In [5]:
```
import csv

def get_domains(examples):
    d = [set() for i in examples[0]]
    for x in examples:
        for i, xi in enumerate(x):
            d[i].add(xi)
    return [list(sorted(x)) for x in d]

def more_general(h1, h2):
    more_general_parts = []
    for x, y in zip(h1, h2):
        mg = x == "?" or (x != "0" and (x == y or y == "0"))
        more_general_parts.append(mg)
    return all(more_general_parts)

def fulfills(example, hypothesis):
    return more_general(hypothesis, example)

def min_generalizations(h, x):
    h_new = list(h)
    for i in range(len(h)):
        if not fulfills(x[i:i+1], h[i:i+1]):
            h_new[i] = '?' if h[i] != '0' else x[i]
    return [tuple(h_new)]

def min_specializations(h, domains, x):
    results = []
    for i in range(len(h)):
        if h[i] == "?":
            for val in domains[i]:
                if x[i] != val:
                    h_new = h[:i] + (val,) + h[i+1:]
                    results.append(h_new)
        elif h[i] != "0":
            h_new = h[:i] + ('0',) + h[i+1:]
            results.append(h_new)
    return results


def generalize_S(x, G, S):
```

```
    S_prev = list(S)
    for s in S_prev:
        if s not in S:
            continue
        if not fulfills(x, s):
            S.remove(s)
            Splus = min_generalizations(s, x)
            S.update([h for h in Splus if any([more_general(g,h) for g in G])])
            S.difference_update([h for h in S if any([more_general(h, h1) for h1 in S if h
            != h1])])
    return S

def specialize_G(x, domains, G, S):
    G_prev = list(G)
    for g in G_prev:
        if g not in G:
            continue
        if fulfills(x, g):
            G.remove(g)
            Gminus = min_specializations(g, domains, x)
            G.update([h for h in Gminus if any([more_general(h, s) for s in S])])
            G.difference_update([h for h in G if any([more_general(g1, h) for g1 in G if h != g1])])
    return G

def candidate_elimination(examples):
    domains = get_domains(examples)[:-1]
    n = len(domains)
    G = set([("?",)*n])
    S = set([("0",)*n])

    print("Maximally specific hypotheses - S ")
    print("Maximally general hypotheses - G ")

    i=0
    print("\nS[0]:",str(S),"\nG[0]:",str(G))


    for xcx in examples:
        i=i+1
        x, cx = xcx[:-1], xcx[-1]
        if cx=='Y':
            G = {g for g in G if fulfills(x, g)}
```

```python
            S = generalize_S(x, G, S)
        else:
            S = {s for s in S if not fulfills(x, s)}
            G = specialize_G(x, domains, G, S)
        print("\nS[{0}]:".format(i),S)
        print("G[{0}]:".format(i),G)
    return

with open('P2_dataset1.txt') as csvFile:
    examples = [tuple(line) for line in csv.reader(csvFile)]
candidate_elimination(examples)
```

```
Maximally specific hypotheses - S
Maximally general hypotheses - G

S[0]: {('0', '0', '0', '0', '0', '0')}
G[0]: {('?', '?', '?', '?', '?', '?')}

S[1]: {('sunny', 'warm', 'normal', 'strong', 'warm', 'same')}
G[1]: {('?', '?', '?', '?', '?', '?')}

S[2]: {('sunny', 'warm', '?', 'strong', 'warm', 'same')}
G[2]: {('?', '?', '?', '?', '?', '?')}

S[3]: {('sunny', 'warm', '?', 'strong', 'warm', 'same')}
G[3]: {('?', 'warm', '?', '?', '?', '?'), ('sunny', '?', '?', '?', '?', '?'), ('?', '?', '?', '?', '?', 'sa
me')}

S[4]: {('sunny', 'warm', '?', 'strong', '?', '?')}
G[4]: {('?', 'warm', '?', '?', '?', '?'), ('sunny', '?', '?', '?', '?', '?')}
```

Find S Algo

In [4]:

```python
import csv
with open('P1_data.csv', 'r') as f:
    reader = csv.reader(f)
    headers = next(reader)
    your_list = list(reader)
h = [['0', '0', '0', '0', '0', '0']]


for i in your_list:
    print(i)
    if i[-1] == "TRUE":
        j = 0
        for x in i:
            if x != "TRUE":
                if x != h[0][j] and h[0][j] == '0':
                    h[0][j] = x
                elif x != h[0][j] and h[0][j] != '0':
                    h[0][j] = '?'
                else:
                    pass
                j = j + 1
print("The maximally specific hypothesis for a given training example is: ")
print(h)
```

