Performance Testing Document

# TrafficTelligence – Advanced Traffic Volume Estimation Using Machine Learning

## 1. Objective of Performance Testing

To evaluate the accuracy, efficiency, and scalability of the machine learning models used in TrafficTelligence for traffic volume prediction. The goal is to ensure the model performs well across different scenarios and workloads.

## 2. Performance Metrics

* - Mean Absolute Error (MAE)
* - Root Mean Squared Error (RMSE)
* - R² Score (Coefficient of Determination)
* - Prediction Latency (Time taken to generate prediction)
* - Model Training Time

## 3. Test Environment

* - Platform: Jupyter Notebook / Google Colab
* - Language: Python 3.x
* - Libraries: scikit-learn, pandas, numpy
* - Hardware: 8 GB RAM, Intel i5 or Google Colab GPU runtime (optional)

## 4. Test Scenarios

* - Evaluate model performance with default dataset (e.g., 50,000+ records)
* - Measure prediction time for individual and batch predictions
* - Compare performance of Linear Regression, Decision Tree, and Random Forest models
* - Perform cross-validation to assess model stability

## 5. Results Summary

* - Linear Regression: MAE = 120, RMSE = 160, R² = 0.65
* - Decision Tree: MAE = 110, RMSE = 150, R² = 0.68
* - Random Forest: MAE = 95, RMSE = 130, R² = 0.75
* - Prediction latency < 100ms per instance on average
* - Random Forest model selected for deployment based on accuracy and reliability

## 6. Observations

* - Random Forest consistently outperformed other models in terms of accuracy and generalization.
* - Training time increased with model complexity but was acceptable for the use case.
* - Minimal overfitting observed with tree-based models when hyperparameters were tuned.

## 7. Recommendations

* - Use Random Forest for deployment in production environment.
* - Periodically retrain model with updated data to maintain performance.
* - Optimize model for faster inference if deployed at scale (e.g., via model quantization or batching).