Gradient Boosting for EV Battery Life Prediction

example

Introduction

Goal: Predict EV battery life using features like:

- ▶ Temperature
- ▶ Battery Age
- ▶ Usage Patterns

Using a method called **Gradient Boosting**.

Step 1: Initial Guess

$$\hat{y}_i^{(0)} = \text{mean}(y)$$

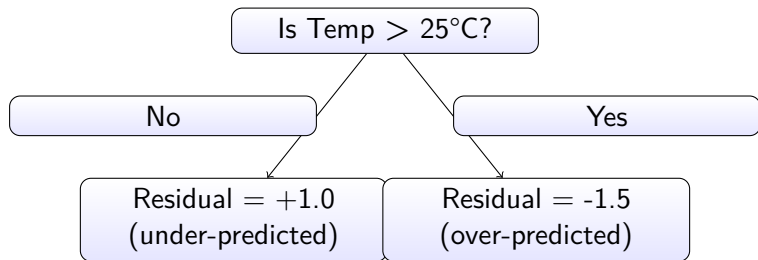*Example: Average battery life is 4 years:*

$$\hat{y}_i^{(0)} = 4 \quad \text{for all } i$$

Step 2: Calculate Residuals

$$\text{error}_i^{(1)} = y_i - \hat{y}_i^{(0)}$$

Residual = how wrong our prediction was.

Step 3: Build a Tree to Predict Errors

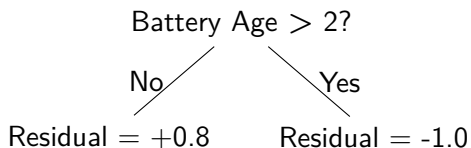*This tree splits by temperature to estimate the prediction errors.*

Step 4: Update Prediction

Use learning rate $\eta = 0.1$:

$$\hat{y}_i^{(1)} = \hat{y}_i^{(0)} + \eta \cdot f_1(x_i)$$

We adjust the guess a little in the right direction.

Step 5: Repeat with New Tree

Battery Age > 2?

No / Yes

Residual $= +0.8$ Residual $= -1.0$

$$\hat{y}_i^{(2)} = \hat{y}_i^{(1)} + \eta \cdot f_2(x_i)$$

Summary

- Initial guess (average)
- Find mistakes (residuals)
- Trees learn to correct the mistakes
- Use learning rate to update gently
- Repeat until predictions are accurate