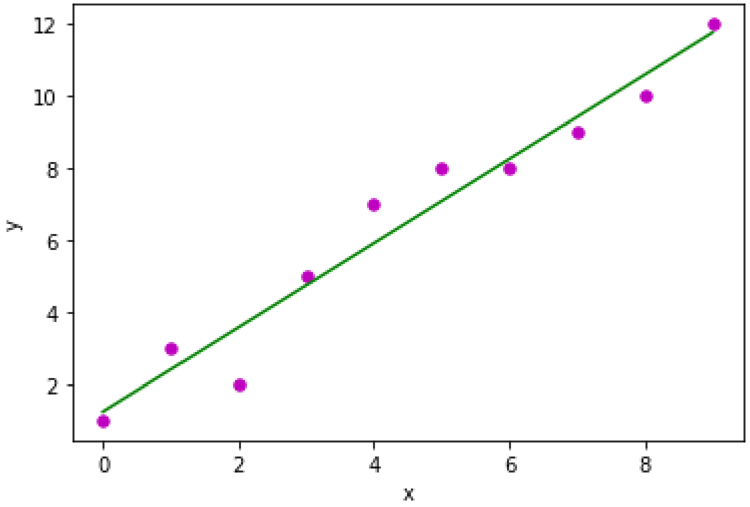
```
["'Sunny'", "'Warm'", "'Normal'", "'Strong'", "'Warm'", "'Same'", 'TRUE']
["'Sunny'", "'Warm'", "'High'", "'Strong'", "'Warm'", "'Same'", 'TRUE']
["'Rainy'", "'Cold'", "'High'", "'Strong'", "'Warm'", "'Change'", 'FALSE']
["'Sunny'", "'Warm'", "'High'", "'Strong'", "'Cool'", "'Change'", 'TRUE']
The maximally specific hypothesis for a given training example is:
[["'Sunny'", "'Warm'", '?', "'Strong'", '?', '?']]
```

Candidate Elimination

In [3]:

```
import numpy as np
import matplotlib.pyplot as plt
def estimate_coef(x, y):
    n =np.size(x)
    m_x, m_y = np.mean(x), np.mean(y)
    SS_xy = np.sum(y*x) - n*m_y*m_x
    SS_xx = np.sum(x*x) -n*m_x*m_x
    b_1 = SS_xy / SS_xx
    b_0 = m_y - b_1*m_x
    return(b_0, b_1)
def plot_regression_line(x, y, b):
    plt.scatter(x, y, color = "m", marker = "o", s = 30)
    y_pred = b[0] + b[1]*x
    plt.plot(x, y_pred, color = "g")
    plt.xlabel('x')
    plt.ylabel('y')
    plt.show()
def main():
    x = np.array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
    y = np.array([1, 3, 2, 5, 7, 8, 8, 9, 10, 12])
    b = estimate_coef(x, y)
    print("Estimated coefficients:\nb_0 = {} \ \nb_1 = {}".format(b[0], b[1]))
    plot_regression_line(x, y, b)
main()
```

```
Estimated coefficients:
b_0 = 1.2363636363636363 \
b_1 = 1.1696969696969697
```



Linear Regression

In [7]:

```
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))
    for k in attr:
        dic[k] = []
    for y in range(len(data)):
        key = data[y][col]
        if delete:
            del data[y][col]
        dic[key].append(data[y])
    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):
    attValues, dic = subtables(data, col, delete=False)
    total_entropy = entropy([row[-1] for row in data])
    for x in range(len(attValues)):
        ratio = len(dic[attValues[x]]) / ( len(data) * 1.0)
```

```
        entro = entropy([row[-1] for row in dic[attValues[x]]])
        total_entropy -= ratio*entro
    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 = [compute_gain(data, col) for col in range(n) ]
    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)
dataset, features = load_csv("NAZIA.csv")
node = build_tree(dataset, features)
print("The decision tree for the dataset using ID3 algorithm is ")
print_tree(node, 0)
testdata, features = load_csv("NAZIATEST.csv")
for xtest in testdata:
    print("The test instance : ",xtest)
```

```
    print("The predicted label : ", end="")
    classify(node,xtest,features)
```

