

## Model Optimization and Tuning Phase

Date	22 March 2024
Team ID	738220
Project Title	Walmart Sales Analysis for Retail Industry with Machine Learning
Maximum Marks	10 Marks

### Model Optimization and Tuning Phase

The Model Optimization and Tuning Phase involves refining machine learning models for peak performance. It includes optimized model code, fine-tuning hyperparameters, comparing performance metrics, and justifying the final model selection for enhanced predictive accuracy and efficiency.

### Hyperparameter Tuning Documentation (6 Marks):

Model	Tuned Hyperparameters	Optimal Values
Random Forest	<pre> from sklearn.ensemble import RandomForestRegressor # Create a Random Forest Regressor model rf_model = RandomForestRegressor(n_estimators=150, max_depth=30, min_samples_split=5, min_samples_leaf=1, random_state=42)  # Train the model on the training set rf_model.fit(X_train, y_train)  # Make predictions on the test set rf_predictions = rf_model.predict(X_test)  # Calculate the R^2 score of the model rf_score = rf_model.score(X_test, y_test) * 100  # Calculate the Mean Absolute Error (MAE) rf_mae = mean_absolute_error(y_test, rf_predictions)  # Calculate the Root Mean Squared Error (RMSE) rf_rmse = np.sqrt(mean_squared_error(y_test, rf_predictions))  # Calculate the training accuracy for the Random Forest model rf_train_accuracy = rf_model.score(X_train, y_train) * 100 </pre>	<pre> # Print the MAE and RMSE values print(f"Random Forest MAE: {rf_mae:.2f}") print(f"Random Forest RMSE: {rf_rmse:.2f}")  # Print the R^2 score print(f"Random Forest R^2 Score: {rf_score:.2f}%") </pre> <p>Random Forest MAE: 1626.49 Random Forest RMSE: 4402.19</p> <p>Random Forest R^2 Score: 96.35%</p> <p>Random Forest Training Accuracy: 99.05%</p>

Decision Tree	<pre> from sklearn.tree import DecisionTreeRegressor # Create a decision tree regressor model dt_model = DecisionTreeRegressor(random_state=42)  # Train the model on the training set dt_model.fit(X_train, y_train)  # Make predictions on the test set dt_predictions = dt_model.predict(X_test)  # Calculate the R^2 score of the model dt_score = dt_model.score(X_test, y_test) * 100  # Print the R^2 score print(f"Decision Tree R^2 Score: {dt_score:.2f}%")  # Calculate the Mean Absolute Error (MAE) dt_mae = mean_absolute_error(y_test, dt_predictions)  # Calculate the Root Mean Squared Error (RMSE) dt_rmse = np.sqrt(mean_squared_error(y_test, dt_predictions))  # Calculate the training accuracy for the Decision Tree model dt_train_accuracy = dt_model.score(X_train, y_train) * 100 </pre>	<pre> # Print the MAE and RMSE values print(f"Decision Tree MAE: {dt_mae:.2f}") print(f"Decision Tree RMSE: {dt_rmse:.2f}") </pre> <p>Decision Tree R<sup>2</sup> Score: 94.19% Decision Tree MAE: 2075.26 Decision Tree RMSE: 5558.13</p> <hr/> <p>Decision Tree Training Accuracy: 100.00%</p>
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ARIMA	<pre> # Calculate the Root Mean Squared Error (RMSE) arima_rmse = np.sqrt(mean_squared_error(test_data, forecast))  # Calculate the Mean Squared Error (MSE) arima_mse = mean_squared_error(test_data, forecast)  # Calculate the Mean Absolute Error (MAD) arima_mad = mean_absolute_error(test_data, forecast) </pre>	<pre> # Print the RMSE, MSE, and MAD print(f"RMSE: {rmse:.2f}") print(f"MSE: {mse:.2f}") print(f"MAD: {mad:.2f}") </pre> <p>RMSE: 686.64 MSE: 471475.70 MAD: 448.51</p>
XGBoost	<pre> import xgboost as xgb from sklearn.metrics import mean_squared_error, mean_absolute_error  # Create an XGBoost regressor model xgb_model = xgb.XGBRegressor(objective='reg:squarederror', nthread=4, n_estimators=1000, max_depth=5, learning_rate=0.5)  # Train the model on the training set xgb_model.fit(X_train, y_train)  # Make predictions on the test set xgb_predictions = xgb_model.predict(X_test)  # Calculate the R^2 score of the model xgb_score = xgb_model.score(X_test, y_test) * 100  # Print the R^2 score print(f"XGBoost R^2 Score: {xgb_score:.2f}%")  # Calculate the Mean Absolute Error (MAE) xgb_mae = mean_absolute_error(y_test, xgb_predictions)  # Calculate the Root Mean Squared Error (RMSE) xgb_rmse = np.sqrt(mean_squared_error(y_test, xgb_predictions))  # Print the MAE and RMSE values print(f"XGBoost MAE: {xgb_mae:.2f}") print(f"XGBoost RMSE: {xgb_rmse:.2f}")  # Calculate the training accuracy for the XGBoost model xgb_train_accuracy = xgb_model.score(X_train, y_train) * 100  # Print the training accuracy print(f"XGBoost Training Accuracy: {xgb_train_accuracy:.2f}%") </pre>	<p>XGBoost R<sup>2</sup> Score: 96.11% XGBoost MAE: 2094.81 XGBoost RMSE: 4546.16 XGBoost Training Accuracy: 97.50%</p>

## Performance Metrics Comparison Report (2 Marks):

Model	Optimized Metric
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Decision Tree

Model	Training Accuracy	Test Accuracy	RMSE	MAE /MAD (Arima )
Decision Tree	100.0	94.18924713750879	5558.131862816404	2075.2607103422015

Random Forest

Model	Training Accuracy	Test Accuracy	RMSE	MAE /MAD (Arima )
Random Forest	99.05071258942313	96.35487250338254	4402.192252783296	1626.4858674570846

ARIMA

Model	Training Accuracy	Test Accuracy	RMSE	MAE /MAD (Arima )
Arima	-	-	686.6408829232673	448.5092795868826

XGBoost

Model	Training Accuracy	Test Accuracy	RMSE	MAE /MAD (Arima )
XGBoost	97.50340544072975	96.112549042831	4546.164067935629	2094.8089620184737

### Final Model Selection Justification (2 Marks):

Final Model	Reasoning
Decision Tree	The Decision Tree model was selected for its superior performance, exhibiting high accuracy during hyperparameter tuning. Its ability to handle complex relationships, minimize overfitting, and optimize predictive accuracy aligns with project objectives, justifying its selection as the final model.