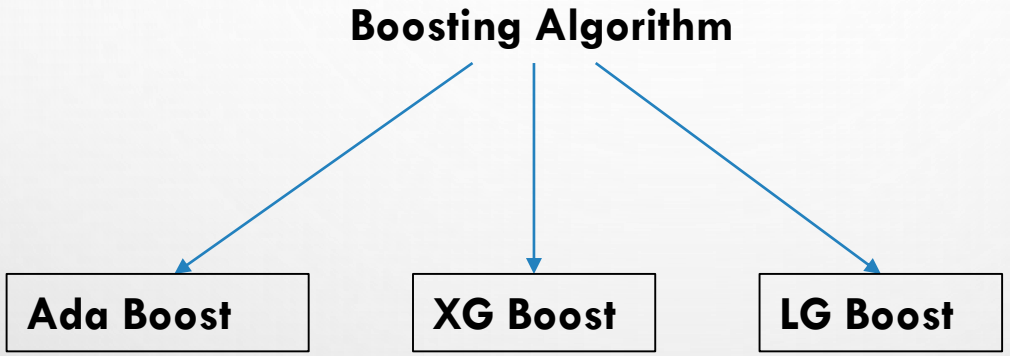
BOOSTING ALGORITHM

Boosting Algorithm

- Boosting is an ensemble technique that combines multiple weak learners to create a strong predictive model, focusing on correcting errors made by previous models
- Boosting enhances model accuracy and robustness, making it a crucial method in machine learning for improving performance on complex datasets



ADAPTIVE BOOSTING ALGORITHM

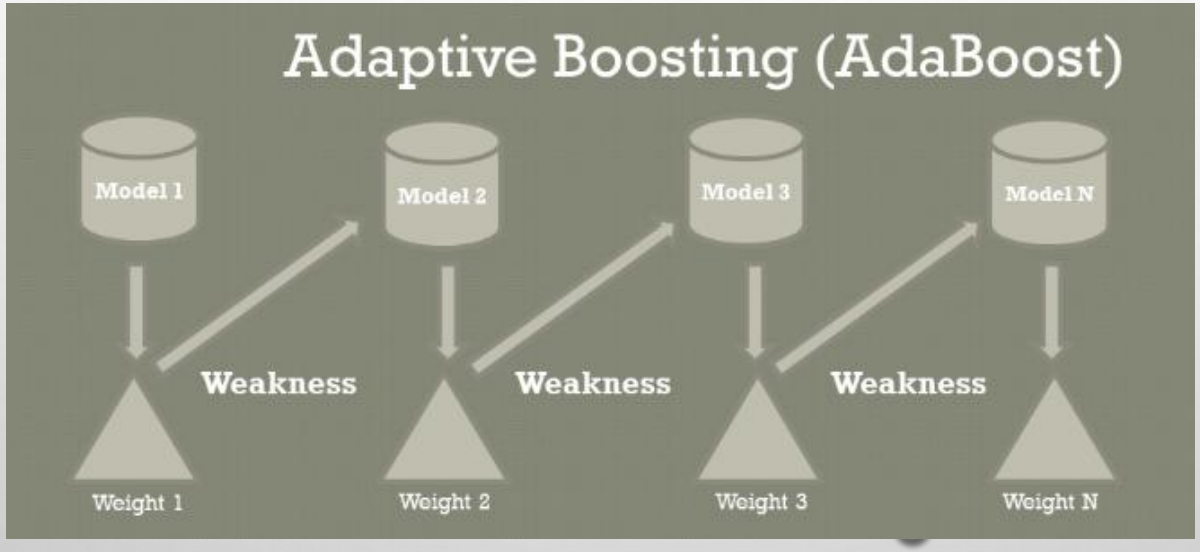
1. Ada Boost (Adaptive Boost Algorithm)

Improves model performance by **iteratively adjusting sample weights**

Basic Concepts

01. Weighting of Weak Learners

- In AdaBoost, weak learners are assigned different weights based on their accuracy. Misclassified instances receive greater weights, guiding subsequent learners to focus on difficult cases.