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

In [2]:

```
import numpy as np
X = np.array(([2, 9], [1, 5], [3, 6]), dtype=float)
y = np.array(([92], [86], [89]), dtype=float)
X = X/np.amax(X,axis=0) # maximum of X array longitudinally
y = y/100
#Sigmoid Function
def sigmoid (x):
    return 1/(1 + np.exp(-x))
def derivatives_sigmoid(x):
    return x * (1 - x) #Variable initialization
epoch=5000 #Setting training iterations
lr=0.1 #Setting learning rate
inputlayer_neurons = 2 #number of features in data set
hiddenlayer_neurons = 3 #number of hidden layers neurons
output_neurons = 1 #number of neurons at output layer #weight and bias initialization
wh=np.random.uniform(size=(inputlayer_neurons,hiddenlayer_neurons))
bh=np.random.uniform(size=(1,hiddenlayer_neurons))
wout=np.random.uniform(size=(hiddenlayer_neurons,output_neurons))
bout=np.random.uniform(size=(1,output_neurons))
#draws a random range of numbers uniformly of dim x*y
for i in range(epoch):
    hinp1=np.dot(X,wh)
    hinp=hinp1 + bh
    hlayer_act = sigmoid(hinp)
    outinp1=np.dot(hlayer_act,wout)
    outinp= outinp1+ bout
    output = sigmoid(outinp) #Backpropagation
    EO = y-output
    outgrad = derivatives_sigmoid(output)
    d_output = EO* outgrad
    EH = d_output.dot(wout.T)
    hiddengrad = derivatives_sigmoid(hlayer_act)#how much hidden layer wts contributed to error
    d_hiddenlayer = EH * hiddengrad
    wout += hlayer_act.T.dot(d_output) *lr# dotproduct of nextlayererror and currentlayerop # bout += np
    wh += X.T.dot(d_hiddenlayer) *lr
#bh += np.sum(d_hiddenlayer, axis=0,keepdims=True) *lr
print("Input: \n" + str(X))
print("Actual Output: \n" + str(y))
print("Predicted Output: \n" ,output)
```

```
Input:
[[0.66666667 1.        ]
 [0.33333333 0.55555556]
 [1.         0.66666667]]
Actual Output:
[[0.92]
 [0.86]
 [0.89]]
Predicted Output:
 [[0.89711912]
 [0.87048596]
 [0.90220388]]
```

Backpropagation

In [8]:

```
import csv
import random
import math

def loadCsv(filename):
    lines = csv.reader(open(filename, "r"));
    dataset = list(lines)
    for i in range(len(dataset)):#converting strings into numbers for processing
        dataset[i] = [float(x) for x in dataset[i]]
    return dataset

def splitDataset(dataset, splitRatio): #67% training size
    trainSize = int(len(dataset) * splitRatio);
    trainSet = []
    copy = list(dataset);
    while len(trainSet) < trainSize:#generate indices for the dataset list randomly to pick ele for tra
        index = random.randrange(len(copy));
        trainSet.append(copy.pop(index))
    return [trainSet, copy]

def separateByClass(dataset):
    separated = {}#creates a dictionary of classes 1 and 0 where the values are the instacnes belonging
    for i in range(len(dataset)):
        vector = dataset[i]
        if (vector[-1] not in separated):
            separated[vector[-1]] = []
        separated[vector[-1]].append(vector)
    return separated

def mean(numbers):
    return sum(numbers)/float(len(numbers))

def stdev(numbers):
    avg = mean(numbers)
    variance = sum([pow(x-avg,2) for x in numbers])/float(len(numbers)-1)
    return math.sqrt(variance)

def summarize(dataset):
    summaries = [(mean(attribute), stdev(attribute)) for attribute in zip(*dataset)];
    del summaries[-1]
    return summaries
```

```

def summarizeByClass(dataset):
    separated = separateByClass(dataset) #print(separated)
    summaries = {}
    for classValue, instances in separated.items(): #summaries is a dic of tuples(mean,std) for each cl
        summaries[classValue] = summarize(instances)
    return summaries

def calculateProbability(x, mean, stdev):
    exponent = math.exp(-(math.pow(x-mean,2)/(2*math.pow(stdev,2))))
    return (1 / (math.sqrt(2*math.pi) * stdev)) * exponent

def calculateClassProbabilities(summaries, inputVector):
    probabilities = {}
    for classValue, classSummaries in summaries.items():#class and attribute information as mean and sd
        probabilities[classValue] = 1
        for i in range(len(classSummaries)):
            mean, stdev = classSummaries[i] #take mean and sd of every attribute for class 0 and 1 sepe
            x = inputVector[i] #testvector's first attribute
            probabilities[classValue] *= calculateProbability(x, mean, stdev);#use normal dist
        return probabilities

def predict(summaries, inputVector):
    probabilities = calculateClassProbabilities(summaries, inputVector)
    bestLabel, bestProb = None, -1
    for classValue, probability in probabilities.items():
        if bestLabel is None or probability > bestProb:
            bestProb = probability
            bestLabel = classValue
    return bestLabel

def getPredictions(summaries, testSet):
    predictions = []
    for i in range(len(testSet)):
        result = predict(summaries, testSet[i])
        predictions.append(result)
    return predictions

def getAccuracy(testSet, predictions):
    correct = 0
    for i in range(len(testSet)):
        if testSet[i][-1] == predictions[i]:
```

```
            correct += 1
    return (correct/float(len(testSet))) * 100.0

def main():
    filename = 'pima-indians-diabetes.csv'
    splitRatio = 0.67
    dataset = loadCsv(filename);
    print('Pima Indian Diabetes Dataset loaded...')
    print('Total instances available :',len(dataset))
    print('Total attributes present :',len(dataset[0])-1)
    print("First Five instances of dataset:")
    for i in range(5):
        print(i+1 , ':' , dataset[i])
    trainingSet, testSet = splitDataset(dataset, splitRatio)
    print('\nDataset is split into training and testing set.')
    print('Training examples = {0} \nTesting examples = {1}'.format(len(trainingSet),len(testSet)))
    # prepare model
    summaries = summarizeByClass(trainingSet);
    #print(summaries)
    # test model
    predictions = getPredictions(summaries, testSet)
    #print(predictions)
    accuracy = getAccuracy(testSet, predictions)
    print('Accuracy of the classifier is : {0}%'.format(accuracy))

main()
```

```
Pima Indian Diabetes Dataset loaded...
Total instances available : 768
Total attributes present : 8
First Five instances of dataset:
1 : [6.0, 148.0, 72.0, 35.0, 0.0, 33.6, 0.627, 50.0, 1.0]
2 : [1.0, 85.0, 66.0, 29.0, 0.0, 26.6, 0.351, 31.0, 0.0]
3 : [8.0, 183.0, 64.0, 0.0, 0.0, 23.3, 0.672, 32.0, 1.0]
4 : [1.0, 89.0, 66.0, 23.0, 94.0, 28.1, 0.167, 21.0, 0.0]
5 : [0.0, 137.0, 40.0, 35.0, 168.0, 43.1, 2.288, 33.0, 1.0]

Dataset is split into training and testing set.
Training examples = 514
```

```
Testing examples = 254
Accuracy of the classifier is : 61.417322834645674%
```

