The analysis focused on several key performance metrics, including accuracy, precision, recall, F1-score, ROC AUC, and execution time. The results indicated that both algorithms achieved high performance across all metrics, with XGBoost slightly outperforming Random Forest in terms of accuracy, precision, recall, F1-score, and ROC AUC. Specifically, XGBoost achieved an accuracy of 98.52%, precision of 98.51%, recall of 98.50%, F1-score of 98.53%, and ROC AUC of 99.74%. In comparison, Random Forest achieved an accuracy of 98.43%, precision of 98.45%, recall of 98.43%, F1-score of 98.49%, and ROC AUC of 99.68%. However, it is important to note that the execution time for XGBoost was significantly longer than that of Random Forest, with XGBoost taking 40 minutes compared to Random Forest’s 6 minutes. This difference in execution time may be a critical factor when considering the practical implementation of these algorithms in real-world scenarios, where computational resources and time constraints are important considerations. Given these findings, while XGBoost offers marginally better predictive performance, Random Forest provides a more efficient solution in terms of execution time. Therefore, for transformer failure prediction, Random Forest may be the more suitable choice, balancing the trade-off between predictive accuracy and computational efficiency. Future research should explore additional algorithms and incorporate a broader range of data sources to further enhance predictive model robustness and improve electrical grid operations.

Algorithm Selection: Given the marginally better predictive performance of XGBoost but significantly longer execution time, Random Forest is recommended for transformer failure prediction in scenarios where computational efficiency is a priority. XGBoost may be considered when the highest possible predictive accuracy is required and computational resources are not a constraint.