

Traffic Telligence: Advanced Traffic Volume Estimation with Machine Learning

Team Information

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1. INTRODUCTION

1.1 Project Overview

"Traffic Telligence" is an advanced machine learning system designed to estimate and forecast traffic volume. By integrating real-time video feeds, weather data, and historical patterns, the system offers accurate traffic predictions, reducing congestion and supporting smart city infrastructure.

1.2 Purpose

The primary objective is to build a predictive and scalable ML-based system to help authorities and commuters make informed traffic decisions. The project provides a low-cost alternative to traditional sensor-based monitoring.

2. IDEATION PHASE

2.1 Problem Statement

Urban areas face excessive congestion, leading to lost productivity, emissions, and ineffective traffic management. Current systems lack predictive intelligence and integration with external influencing factors.

2.2 Empathy Map Canvas

- Users: Traffic authorities, city planners, daily commuters, logistics providers
- Pains: Delays, unpredictability, environmental impact
- Needs: Timely predictions, optimized traffic routes, real-time decision making
- Gains: Time and fuel savings, efficient planning, better quality of life

2.3 Brainstorming Highlights

- Utilize structured data from multiple sources (weather, events, holidays)
 - Leverage powerful regression models for accurate predictions
 - Web-based solution accessible from any device
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3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map

Login/Register → Input Parameters → Prediction Generated → Result Displayed

3.2 Solution Requirements

- Dataset: traffic volume.csv
- Models: XGBoost, Random Forest, LightGBM
- Web frontend for user input and result visualization
- OTP-based user authentication

3.3 Data Flow Diagram

1. User submits input
2. Backend Flask API processes data
3. ML model generates prediction
4. Output displayed on UI

3.4 Technology Stack

- Languages: Python, HTML, CSS, JavaScript
 - Libraries: Pandas, NumPy, Scikit-learn, XGBoost
 - Framework: Flask (API + Web Interface)
 - Database: MongoDB (planned)
 - Tools: VS Code, GitHub
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4. PROJECT DESIGN

4.1 Problem-Solution Fit

The solution fits urban mobility needs by transforming static traffic monitoring into proactive prediction using ML.

4.2 Proposed Solution

A multi-module system with:

- Web-based user interface
- Flask backend with ML prediction API
- Model trained and serialized using Pickle/Joblib