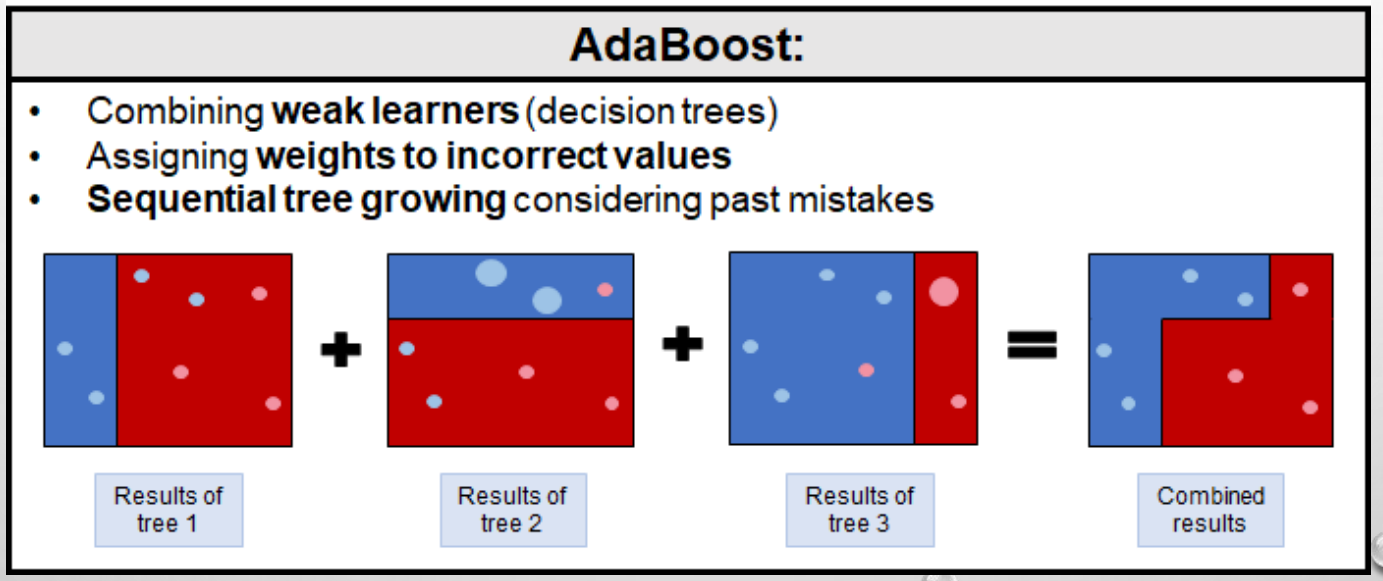
02. Combination of Predictions

- The final prediction in AdaBoost is achieved by combining the predictions of all weak learners. Each learner contributes based on its weight, leading to a strong composite model that improves accuracy

1. Ada Boost (Adaptive Boost Algorithm)

Iterative Learning

- During training, AdaBoost adjusts the weights of each sample after every iteration. This adjustment emphasizes misclassified samples, ensuring the model learns from its previous mistakes.



