To study Decision Trees from basic to advanced, here’s a comprehensive list of topics to cover:

**Beginner Level**

1. Introduction to Decision Trees

- What is a Decision Tree?

- Decision Trees for Classification vs. Regression

- Key Concepts: Root Node, Decision Nodes, Leaf Nodes, Branches, Splitting

2. How Decision Trees Work

- Structure of a Decision Tree

- Recursive Partitioning

- How splits are made based on features

3. Building Blocks

- Entropy: Concept and mathematical formula

- Information Gain: How it's used to determine splits

- Gini Impurity: Explanation and formula

- Comparison: Information Gain vs. Gini Impurity

4. Advantages and Disadvantages of Decision Trees

- Interpretability

- Handling of Categorical and Numerical Data

- Overfitting in Decision Trees

- Pruning as a solution to overfitting

**Intermediate Level**

5. Building a Decision Tree

- Steps to build a Decision Tree from scratch

- Recursive binary splitting algorithm

- Choosing the right split criteria (Information Gain vs Gini Index)

6. Decision Trees for Classification

- Categorical Target Variables

- Use of Entropy and Information Gain

7. Decision Trees for Regression

- Continuous Target Variables

- Mean Squared Error (MSE) as a loss function

- Comparison with Linear Regression

8. Handling Categorical and Numerical Data

- Dealing with mixed types of variables

- Binarization of categorical features

- Handling missing data in decision trees

9. Tree Pruning Techniques

- Pre-pruning: Limiting depth, minimum samples per split

- Post-pruning: Reducing overfitting by cutting branches

- Cost Complexity Pruning

10. Hyperparameters of Decision Trees

- Max Depth

- Min Samples Split

- Min Samples Leaf

- Max Features

11. Metrics for Evaluating Decision Trees

- Classification Accuracy

- Confusion Matrix, Precision, Recall, F1-Score for classification

- RMSE, MAE, and R-squared for regression trees

12. Handling Imbalanced Data

- Strategies for dealing with imbalanced datasets

- Class weighting in Decision Trees

**Advanced Level**

13. Decision Trees and Ensemble Methods

- Introduction to Random Forest (ensemble of decision trees)

- Bagging and Bootstrapping

- Boosting (AdaBoost, Gradient Boosting)

- Extreme Gradient Boosting (XGBoost)

- Comparison between Random Forest and Boosting methods

14. Feature Importance in Decision Trees

- How to interpret feature importance

- Using SHAP values with Decision Trees

- Feature selection techniques using decision tree models

15. Regularization in Decision Trees

- Pruning methods (cost complexity pruning)

- L1 and L2 regularization (in decision trees for regularization)

16. Handling Bias and Variance in Decision Trees

- Bias-Variance Tradeoff

- Overfitting vs Underfitting in Decision Trees

- Model complexity control

17. Advanced Pruning Techniques

- Reduced Error Pruning

- Pessimistic Pruning

- Minimum Description Length (MDL) pruning

18. Random Forests in Depth

- Understanding feature bagging

- Out of Bag (OOB) error estimation

- Importance of random feature selection

19. Gradient Boosting in Depth

- How Gradient Boosting improves over decision trees

- Loss functions in Gradient Boosting

- XGBoost and LightGBM: Their optimizations over traditional boosting methods

20. Decision Trees in Real-World Applications

- Application in healthcare, finance, fraud detection

- Challenges and considerations in using decision trees in production environments

**Conclusion**

- Interpretability vs Performance: Trade-offs in using decision trees

- Comparison to other models: Decision Trees vs SVMs, Neural Networks, etc.

Covering these topics will give you a comprehensive understanding of Decision Trees, from the fundamentals to the most advanced techniques and their applications in real-world problems.