Bayesian Algo

In [11]:

```
import pandas as pd
msg=pd.read_csv('P6_naivetext1.csv',names=['message','label'])
print('Total instances in the dataset:',msg.shape[0])
msg['labelnum']=msg.label.map({'pos':1,'neg':0})
X=msg.message
Y=msg.labelnum

print('\nThe message and its label of first 5 instances are listed below')
X5, Y5 = X[0:5], msg.label[0:5]
for x, y in zip(X5,Y5):
    print(x,',',y)

#splitting the dataset into train and test data
from sklearn.model_selection import train_test_split
xtrain,xtest,ytrain,ytest=train_test_split(X,Y)
print('\nDataset is split into Training and Testing samples')
print('Total training instances :', xtrain.shape[0])
print('Total testing instances :', xtest.shape[0])

#output of count vectoriser is a sparse matrix
# CountVectorizer - stands for 'feature extraction'
from sklearn.feature_extraction.text import CountVectorizer
count_vect = CountVectorizer()
xtrain_dtm = count_vect.fit_transform(xtrain) #Sparse matrix
xtest_dtm=count_vect.transform(xtest)
print(count_vect.get_feature_names())
print('\nTotal features extracted using CountVectorizer:',xtrain_dtm.shape[1])

print('\nFeatures for first 5 training instances are listed below')
df=pd.DataFrame(xtrain_dtm.toarray(),columns=count_vect.get_feature_names())
print(df[0:5])#tabular representation
#print(xtrain_dtm) #Same as above but sparse matrix representation

# Training Naive Bayes (NB) classifier on training data.
from sklearn.naive_bayes import MultinomialNB
clf = MultinomialNB().fit(xtrain_dtm,ytrain)
predicted = clf.predict(xtest_dtm)

print('\nClassstification results of testing samples are given below')
for doc, p in zip(xtest, predicted):
    pred = 'pos' if p==1 else 'neg'
```

```python
    print('%s -> %s ' % (doc, pred))

#printing accuracy metrics
from sklearn import metrics
print('\nAccuracy metrics')
print('\nAccuracy of the classifer is',metrics.accuracy_score(ytest,predicted))
print('\nConfusion matrix')
print(metrics.confusion_matrix(ytest,predicted))
print('\nRecall')
print(metrics.recall_score(ytest,predicted))
print('\nPrecison ')
print(metrics.precision_score(ytest,predicted))
```

```
Total instances in the dataset: 18

The message and its label of first 5 instances are listed below
I love this sandwich , pos
This is an amazing place , pos
I feel very good about these beers , pos
This is my best work , pos
What an awesome view , pos

Dataset is split into Training and Testing samples
Total training instances : 13
Total testing instances : 5
['about', 'am', 'an', 'awesome', 'beers', 'best', 'boss', 'can', 'deal', 'do', 'enemy', 'feel', 'good', 'gr
eat', 'he', 'holiday', 'horrible', 'house', 'is', 'juice', 'like', 'love', 'my', 'not', 'of', 'place', 'res
taurant', 'sandwich', 'stuff', 'sworn', 'taste', 'the', 'these', 'this', 'tired', 'to', 'today', 'very', 'v
iew', 'went', 'what', 'with', 'work']

Total features extracted using CountVectorizer: 43

Features for first 5 training instances are listed below
   about  am  an  awesome  beers  best  boss  can  deal  do  ...  this  tired  \
0      0   0   0        0      0     0     1    0     0   0  ...     0      0
1      0   0   0        0      0     0     0    1     1   0  ...     1      0
2      0   0   0        0      0     0     0    0     0   1  ...     1      0
3      1   0   0        0      1     0     0    0     0   0  ...     0      0
4      0   0   0        0      0     1     0    0     0   0  ...     1      0

   to  today  very  view  went  what  with  work
```