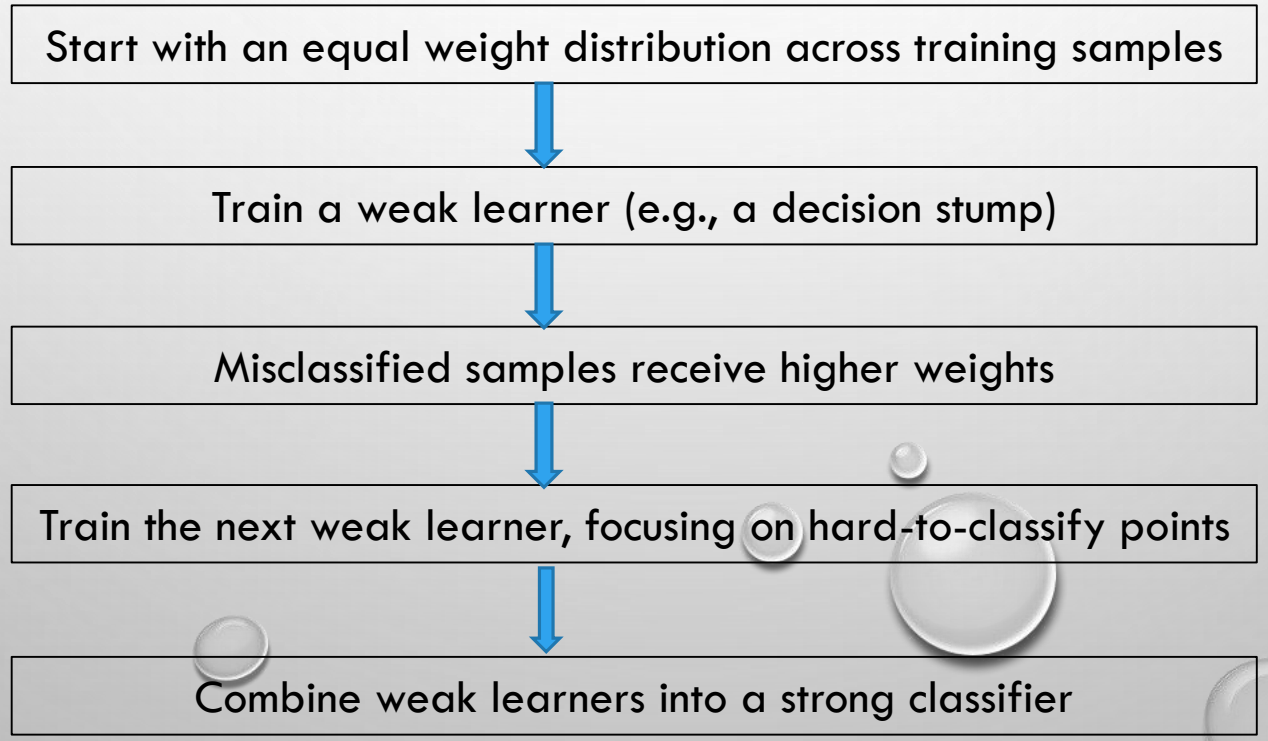
1. Ada Boost (Adaptive Boost Algorithm)

Decision Stumps

- Implementation of Decision Stumps → Decision stumps serve as a simple, single- level decision tree used for classification tasks, emphasizing swift computational efficiency and ease of implementation.

- Comparison with Other Learners → This section explores how decision stumps stack up against more complex algorithms, highlighting their strengths in speed and simplicity versus limitations in accuracy.

Steps involved →



1. **Ada Boost (Adaptive Boost Algorithm)**

Performance Benefits

- Reduction of Bias and Variance → AdaBoost effectively combines multiple weak learners to create a strong predictive model, resulting in lower bias and variance, which improves overall model robustness
- High Accuracy → AdaBoost enhances accuracy by focusing on misclassified instances, thereby adjusting weights and iteratively refining predictions to achieve results that often outperform other algorithms
- Integration with Other Models → AdaBoost can easily be integrated with various machine learning models, including decision trees and support vector machines, allowing for hybrid approaches that leverage strengths of multiple algorithms.

Application

- **Computer Vision**: Face detection
- **Finance**: Fraud detection in transactions
- **Healthcare**: Disease prediction models
- **Marketing**: Customer churn prediction

