

Decision Tree — Deep Dive for AI Engineers

1. What Is a Decision Tree?

A decision tree is a rule-based ML model that predicts outcomes by recursively splitting data using simple threshold-based questions.

2. Tree Structure

A tree consists of a root node, internal nodes, and leaf nodes where predictions are produced.

3. Decision Process

At each node, the tree evaluates all candidate splits and selects the one that best separates the data.

4. Regression Splits

For regression, splits minimize variance or mean squared error in child nodes.

5. Classification Splits

For classification, splits maximize class purity using Gini impurity or entropy.

6. Recursive Growth

The tree grows recursively until stopping criteria are met.

7. Strengths

Decision trees capture non-linear relationships, feature interactions, and require no feature scaling.

8. Overfitting

Trees can easily overfit by memorizing training data, leading to high variance.

9. Bias–Variance Tradeoff

Trees have low bias but high variance.

10. Regularization

Limiting depth, enforcing minimum samples per leaf, and minimum split sizes help control overfitting.

11. Practical Usage

Trees are rarely used alone in production due to instability.

12. Trees in Ensembles

Random Forest and boosting methods use trees as base learners.

13. Interpretability

Tree rules are human-readable and useful for explainability.

14. When to Use

Suitable for small datasets, explainability needs, and prototyping.

15. Limitations

Sensitive to noise, unstable, and cannot extrapolate trends.

16. Interview Summary

Decision trees recursively split data to minimize error but overfit easily, hence they are used inside ensembles.

17. Key Takeaway

Decision trees are foundational to modern ML but should rarely be deployed alone.