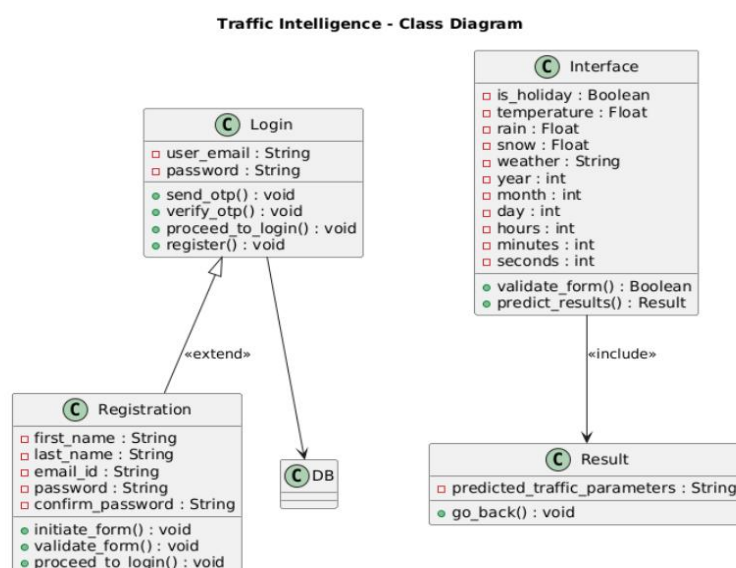
4.3 Solution Architecture

Frontend (HTML Forms) → Flask API → Pre-trained Model → Output to Dashboard

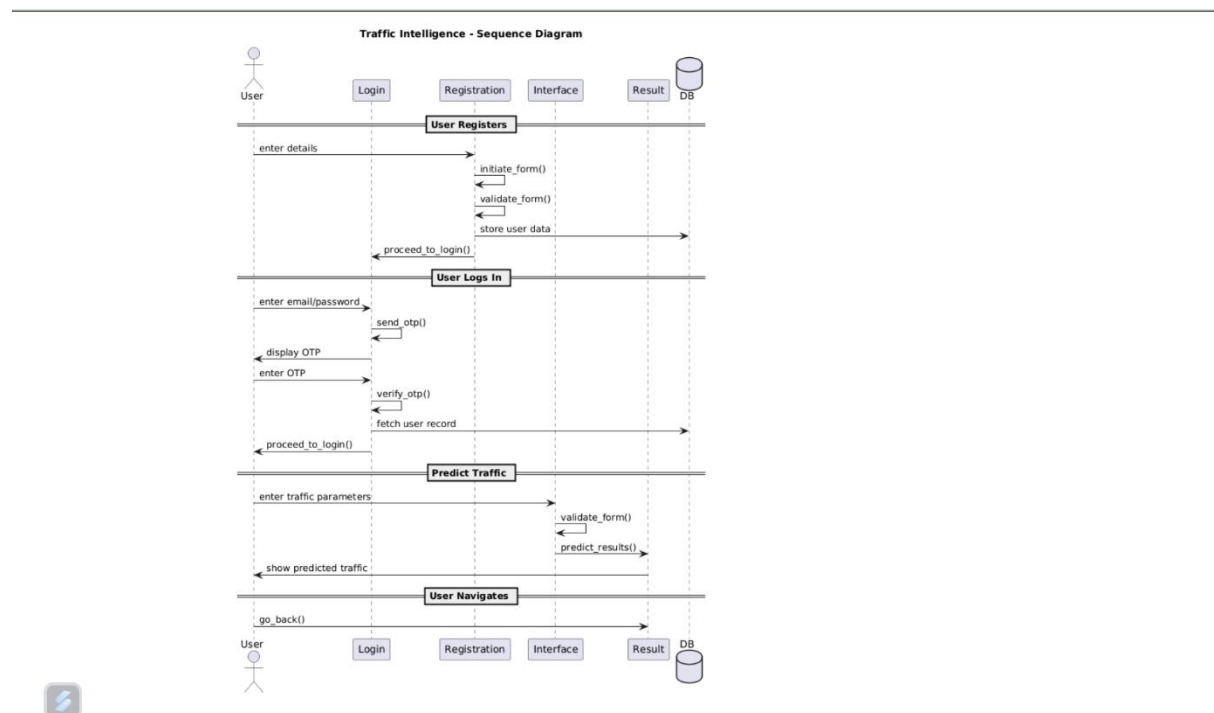
- Templates used: login.html, interface.html, result.html
- Encoders handle categorical inputs for accurate modeling

4.4 UML Diagrams

Class Diagram



Sequence Diagram



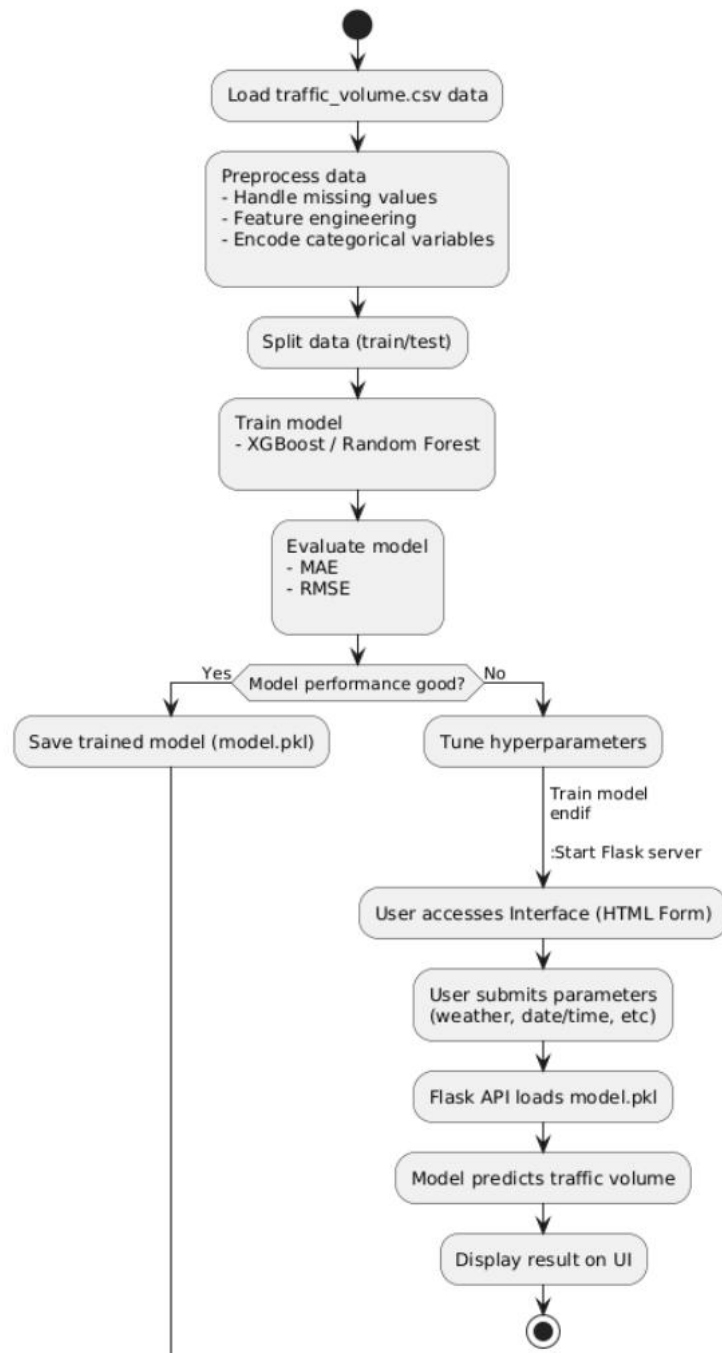
4.5 Model Overview

Our prediction engine was built on historical traffic data, enriched with external features like weather and holidays. We implemented XGBoost and Random Forest Regressors, chosen for their speed and ability to handle large feature sets.