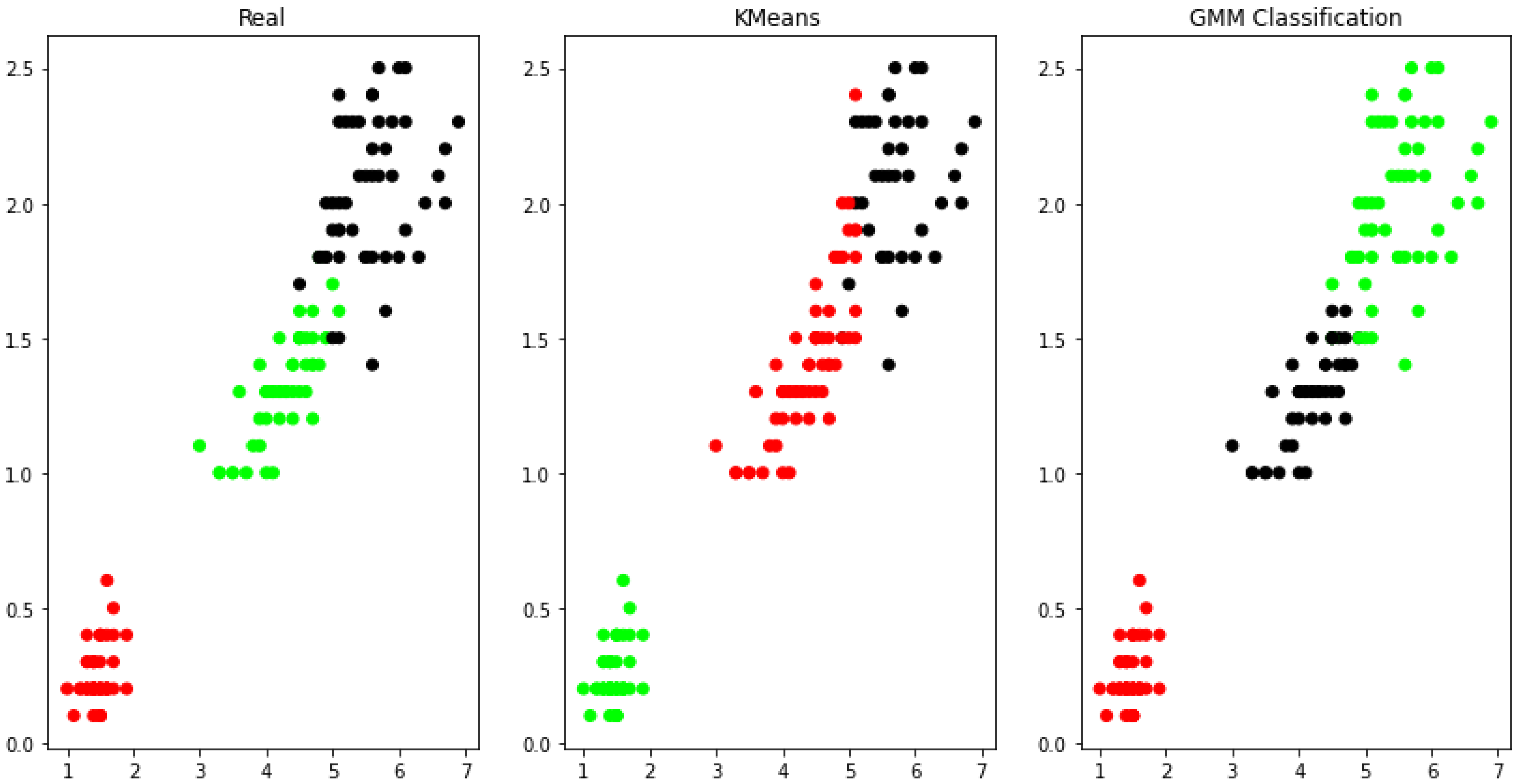
```
0   0      0     0     0     0     0     0     0
1   0      0     0     0     0     0     1     0
2   0      0     0     0     0     0     0     0
3   0      0     1     0     0     0     0     0
4   0      0     0     0     0     0     0     1

[5 rows x 43 columns]

Classstification results of testing samples are given below
We will have good fun tomorrow -> pos
I am sick and tired of this place -> neg
This is an amazing place -> pos
I love to dance -> pos
That is a bad locality to stay -> neg

Accuracy metrics

Accuracy of the classifer is 1.0

Confusion matrix
[[2 0]
 [0 3]]

Recall
1.0

Precison
1.0
```