XG BOOSTING ALGORITHM

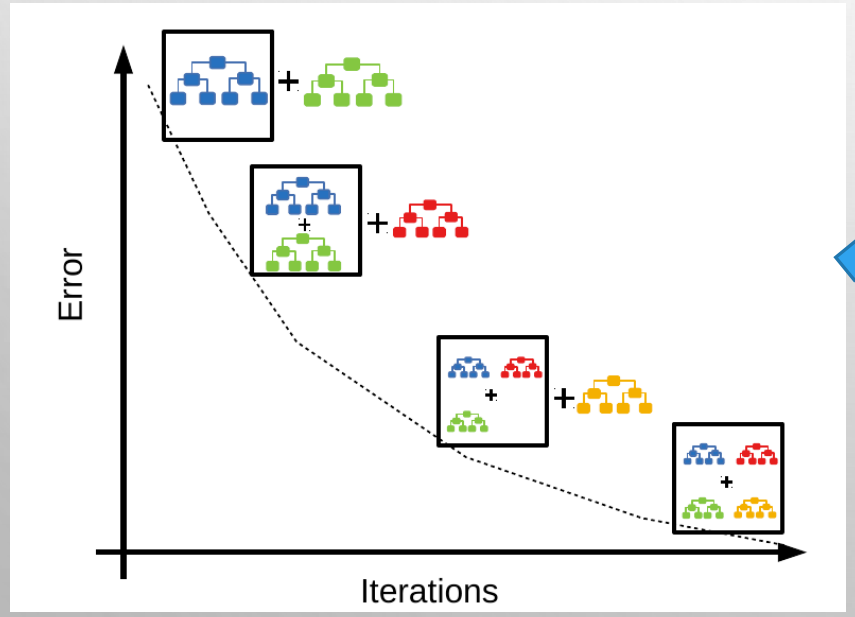
2. XG Boost (Extreme Gradient Boosting)

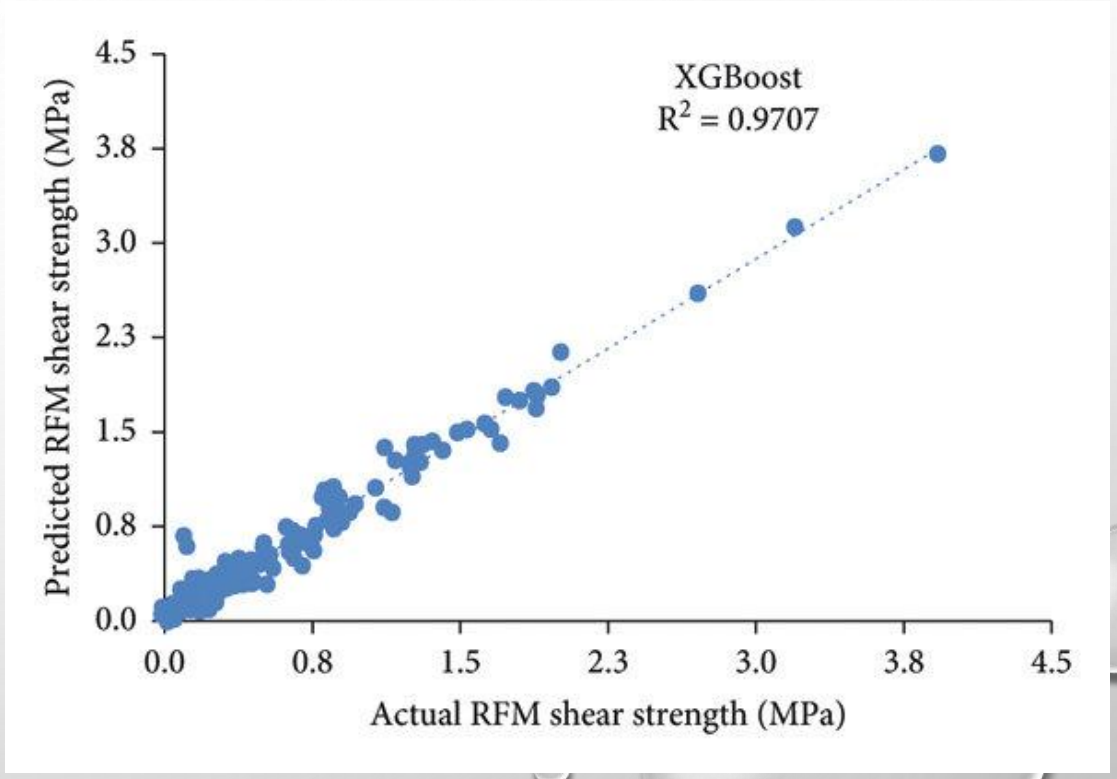
XGBoost is an optimized version of Gradient Boosting, designed for speed and performance