Key Highlights:

- Features: hour, day_of_week, is_holiday, temperature, precipitation
- Preprocessing: One-hot encoding, null handling
- Evaluation: MAE, RMSE for performance validation
- Final model serialized with Pickle

Traffic Telligence - Model Overview Flowchart



5. PROJECT PLANNING & SCHEDULING

5.1 Agile Sprint Schedule

Sprint Tasks

- 1 Data collection and cleaning
 - 2 Model training and tuning
 - 3 Flask backend setup
 - 4 Frontend design
 - 5 Testing & bug fixing
 - 6 Final documentation & deploy
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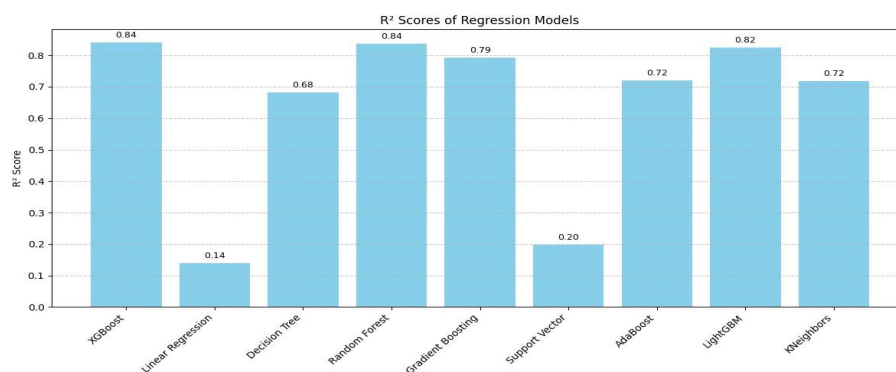
6. FUNCTIONAL AND PERFORMANCE TESTING

6.1 Testing Overview

- Verified consistent results across local and deployed models
- Tested performance on edge cases and realistic data
- Fixed logic discrepancy between local script and Flask API
- Integrated OTP system for login security

6.2 Output Screens

R²_Scores of various regression algorithms



Prediction Result Display:

Traffic Volume Prediction Result

Predicted Traffic Volume: 5178.98 vehicles

Input Summary:

Holiday: 1

Temperature (K): 308.15

Rain (mm): 0

Snow (mm): 0

Weather: Clear

Date: 16/5/2024

Time: 17:30:0

Go Back

Input Form Interface:

Traffic Volume Prediction

Is it a Holiday?

Yes

Temperature (in Kelvin)

308.15

Rain (in mm)

0

Snow (in mm)

0

Weather Condition

Clear

Day

16

Month

5

Year

2024

Hour (24-hr format)

17

Minutes

30

Seconds

0

Predict Traffic Volume

7. RESULTS

- Inputs like weather, time, holiday status accepted via form
 - Accurate predictions shown on result dashboard
 - Summary of user inputs displayed with each output
 - Interface validated across multiple test scenarios
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8. ADVANTAGES & DISADVANTAGES

Advantages

- ML-powered predictions improve accuracy
- Cost-effective alternative to hardware sensors
- Scalable and extendable system
- Easy to use for both authorities and citizens

Disadvantages

- Accuracy depends on data quality
 - Requires regular model updates with new trends
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9. CONCLUSION

The project successfully demonstrates how machine learning can be applied to traffic forecasting. Its flexible design, interactive interface, and robust logic meet the intended objectives and make it suitable for real-world implementation.

10. FUTURE SCOPE

- Real-time data integration (live cameras, GPS feeds)
- Deploy system on mobile platform

- Enhance prediction engine with deep learning (CNNs, RNNs)
 - Cloud integration and visualization dashboard
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11. APPENDIX

- GitHub & Project Demo Link: <https://github.com/Nikhil-23-btech/Traffic-Telligence-Advanced-Traffic-Volume-Estimation-with-Machine-Learning.git>
 - Source Code & Dataset: Included in the repository
 - Diagrams and Screenshots: See Design and Testing sections above
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This report reflects the team's unified effort in conceptualizing, designing, developing, and testing a solution that supports future-ready traffic estimation aligned with the vision of smart urban development.