

Milestone 3: Customer Churn Prediction

1. Introduction

- This report evaluates the performance of various machine learning algorithms for predicting customer churn.
- Initial evaluations were conducted without hyperparameter tuning to establish baseline performance metrics.
- Subsequently, tuning was performed to improve the performance of the top models.
- Metrics used include Accuracy, Precision, Recall, F1-score, and AUC.

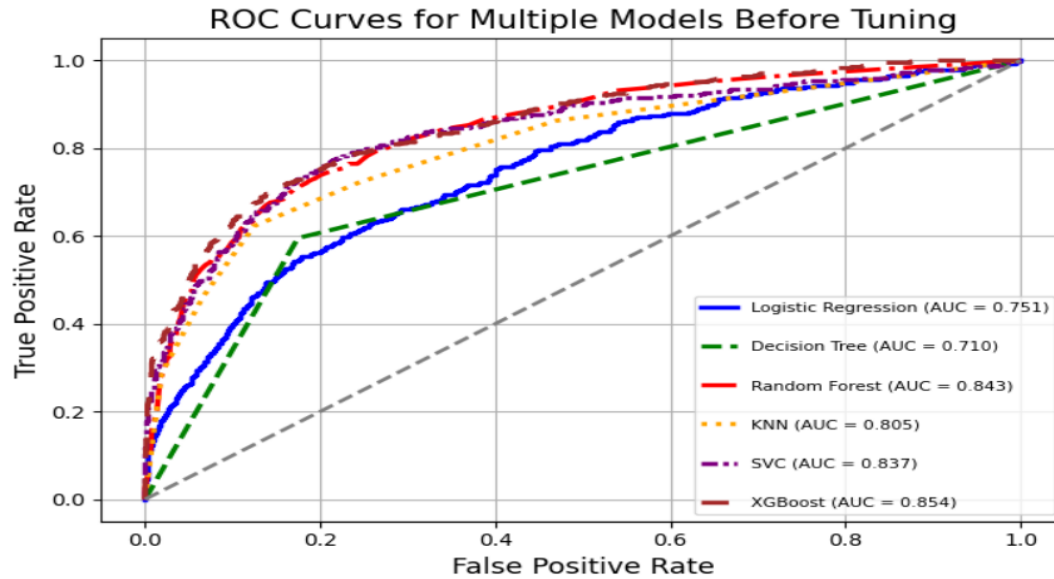
2. Model Evaluation Before Tuning

- The following table shows the evaluation metrics before any hyperparameter tuning:

Algorithm	Train Accuracy	Test Accuracy	Precision	Recall	F1-score	AUC
Logistic Regression	0.8238	0.7830	0.4698	0.4951	0.4821	0.7506
Decision Tree	0.9998	0.7785	0.4664	0.5956	0.5231	0.7104
Random Forest	0.9998	0.8325	0.5884	0.5956	0.5920	0.8430
KNN	0.8996	0.8240	0.5619	0.6225	0.5907	0.8052
SVC	0.8677	0.8360	0.5985	0.5956	0.5971	0.8374
XGBoost	0.9473	0.8535	0.6584	0.5858	0.6200	0.8537

3. Performance Analysis (Before Tuning)

- XGBoost achieved the highest Test Accuracy (85.35%) and AUC (0.8537), indicating strong predictive performance.
- Decision Tree and Random Forest models showed signs of overfitting due to very high training accuracy.
- SVC and XGBoost provided the most balanced results in terms of both Precision and Recall.



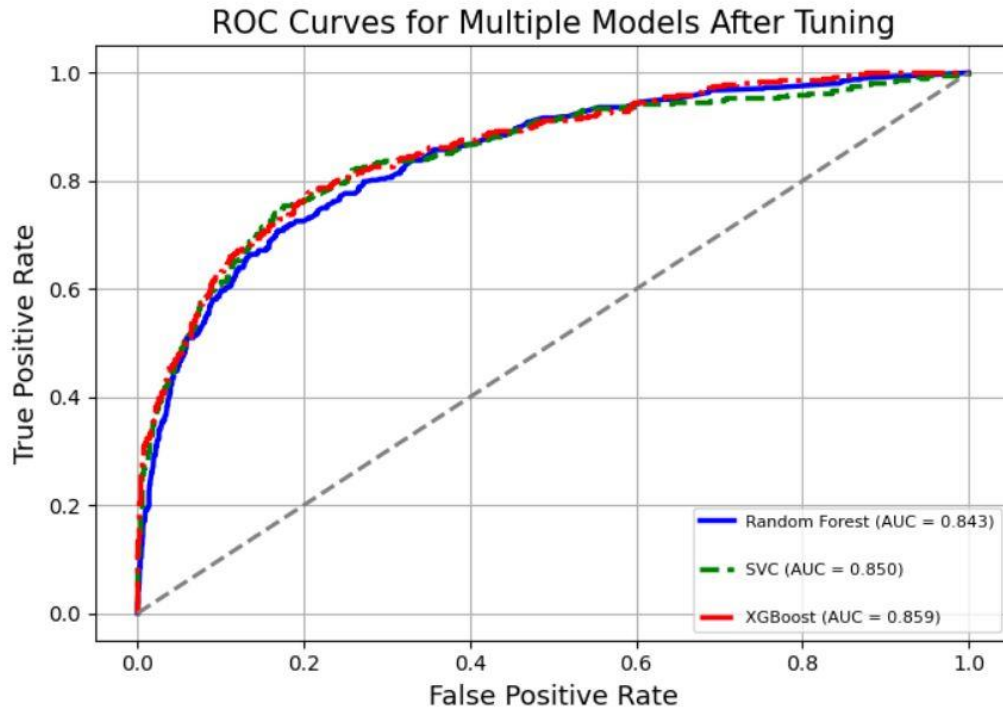
4. ROC Curve Analysis (Before Tuning)

- The ROC curves illustrated strong discriminative power for XGBoost and SVC, with XGBoost achieving the highest AUC. Random Forest also performed well but showed minor overfitting.

5. Model Evaluation After Hyperparameter Tuning

- After tuning, the performance of the top models improved. The results are summarized below:

Algorithm	Train Accuracy	Test Accuracy	Precision	Recall	F1-score	AUC
Random Forest	0.9995	0.8320	0.5857	0.6029	0.5942	0.8434
SVC	0.8784	0.8465	0.6241	0.6225	0.6233	0.8319
XGBoost	0.9109	0.8510	0.6410	0.6127	0.6266	0.8625



6. Final Conclusion and Selected Model

- Based on the evaluation after tuning, XGBoost remains the best-performing model with the highest AUC (0.8625) and a well-balanced Precision and Recall. Hence, it is selected as the final model for deployment.
- The best hyperparameters for XGBoost are:
 - colsample_bytree = 0.8
 - gamma = 0.1
 - learning_rate = 0.05
 - max_depth = 6
 - n_estimators = 300
 - scale_pos_weight = 5
 - subsample = 0.8
 - random_state = 60