Uses **Gradient Boosting,** where new trees correct errors of previous trees

Key Features

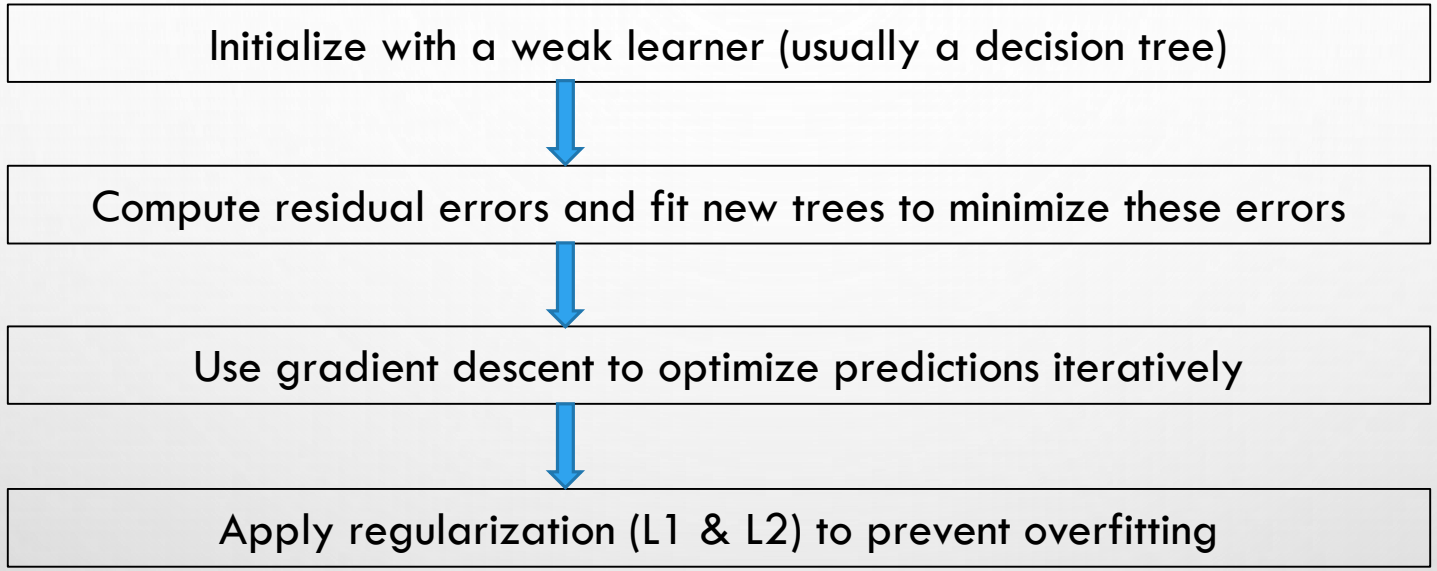
- High efficiency & scalability
- Handles missing values automatically
- Supports both classification and regression





2. XG Boost (Extreme Gradient Boosting)

Steps involved →



2. XG Boost (Extreme Gradient Boosting)

Merits

- High accuracy and efficiency
- Handles missing data automatically
- Works well on both small and large datasets

Limitations

- Requires hyperparameter tuning for best performance
- Computationally expensive for extremely large datasets
- Not ideal for sparse, unstructured data (e.g., images, text)