In [12]:

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

names  = ['Sepal_Length','Sepal_Width','Petal_Length','Petal_Width','Class']
dataset = pd.read_csv("8-dataset.csv",names=names)
X = dataset.iloc[:,:-1]
label = {'Iris-setosa':0,'Iris-versicolor':1,'Iris-virginica':2}
y = [label[c] for c in dataset.iloc[:,-1]]
plt.figure(figsize=(14,7))
colormap=np.array(['red','lime','black'])

plt.subplot(1,3,1)
plt.title('Real')
plt.scatter(X.Petal_Length,X.Petal_Width,c = colormap[y])

model=KMeans(n_clusters = 3,random_state=0).fit(X)
plt.subplot(1,3,2)
plt.title('KMeans')
plt.scatter(X.Petal_Length,X.Petal_Width,c=colormap[model.labels_])

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

gmm = GaussianMixture(n_components=3,random_state=0).fit(X)
y_cluster_gmm=gmm.predict(X)
plt.subplot(1,3,3)
plt.title('GMM Classification')
plt.scatter(X.Petal_Length,X.Petal_Width,c = colormap[y_cluster_gmm])

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

```
The accuracy score of K-Mean:  0.24
The Confusion matrixof K-Mean:
 [[ 0 50  0]
```

```
 [48  0  2]
 [14  0 36]]
The accuracy score of EM:  0.36666666666666664
The Confusion matrix of EM:
  [[50  0  0]
 [ 0  5 45]
 [ 0 50  0]]
```



EM vs KNN

In [13]:

```python
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn import datasets

iris=datasets.load_iris()
print("Iris Data set loaded...")
iris_data=iris.data
iris_labels=iris.target #print(iris_data) #print(iris_labels)
x_train,x_test,y_train,y_test=train_test_split(iris_data,iris_labels,test_size=0.1)
print("Dataset is split into training and testing...")
print("Size of trainng data and its label",x_train.shape,y_train.shape)
print("Size of trainng data and its label",x_test.shape, y_test.shape)




# Prints Label no. and their names
for i in range(len(iris.target_names)):
    print("Label", i , "-",str(iris.target_names[i]))

classifier=KNeighborsClassifier(n_neighbors=1)
classifier.fit(x_train,y_train)
y_pred=classifier.predict(x_test)

# Display the results
print("Results of Classification using K-nn with K=1 ")
for r in range(0,len(x_test)):
    print(" Sample:", str(x_test[r]), " Actual-label:", str(y_test[r]), " Predicted-label:",str(y_pred[r
print("Classification Accuracy :" , classifier.score(x_test,y_test))
```

```
Iris Data set loaded...
Dataset is split into training and testing...
Size of trainng data and its label (135, 4) (135,)
Size of trainng data and its label (15, 4) (15,)
Label 0 - setosa
Label 1 - versicolor
Label 2 - virginica
Results of Classification using K-nn with K=1
 Sample: [5.7 2.9 4.2 1.3]  Actual-label: 1  Predicted-label: 1
 Sample: [5.  3.  1.6 0.2]  Actual-label: 0  Predicted-label: 0
 Sample: [6.9 3.1 5.4 2.1]  Actual-label: 2  Predicted-label: 2
```

