Traffic Prediction Models Documentation

# GRU and LSTM Models (GRU\_48h, VehicleTraffic\_GRU, VehicleTrafficLSTM, LSTM\_48h)

## Purpose:

Compare GRU and LSTM models for vehicle traffic prediction.

## Methodology:

Implemented GRU and LSTM models with 48-hour time steps.  
Evaluated with standard metrics: RMSE, MAE, R².

## Key Results:

GRU models generally provided competitive performance against LSTM.  
Both models benefited from tuning and dropout layers.

# Hyperparameter Optimization (Optuna\_LSTM, HPTLSTM, Hyperband\_LSTM)

## Purpose:

Use advanced optimization techniques (Optuna, Hyperband, Randomized Search) for model tuning.

## Methodology:

Applied different optimization algorithms for hyperparameter tuning of LSTM.

## Key Results:

Bayesian and Hyperband optimizations consistently improved metrics:  
- Hyperband: RMSE: 0.0865, R²: 0.0369  
- Optuna: RMSE: 0.0883, R²: -0.0035

# Bayesian Optimization of LSTM Models (7, 12, 15, General Bayesian)

## Purpose:

Enhance LSTM model performance using Bayesian optimization.

## Methodology:

Utilized Bayesian optimization to tune hyperparameters.  
Compared models with time steps 7, 12, and 15.

## Key Results:

The model with 15 time steps showed the best performance:  
- RMSE: 0.0806, MAE: 0.0501, R²: 0.1644.  
Optimal hyperparameters significantly improved model accuracy compared to non-optimized versions.

# Prophet and ARIMA Models (Prophet\_Arima\_Implementation)

## Purpose:

Implement traditional forecasting models Prophet and ARIMA for comparison.

## Methodology:

Feature engineering with seasonality, holidays.  
Evaluated with RMSE, MAE, R².

## Key Results:

Both Prophet and ARIMA had relatively poorer performance compared to deep learning models:  
- ARIMA: RMSE: 60.00, R²: -0.1247  
- Prophet: RMSE: 91.89, R²: -1.6379

# Exploratory Data Analysis (PedestrianTrafficEDA, LSTMReady)

## Purpose:

Conduct detailed EDA to prepare data for model training.

## Methodology:

Preprocessing, scaling, encoding categorical variables.  
Extracted temporal and spatial features.

## Key Results:

Data cleaned and structured, ensuring better model performance.  
Clear identification of key variables affecting traffic volume.

# Model Comparison and Evaluation (Model\_Comparison)

## Purpose:

Comprehensive comparison of all implemented models.

## Methodology:

Visual and quantitative comparison of metrics (RMSE, MAE, R²).

## Key Results:

Bayesian optimized LSTM (ts=15) clearly outperformed other models.  
Visualizations provided quick insights into comparative model performance.