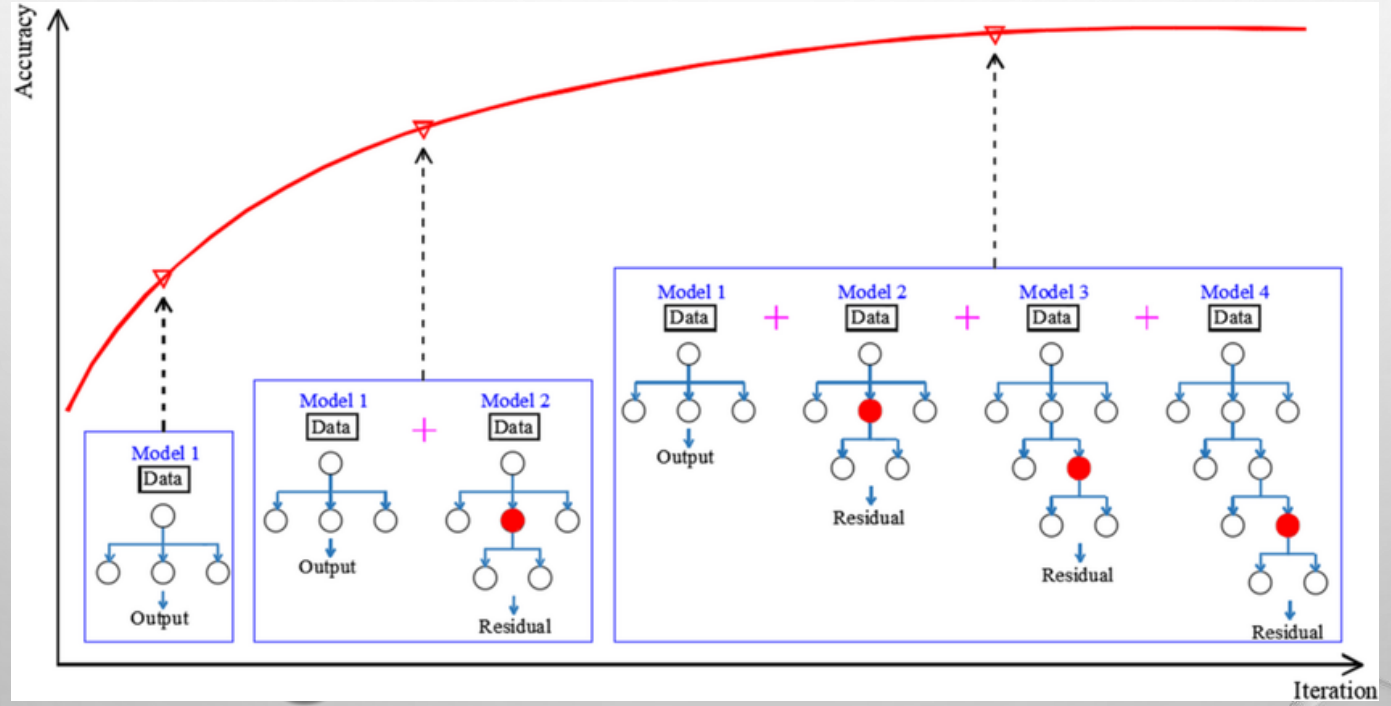
LG BOOSTING ALGORITHM

3. LG Boost (Light Gradient Boosting)

A Fast and Scalable Boosting Algorithm

Key Features

- Based on **Gradient Boosting Decision Trees (GBDT)**
- Uses **leaf-wise growth** instead of level-wise (used in XGBoost)



3. LG Boost (Light Gradient Boosting)

Steps involved →

Histogram-based splitting: Groups continuous features into bins for faster computation

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Leaf-wise growth strategy: Expands the tree by splitting the leaf with the largest gain, improving accuracy

↓

Sparse feature handling: Efficiently processes missing and categorical data

↓

Multi-threading & GPU acceleration for high-speed training

COMPARISON WITH OTHER BOOSTING ALGORITHMS

Comparison with Other Boosting Algorithms

Algorithm	Speed	Accuracy	Handles Large Datasets	GPU Support
AdaBoost	Slow	Moderate	No	No
XGBoost	Fast	High	Yes	Yes
LightGBM	Fastest	Highest	Yes	Yes

ADA boost → It creates multiple weak models (usually **decision stumps**—single-level decision trees)

XG Boost → Uses **Gradient Boosting,** where new trees correct errors of previous trees.

LG Boost → Similar to XGBoost but **grows trees vertically** (leaf-wise) instead of level-wise