

Gradient Boosting In-Depth Intuition

Building Strong Models by Addressing Weaknesses

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Introduction

- ▶ Gradient Boosting is a powerful ML technique that:
- ▶ Improves performance using weak learners (typically decision trees).
- ▶ Iteratively corrects model errors by focusing on residuals.

Foundation: Linear Regression

- ▶ Predictive formula:

$$y = a_1 + b_1 \cdot x$$

- ▶ Residuals represent the difference between actual and predicted values:

$$r_i = y_i - \hat{y}_i$$

Core Idea of Gradient Boosting

- ▶ Learn from residuals at each step.
- ▶ Build a new model on the errors of the previous model.

Iterative Learning Process

- ▶ Each model focuses on where the previous one failed.
- ▶ Residuals guide model training:

$$\hat{y}_i^{(t)} = \hat{y}_i^{(t-1)} + \eta \cdot h_t(x_i)$$

Minimizing the Loss Function

- ▶ Objective: reduce error over time.
- ▶ Loss function:

$$\text{Loss} = \sum_{i=1}^n L(y_i, \hat{y}_i)$$

Power of Weak Learners

- ▶ Decision trees are used as weak learners.
- ▶ Individually simple, together strong when combined iteratively.

Final Model Construction

- ▶ Aggregates outputs from all learners.
- ▶ Produces accurate and robust predictions.

Conclusion

- ▶ Gradient boosting transforms model weaknesses into strengths.
- ▶ Combines multiple weak models to build a high-performance model.