AI Lab Assignment: Simple Linear Regression with Gradient Descent

Problem Statement

You are required to implement simple linear regression using gradient descent to predict Sales (Y) from Advertising Budget (X). Do not use machine learning libraries (like scikit-learn). You must implement the gradient descent algorithm manually.

Note: The dataset provided contains some missing values (null) and outliers. You need to decide how to handle them before applying gradient descent.

Dataset (Unprocessed)

X (Advertising Budget, $1000s)	Y (Sales, units)
1.1	1.5
2.0	1.7
2.9	NULL
3.8	4.0
4.5	4.1
5.0	100.0
6.2	6.1
NULL	6.5
7.5	7.4
8.3	-5.0
9.1	9.0

Tasks

1. Handle missing values and outliers in the dataset.
2. Implement the hypothesis function:

$$h_\theta(x) = \theta_0 + \theta_1 x$$

3. Implement gradient descent update rules for parameters θ_0, θ_1.

   For a general loss function L:

$$\theta_j = \theta_j - \alpha \frac{\partial L}{\partial \theta_j}$$

   where α is the learning rate.

4. Try different loss functions:
   a. Mean Square Error (MSE)

$$L = \frac{1}{2m} \sum_{i=1}^{m} (h_\theta(x_i) - y_i)^2$$

   b. Mean Absolute Error (MAE)

$$L = \frac{1}{m} \sum_{i=1}^{m} |h_\theta(x_i) - y_i|$$

5. Compare results:

- Report final parameters θ_0, θ_1

- Plot fitted line vs. data points

- Compare convergence speed & stability for different loss functions

Hints

- Normalize data before applying gradient descent for faster convergence.

- Choose a small learning rate (α ≈ 0.01).

- For MAE, the derivative involves sign(h(x) - y).

- Think carefully about how null values and outliers affect gradient descent.