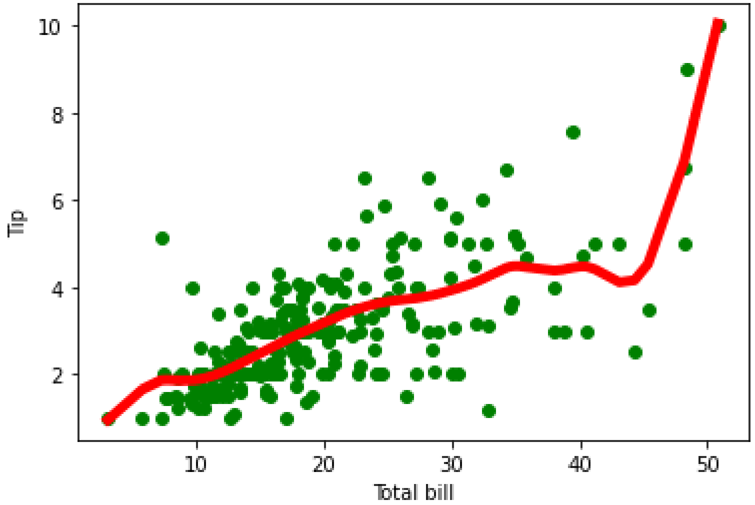
```
 Sample: [5.  3.2 1.2 0.2]  Actual-label: 0  Predicted-label: 0
 Sample: [6.2 2.8 4.8 1.8]  Actual-label: 2  Predicted-label: 2
 Sample: [4.8 3.4 1.9 0.2]  Actual-label: 0  Predicted-label: 0
 Sample: [6.4 3.2 5.3 2.3]  Actual-label: 2  Predicted-label: 2
 Sample: [4.6 3.1 1.5 0.2]  Actual-label: 0  Predicted-label: 0
 Sample: [6.4 3.1 5.5 1.8]  Actual-label: 2  Predicted-label: 2
 Sample: [5.  3.4 1.5 0.2]  Actual-label: 0  Predicted-label: 0
 Sample: [7.7 2.8 6.7 2. ]  Actual-label: 2  Predicted-label: 2
 Sample: [6.9 3.1 4.9 1.5]  Actual-label: 1  Predicted-label: 1
 Sample: [5.  3.3 1.4 0.2]  Actual-label: 0  Predicted-label: 0
 Sample: [6.3 3.4 5.6 2.4]  Actual-label: 2  Predicted-label: 2
 Sample: [6.9 3.2 5.7 2.3]  Actual-label: 2  Predicted-label: 2
Classification Accuracy : 1.0
```

KNN Algo

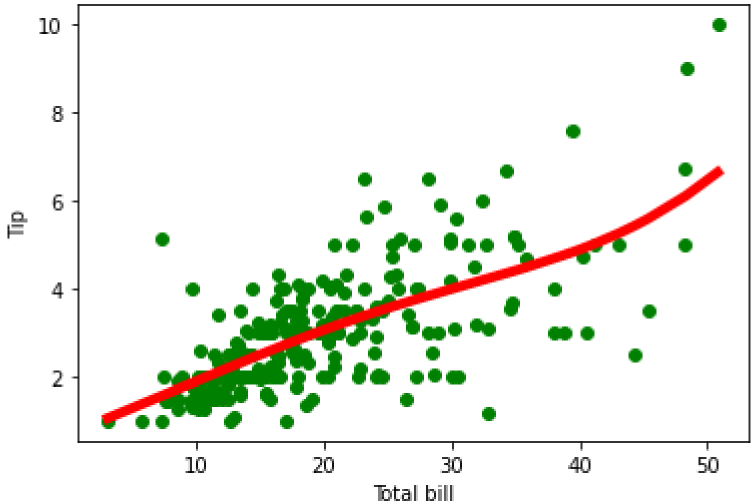
In [3]:

```
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
def kernel(point,xmat, k):
    m,n = np.shape(xmat)
    weights = np.mat(np.eye((m))) # eye - identity matrix
    for j in range(m):
        diff = point - X[j]
        weights[j,j] = np.exp(diff*diff.T/(-2.0*k**2))
    return weights
def localWeight(point,xmat,ymat,k):
    wei = kernel(point,xmat,k)
    W = (X.T*(wei*X)).I*(X.T*(wei*ymat.T))
    return W
def localWeightRegression(xmat,ymat,k):
    m,n = np.shape(xmat)
    ypred = np.zeros(m)
    for i in range(m):
        ypred[i] = xmat[i]*localWeight(xmat[i],xmat,ymat,k)
    return ypred
def graphPlot(X,ypred):
    sortindex = X[:,1].argsort(0) #argsort - index of the smallest
    xsort = X[sortindex][:,0]
    fig = plt.figure()
    ax = fig.add_subplot(1,1,1)
    ax.scatter(bill,tip, color='green')
    ax.plot(xsort[:,1],ypred[sortindex], color = 'red', linewidth=5)
    plt.xlabel('Total bill')
    plt.ylabel('Tip')
    plt.show();
# load data points
data = pd.read_csv('tips.csv')
bill = np.array(data.total_bill) # We use only Bill amount and Tips data
tip = np.array(data.tip)
mbill = np.mat(bill) # .mat will convert nd array is converted in 2D array
mtip = np.mat(tip)
m= np.shape(mbill)[1]
one = np.mat(np.ones(m))
X = np.hstack((one.T,mbill.T)) # 244 rows, 2 cols


