Real-Time Traffic Flow Visualization with AI

Hao Chen,1336564 advisor:Hamza Djigal

Master of Computer Information Systems-CSMT,Wenzhou-Kean university

1.Introduction

- Effective traffic management is the foundation of modern smart cities.
- The ability of this project to predict and visualize real-time traffic flow is essential for reducing congestion, making transportation smoother, and reducing harm to the environment.
- This project serves as a powerful tool for urban planners, traffic managers, and commuters alike.

2.Research Objectives

This research aims to use AI to visualize and predict traffic flow in real time:

- Developing a real-time traffic flow prediction and visualization system:
1. Utilize real-time traffic data sources, such as APIs (e.g., Amap API), to collect traffic flow data
2. Design and implement AI-based models to predict traffic flow in real time
- Exploring the application of AI technologies in traffic prediction:
1. Investigate how machine learning and deep learning techniques (e.g., Random Forest, LSTM, CNN) can be applied to analyze and model traffic flow data
- Creating user-friendly traffic visualization tools:
1. Build interactive visual interfaces to display real-time traffic status and predicted flow
2. Enable stakeholders, such as traffic management authorities and commuters, to better understand current and future traffic conditions
- Supporting long-term development in smart cities:
1. Reduce the environmental and economic burdens caused by traffic congestion
2. Provide data support for other smart city functionalities, such as autonomous driving and intelligent public transportation

3.Machine Learning Models

Random Forest Classifier for this project include:

- The model was trained with 80% of the data, while 20% was used for testing.Use the train_test_split method to prepare the data and the RandomForestClassifier method to learn and predict the data.
- Congestion Achieved the best performance, with a precision of 0.88,recall of 0.9,F1score of 0.89 .
- The model achieved an overall accuracy of 0.72.

Classification Report				
Category	Precision	Recall	F1score	Support
Congestion	0.88	0.9	0.89	48
Slow traffic	0.5	0.4	0.44	20
Smooth traffic	0.38	0.5	0.43	10
Overall accuracy	0.72			78

4.Data Pipeline

- **Data collection** is carried out through the following steps:

Identify Data Sources:The data source is the Amap API, which provides traffic status information, including road congestion level, description, and geographic location information.

- Select Sampling Area and Targets

We selected the main roads in Beijing as target collection points and used longitude and latitude to mark the locations.

- Develop Automated Data Collection Scripts

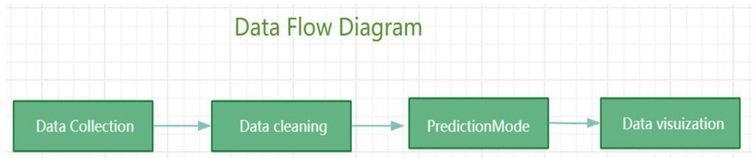
① Tools and libraries used: Python, requests (for API calls), pandas (for data storage), schedule (for scheduled tasks).

② Implementation method: The scheduled task collects traffic data of the target road section every 25 minutes and stores it as a CSV file.

③ Data content: including timestamp, road name, longitude and latitude, traffic status (smooth, slow, congested, severe congestion) and its numerical representation.

④ Data Storage:the collected data is stored in an csv file.

Data processing: loading the data , remove duplicate values, and saving the cleaned data.
Predictive modeling: Using random forests, we predict traffic conditions such as "smooth", "slow", and "congested"
Data visualization: interactive visual interfaces to display real-time traffic status and predicted flow

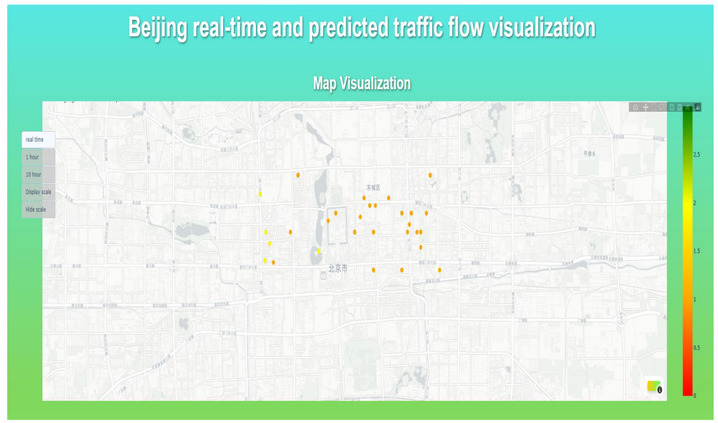


5.Visuals

Users can click on each marked point to view the relevant traffic data or road section name at that location. Users can freely zoom and move around the map to view traffic data at different locations.The map can clearly show the layout of traffic information.

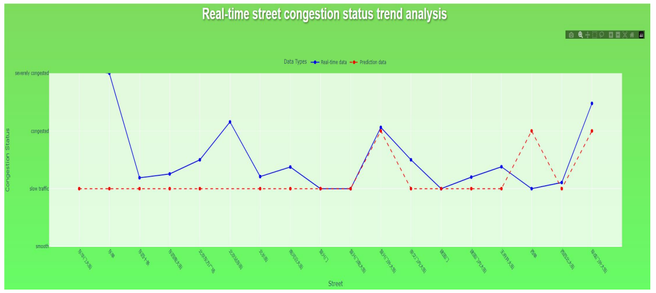
The color scale shows the frequency of different traffic conditions. For example, the proportion of traffic in different conditions such as "smooth", "slow traffic", "congestion", and "severe congestion". Users can quickly understand the different traffic conditions.

The time series trend chart uses machine learning for prediction, and users can see the fluctuations in traffic flow and analyze the peak and off-peak hours.



6.Visuals

Line chart:
The solid blue line represents real-time data. The dotted red line represents predicted data.
X-axis: represents different street names. Y-axis: represents the congestion status of the street.
The real-time data (blue line) shows congestion fluctuations on some streets, and some streets reach "severe congestion".
The predicted data (red line) is relatively stable, and most streets are predicted to be in a "slow" state.



7.Conclusions

- The Traffic Real-time System demonstrates an AI-based traffic prediction system, which systematically analyzes methods to improve traffic flow management from data collection to model training to visualization. This tool has practical application value and is suitable for smart city planning and traffic optimization.

8.Future Work

There are still areas for improvement. Future efforts could focus on expanding the system to cover multiple cities, incorporating more diverse data sources, and enhancing its accuracy. Additionally, features like long-term congestion forecasting and integration with autonomous vehicle systems could further increase its utility.