Linear Regression Analysis Report

Introduction

This report presents the findings of a simple linear regression analysis conducted on a dataset relating **Advertising Expenditure** to **Sales**.

The primary objective is to explore the linear relationship between these two variables and to develop a predictive model for sales based on advertising spend.

Dataset Description

The dataset contains **100 hypothetical observations** with two numerical columns:

- **Advertising Budget (X)** – measured in thousands of dollars.
- **Sales (Y)** – measured in thousands of units.

Methodology

1. **Data Split**: The dataset was randomly split into **training (80%)** and **testing (20%)** sets.
2. **Model**: A simple linear regression model was fit using the training data with the formula:
   $Y' = b0+b1X$
   where
   - $\mathbf{b_0}$ is the intercept.
   - $\mathbf{b_1}$ is the slope (coefficient for advertising).

Results

The fitted model estimates were:

- **Intercept (b_0):** approximately **20**
- **Slope (b_1):** approximately **3.5**

Interpretation:
For every additional **$1,000** increase in advertising, sales are expected to rise by roughly **3.5 thousand units**.

Model Performance

Evaluation on the test set yielded:

- **Mean Squared Error (MSE):** about **1500**
- **R-squared (R^2):** about **0.85**

This indicates that roughly **85% of the variation in sales** is explained by the advertising budget.

Conclusions & Recommendations

- The analysis reveals a **strong positive linear relationship** between advertising spend and sales.
- The simple model performs well; however, **real-world sales are influenced by many other factors** (market conditions, product quality, seasonality, etc.).

Future work could include:

1. Adding more predictors (e.g., pricing, market trends, competitor activity).
2. Checking residual plots for bias and constant variance.
3. Using cross-validation to ensure the model's predictions generalize well.

Graph


Linear Regression: Advertising vs Sales
Actual
Predicted
Sales (thousands of units)
Advertising Budget (thousands of $)
50
100
150
200
250
300
350
20
40
60
80
100