# Model Performance Report

This document summarizes the performance of various machine learning models evaluated for the given dataset. Metrics like Accuracy, Macro-F1 Score, Precision, and Recall were used to compare their effectiveness.

## Model Performance Metrics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Accuracy | Macro-F1 Score | Precision | Recall |
| Logistic Regression | 0.91 | 0.76 | 0.8 | 0.73 |
| Decision Tree | 0.97 | 0.91 | 0.9 | 0.92 |
| Random Forest | 0.99 | 0.98 | 0.98 | 0.98 |
| XGBoost | 0.99 | 0.97 | 0.97 | 0.97 |

## Observations

- Random Forest and XGBoost performed the best in terms of all metrics, with Random Forest slightly ahead.  
- Logistic Regression had the lowest performance, especially in terms of Macro-F1 Score.  
- Decision Tree performed better than Logistic Regression but fell short compared to ensemble methods.

# Steps Undertaken in the Project

## 1. Exploratory Data Analysis (EDA)

Analyzed data for insights, distributions, patterns, and relationships between features and target variables. Visualized correlations and addressed multicollinearity.

## 2. Handling Missing Data

Identified and imputed missing values appropriately based on the type of feature and its distribution.

## 3. Encoding Categorical Variables

Converted categorical variables into numerical representations using encoding techniques like one-hot encoding or label encoding.

## 4. Feature Engineering

Performed feature engineering to create new relevant features, handled outliers using the IQR method, and selected important features based on statistical tests and feature importance scores.

## 5. Train-Validation Split

Split the dataset into training and validation sets to evaluate model performance.

## 6. Stratification

Used stratified sampling during the train-validation split to maintain the class distribution in both sets.

## 7. Model Selection and Training

Trained multiple models (Logistic Regression, Decision Tree, Random Forest, XGBoost) using hyperparameter tuning techniques like RandomizedSearchCV. Evaluated the models using metrics such as accuracy, macro-F1 score, precision, and recall.

## 8. Model Interpretation: Feature Importance

Interpreted model results using feature importance scores to understand the impact of each feature on predictions. Identified the most influential features in the classification task.