TAREA 1: Regresiones

Inteligencia Artificial

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Step 1: Importing libraries and dataset

In [6]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from sympy import symbols
from sklearn import linear_model
from sklearn.metrics import mean_squared_error

df = pd.read_csv("https://raw.githubusercontent.com/ulises1229/IA-2021-II/

#df.head()
```

The formula for our lineal model is:

$$\hat{y} = b_0 + b_1 x$$

Where the slope can be understood as follows:

$$b1 = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}} = \frac{S_{xy}}{S_{xx}}$$

Step 2: Definition of a class to graph all the functions we want

In [7]:
```
class Graph:

    def plotGraph(self, title, xlabel,ylabel):
        plt.title(title)
        plt.ylabel(ylabel)
        plt.xlabel(xlabel)
    def plotScatter(self, x, y, label):
        plt.scatter(x,y,label = label)
    def plotFunction(self, rangex,func, color, legend):
        plt.plot(rangex,func, color = color, label = legend)
    def showPlot(self):
        plt.show()
```

Step 3: we define a class that contains the following methods:

1. Constructor: that contains our variables.

2.Linear regression: main function to make our linear model

3. predict: receives a value on the "x" axis and returns a y value that fits the linear model

4. MSE: here we calculate the mean square error

In [88]:

```
class Regression:
    def __init__(self, x, y,x_t,y_t):
        self.x = x
        self.y = y
        self.x_t = x_t
        self.y_t = y_t
        self.a = symbols('a')

    """ In this method we are doing a linear regression model"""
    def linearRegression(self):
        """We have to calculate the slope of the regression line"""
        #the first step is to calculate the sum of the square of the diffe
        x_mean = self.x.mean()
        diffx = x_mean-self.x
        diffx_squared = diffx**2
        SSxx = diffx_squared.sum()
        #The second step is to calculate SSxy
        y_mean = self.y.mean()
        diffy = y_mean-self.y
        SSxy = (diffx * diffy).sum()
        #once we have SSxx and SSxy we can calculate the slope just diving
        b1 = SSxy/SSxx
        #finally, solving for the intercept we obtain:
        b0 = y_mean -b1*x_mean
        equation = b1*self.a+b0
        return (equation, b0, b1)
    """Here we use our linear regression model to predict data """
    def predict(self, value):
        objG = Graph()
        equation, b0, b1 = self.linearRegression()
        y = equation.subs(self.a,value)
        y_predict_1 = b1*self.x+b0 #predicted values
        y_predict_2 = b1*self.x_t+b0 #predicted values with data for testi
        #Plotting our model
        objG.plotScatter(self.x,self.y,'Training values')
        mse_1 = self.MSE(self.y, y_predict_1) #minimum squared error
        mse_2 = self.MSE(self.y_t, y_predict_2) #minimum squared error wit
        plt.plot(value, y, color= "green", marker ="*", markersize =10,lab
        print(" Prediction ")
        print("X: ", value)
        print("Y: ", y)
        print("Mean Squared Error with data for training", mse_1)
        print("Mean Squared Error with data for testing", mse_2)
        print("Mean Squared Error with Sklearn", mean_squared_error(self.y
        return y,b0,b1
    """This method is used to calculate the Mean Square Error"""
    def MSE(self, y, y_predict):
        mse = np.mean((y-y_predict)**2)
        return (mse)

    """Steps in gradient descent"""
    #1 initialize betas, learnin rate, max_iter
    #2 for loop that will run n times
    #3 save a variable that holdes the error
    #4 predictions using line equation
    #5 calculate the error and append it to a vector so we can plot after
```

```
    #6 calculate partial derivatives for both coefficients
    #7 increase the cost of both coefficients
    #8 update values of the coefficients

    def gd_method(self, alpha):
        #initializing parameters
        equation, b0,b1 = self.linearRegression()
        #we are doing this to see the effects in the error plot
        b0 = 0
        b1 = 1
        max_iter = 100
        error = []
        for i in range(max_iter):
            error_cost = 0
            cost_b0 = 0
            cost_b1 = 0

            for j in range(len(self.x)):
                y_predict = (b0+b1*self.x[j])#predict value for actual x

                error_cost = error_cost + (self.y[j]-y_predict)**2 #we are
                for k in range(len(self.x)):
                    partial_wrt_b0 = -2 * (self.y[k] - (b0 + b1*self.x[k])
                    partial_wrt_b1 = (-2*self.x[k])*(self.y[k]-(b0+b1*self

                    cost_b0 = cost_b0 + partial_wrt_b0
                    cost_b1 = cost_b1 + partial_wrt_b1

                #updating values
                b0 = b0 - alpha*cost_b0
                b1 = b1 - alpha*cost_b1

            error.append(error_cost)#the error is append to the vector
        y_predict = b0 + b1*self.x#creating a newvector with predicted val
        objG = Graph()
        plt.plot(self.x, y_predict, label = "Predicted line with GD")
        return error
```

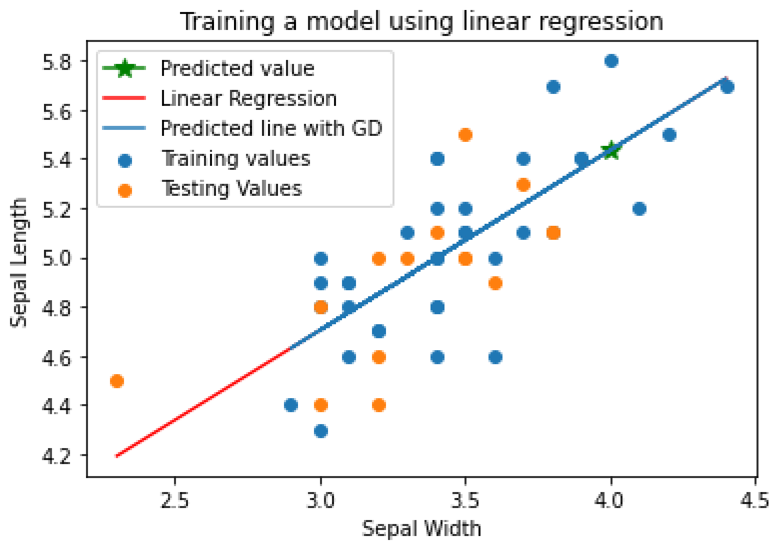
Step 4: Our main function in which we call the classes and methods that we previously defined

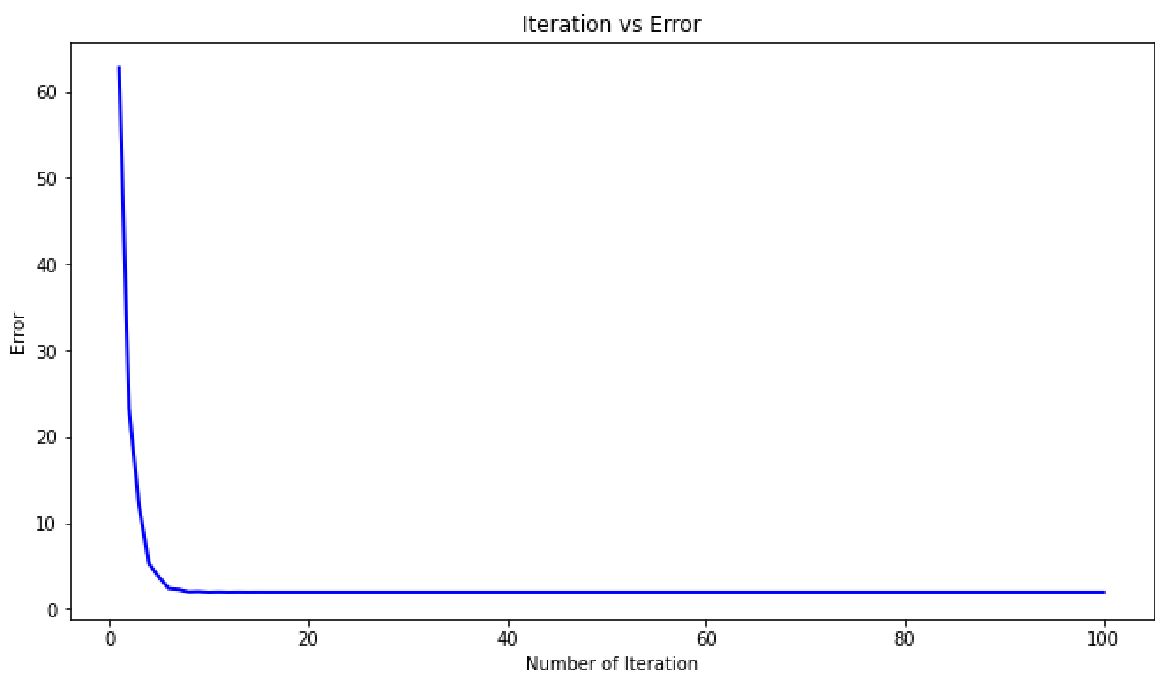
In [89]:

```
def main():

    #Data definition, 30%=testing, 70%=training
    wSep = df.Sepal_Width[df.Species == 'setosa']
    lSep = df.Sepal_Length[df.Species == 'setosa']
    N_train = (int)((len(wSep))*0.7)#Number of data to train the model
    x_train = wSep[:N_train]
    x_test = wSep[N_train:]
    y_train = lSep[:N_train]
    y_test = lSep[N_train:]
    # Plot data
    objG = Graph()
    objR = Regression(x_train,y_train,x_test, y_test)
    y,b0,b1 = objR.predict(4)
    #Data for plot the linear regression
    objG.plotGraph('Training a model using linear regression', 'Sepal Widt
    objG.plotScatter(x_test,y_test, 'Testing Values')
    r = np.linspace(np.min(wSep),np.max(wSep),len(wSep))
    objG.plotFunction(r,b1*r+b0, 'red', 'Linear Regression')
    #printing the results
    print("Total number of data: ", len(wSep))
    print("For training: ", len(x_train))
    print("For testing: ", len(x_test))
    error = objR.gd_method(0.001)
    plt.legend()
    #now we can plot the error that we have obtain with GD
    plt.figure(figsize=(11,6))
    plt.plot(np.arange(1,len(error)+1),error,color='blue',linewidth=2)
    plt.title("Iteration vs Error")
    plt.xlabel("Number of Iteration")
    plt.ylabel("Error")
if __name__ == "__main__":
    main()
```

```
 Prediction
X:  4
Y:  5.43412707909537
Mean Squared Error with data for training 0.054738918613993486
Mean Squared Error with data for testing 0.055466874516721915
Mean Squared Error with Sklearn 0.055466874516721915
Total number of data:  50
For training:  35
For testing:  15
```


Training a model using linear regression
Predicted value
Linear Regression
Predicted line with GD
Training values
Testing Values
Sepal Length
Sepal Width
5.8
5.6
5.4
5.2
5.0
4.8
4.6
4.4
4.2
2.5
3.0
3.5
4.0
4.5


Iteration vs Error
Error
Number of Iteration
60
50
40
30
20
10
0
0
20
40
60
80
100