```

```
ypred = localWeightRegression(X,mtip,2) # increase k to get smooth curves
graphPlot(X,ypred)

ypred1 = localWeightRegression(X,mtip,10) # increase k to get smooth curves
graphPlot(X,ypred1)

```



Locally Weighted



In [19]:

```
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 #Read the attributes
lines = list(csv.reader(open('P7_data7_names.csv', 'r')));
attributes = lines[0]
#attributes = ['age', 'sex', 'cp', 'trestbps', 'chol', 'fbs', 'restecg', 'thalach', 'exang', # 'oldpeak'
#Read Cleveland Heart dicease data
heartDisease = pd.read_csv('P7_data7_heart.csv', names = attributes)
heartDisease = heartDisease.replace('?', np.nan)
# Display the data
print('Few examples from the dataset are given below')
print(heartDisease.head())
print('\nAttributes and datatypes')
print(heartDisease.dtypes)
# Model Baysian Network
model = BayesianModel([('age', 'trestbps'), ('age', 'fbs'), ('sex', 'trestbps'), ('sex', 'trestbps'),
('exang', 'trestbps'),('trestbps','heartdisease'),('fbs','heartdisease'),
('heartdisease','restecg'),('heartdisease','thalach'),('heartdisease','chol')]) # Learning CPDs using Ma
print('\nLearning CPDs using Maximum Likelihood Estimators...');
model.fit(heartDisease, estimator=MaximumLikelihoodEstimator)
# Inferencing with Bayesian Network print('\nInferencing with Bayesian Network:')
HeartDisease_infer = VariableElimination(model) # Computing the probability of bronc given smoke.
print('\n1.Probability of HeartDisease given Age=20')
q = HeartDisease_infer.query(variables=['heartdisease'], evidence={'age': 67.0})
print(q)
print('\n2. Probability of HeartDisease given chol (Cholestoral) =100')
q = HeartDisease_infer.query(variables=['heartdisease'], evidence={'chol': 286})
print(q)
```

```
Few examples from the dataset are given below
    age  sex   cp  trestbps   chol  fbs  restecg  thalach  exang  oldpeak  \
0  63.0  1.0  1.0     145.0  233.0  1.0      2.0    150.0    0.0      2.3
1  67.0  1.0  4.0     160.0  286.0  0.0      2.0    108.0    1.0      1.5
2  67.0  1.0  4.0     120.0  229.0  0.0      2.0    129.0    1.0      2.6
3  37.0  1.0  3.0     130.0  250.0  0.0      0.0    187.0    0.0      3.5
4  41.0  0.0  2.0     130.0  204.0  0.0      2.0    172.0    0.0      1.4
```

```
   slope   ca  thal  heartdisease
0    3.0  0.0   6.0             0
1    2.0  3.0   3.0             2
2    2.0  2.0   7.0             1
3    3.0  0.0   3.0             0
4    1.0  0.0   3.0             0

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

Learning CPDs using Maximum Likelihood Estimators...

1.Probability of HeartDisease given Age=20
+-----------------+---------------------+
| heartdisease    |   phi(heartdisease) |
+=================+=====================+
| heartdisease(0) |              0.2267 |
+-----------------+---------------------+
| heartdisease(1) |              0.3867 |
+-----------------+---------------------+
| heartdisease(2) |              0.3867 |
+-----------------+---------------------+

2. Probability of HeartDisease given chol (Cholestoral) =100
+-----------------+---------------------+
| heartdisease    |   phi(heartdisease) |
+=================+=====================+
| heartdisease(0) |              0.0000 |
```

```
+-----------------+---------------------+
| heartdisease(1) |              0.0000 |
+-----------------+---------------------+
| heartdisease(2) |              1.0000 |
+-----------------+---------------------+

/home/user/anaconda3/lib/python3.9/site-packages/pgmpy/models/BayesianModel.py:8: FutureWarning: BayesianMo
del has been renamed to BayesianNetwork. Please use BayesianNetwork class, BayesianModel will be removed in
future.
  warnings.warn(
```

In [ ]:

```
1
```