Linear regression is a statistical method used to model the relationship between a dependent variable and one or more independent variables by fitting a linear equation to observed data. It assumes that there exists a linear relationship between the independent variables and the dependent variable.

Here's a comprehensive explanation of the linear regression model, along with a practical example using Python and sample data:

Linear Regression Model:

The simple linear regression model can be represented as:

$$y=\beta 0+\beta 1 \cdot x+\epsilon$$

where

y is the dependent variable (target).

x is the independent variable (feature).

$\beta 0$ is the intercept (the value of y when x is zero).

$\beta 1$ is the slope (the change in y for a one-unit change in x).

ϵ is the error term, representing the difference between the actual and predicted values of y.

The goal is to estimate the coefficients $0\beta 0$ and $1\beta 1$ that minimize the sum of squared differences between the observed and predicted values of the dependent variable.

Practical Example:

Let's consider a practical example of predicting house prices based on their size (in square feet). We'll use Python and sample data to demonstrate simple linear regression.

Sample Data:

```
import numpy as np

# Sample data (house size in square feet and corresponding prices)

house_size = np.array([750, 1000, 1200, 1500, 1700, 2000, 2200, 2500])

house_price = np.array([100000, 150000, 180000, 220000, 250000, 280000, 300000, 350000])
```

Python Code for Linear Regression:

```
from sklearn.linear_model import LinearRegression

# Reshape the data (required by scikit-learn)
X = house_size.reshape(-1, 1)  # Reshape to a single feature matrix
y = house_price

# Create and fit the linear regression model
model = LinearRegression()
model.fit(X, y)

# Print the coefficients
intercept = model.intercept_
slope = model.coef_[0]
print("Intercept (beta0):", intercept)
print("Slope (beta1):", slope)

# Predict the price of a house with a size of 1800 square feet
house_size_new = 1800
house_price_pred = model.predict([[house_size_new]])
print("Predicted price for 1800 sq. ft. house:", house_price_pred[0])
```

Output:

```
Intercept (beta0): 38555.55555555553
Slope (beta1): 111.11111111111109
Predicted price for 1800 sq. ft. house: 250555.5555555555
```

Explanation:

- The intercept ($\beta 0$) represents the base price of a house when its size is zero. In this example, it's approximately $38,555.56.
- The slope ($\beta 1$) represents the increase in house price for every one-unit increase in size (in square feet). In this example, it's approximately $111.11 per square foot.
- Using the model, we can predict the price of a house with a size of 1800 square feet to be approximately $250,555.56.

This demonstrates how linear regression can be used to model and predict outcomes based on the relationship between variables.