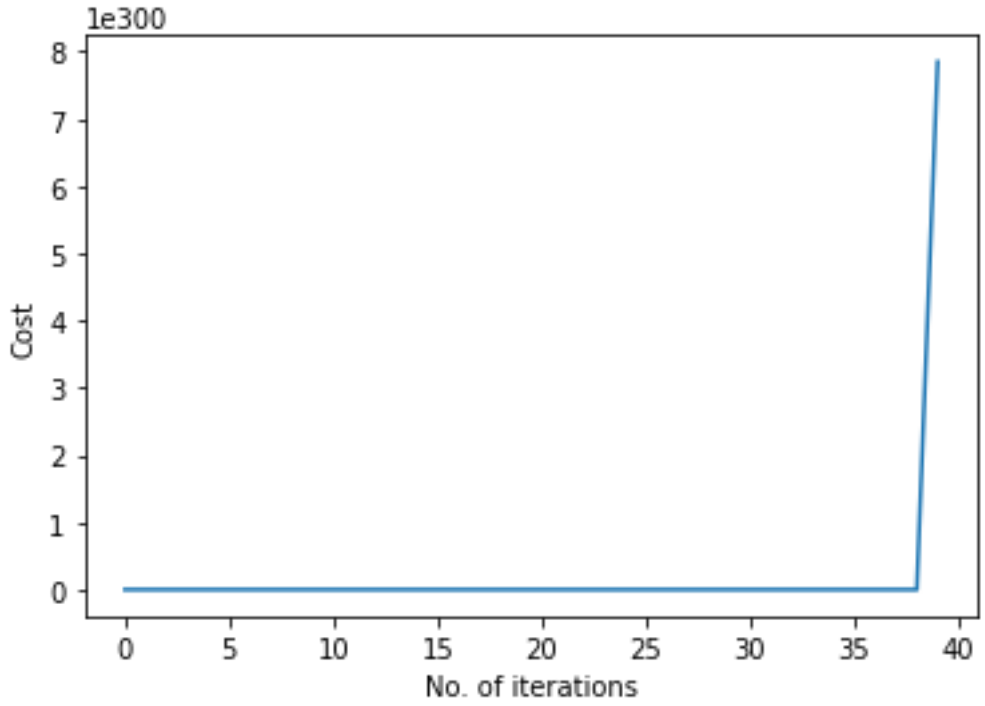
Output:

```
Running Gradient Descent...
/opt/conda/lib/python3.7/site-packages/ipykernel_launcher.py:23: RuntimeWar
ning: overflow encountered in square
/opt/conda/lib/python3.7/site-packages/numpy/core/fromnumeric.py:87: Runtim
eWarning: overflow encountered in reduce
  return ufunc.reduce(obj, axis, dtype, out, **passkwargs)
```

```
/opt/conda/lib/python3.7/site-packages/ipykernel_launcher.py:32: RuntimeWar
ning: invalid value encountered in subtract
Theta found by Gradient Descent: slope = [nan] and intercept [nan]
```
Out[1]:

```
Text(0, 0.5, 'Cost')
```





11)Locally weighted regression:

```
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('../input/localw/data10_tips.csv')
bill = np.array(data.total_bill) # We use only Bill amount and Tips dat
a
tip = np.array(data.tip)

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

Output: