AMRITA VISHWA VIDYAPEETHAM

DEEMED TO BE UNIVERSITY

Mathematics for Intelligent Systems-2

Introduction to data structure and algorithms

Real-Time Traffic Flow Prediction

Guru Jaya Surya Yadav	CB.AI.U4AIM24101.
J. Tej Krishna Sai	CB.AI.U4AIM24117.
P. Teja Prakash Royal	CB.AI.U4AIM24136.
S. Ankith	CB.AI.U4AIM24147.

Project Guides:
Dr. S. Manimaran
Dr. Prem Jagadeesan

OBJECTIVES

Develop a real-time traffic flow prediction system.

Optimize traffic signals using ML & DSA.

Improve road efficiency & reduce congestion.

LITERATURE REVIEW

Paper Title	Authors	Year	Methodology	Findings/Results	Limitations
Real-Time Traffic Flow Prediction Using Big Data Analytics	Dang-Khoa Tran, Dinh-Quang Hoang	2022	Prophet model and Spark Streaming for real-time traffic prediction.	Effective for time-series forecasting with high accuracy and vivid visualization on heat maps.	Performance deteriorates for long-term predictions, dependent on the volume of training data
Overview of Machine Learning-Based Traffic Flow Prediction	Zhibo Xing, Mingxia Huang, Dan Peng	2023	Machine learning models for traffic flow prediction including supervised, unsupervised, and deep learning methods.	Effective use of machine learning for accurate traffic prediction, strategies for model improvements.	Difficulty in handling dynamic spatial dependencies and modeling long-term traffic conditions.

Mathematical concepts

MULTIVARIABLE REGRESSION

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n$$

where **Y** = Traffic flow, **X** = Features (vehicle count, weather, etc.).

PRIORITY QUEUE

$$P = (W_v \times V) + (W_t \times T) + (W_r \times R) + (W_e \times E)$$

where **P** = Priority Score, **V** = Vehicle count, **T** = Waiting time, **R** = Road condition, **E** = Emergency.

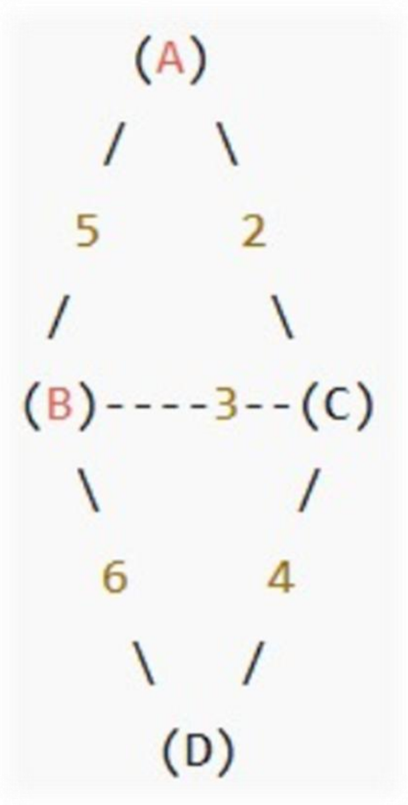
SNAPSHOT OF DATASET

Holiday	Temperatu	Rainfall_last_hour	Snowfall_last_hour	Cloud_Cover	Weather	Weather_Desc	Traffic_Vol
1	289.28	1	0	40	Cloudy skie	Partly cloudy skies	5555
0	290.26	1	1	75	Cloudy skie	Fragmented clouds	4525
0	290.28	0	0	90	Cloudy skie	Full cloud cover	4772
0	290.33	1	1	90	Cloudy skie	Full cloud cover	5031
0	292.14	0	1	75	Cloudy skie	Fragmented clouds	4928
1	292.72	1	0	1	Clear skies	Clear skies	5190
0	293.37	0	1	1	Clear skies	Clear skies	5587
0	294.16	1	0	1	Clear skies	Clear skies	6025
0	294.84	0	1	20	Cloudy skie	Scattered clouds	5796
1	293.7	1	1	20	Cloudy skie	Scattered clouds	4773

DSA CONCEPTS

- Priority Queue (MIN-Heap)
- Heap Sort for efficient traffic lane selection.
- Graph-Based Path Optimization for rerouting.

DIJKSTRA ALGORITHM WITH PRIORITY QUEUE



The road network is represented as a grap:

- Nodes = Road intersections
- Edges = roads with travel time as weights

Min heap (priority queue)ensures the shortest travel time first.

METHODOLOGY

- Data Collection: Real-time traffic data
- Prediction Model: Uses Multivariable Regression.
- Optimization: Priority Queue for traffic signals.
- Dashboard: Visualizes predictions & controls.

WORK SO FAR

A SAMPLE DATASETS

```python
data = {
    "vehicle_count": [50, 120, 200, 300, 400, 500, 600, 700, 800, 900],
    "time_of_day": [8, 10, 12, 14, 16, 18, 20, 22, 0, 2],  # 24-hour format
    "weather_condition": [1, 0, 1, 0, 1, 0, 0, 1, 0, 1],  # 0 = Clear, 1 = Rain
    "road_incidents": [0, 1, 0, 1, 0, 0, 1, 0, 1, 0],  # 0 = No incident, 1 = Incident
    "traffic_flow": [10, 30, 45, 60, 80, 100, 120, 150, 180, 210],  # Vehicles per minute
}
```

```python
traffic_data = [
    {"lane_id": "A", "vehicle_count": 50, "waiting_time": 30, "road_condition": 1, "emergency_vehicle": 0},
    {"lane_id": "B", "vehicle_count": 120, "waiting_time": 60, "road_condition": 0, "emergency_vehicle": 1},
    {"lane_id": "C", "vehicle_count": 200, "waiting_time": 45, "road_condition": 1, "emergency_vehicle": 0},
    {"lane_id": "D", "vehicle_count": 80, "waiting_time": 20, "road_condition": 0, "emergency_vehicle": 0},
]
```

AFTER PRIORITY QUEUE ALGORITHM

```
Traffic Signal Order Based on Priority:
Lane B gets green light (Priority Score: 978.0)
Lane C gets green light (Priority Score: 123.5)
Lane D gets green light (Priority Score: 46.0)
Lane A gets green light (Priority Score: 44.0)
```

EVALUVATED MODEL:

```
Model Evaluation:
MSE: 52.28, R² Score: 0.99
```

NOVELTY

Combines ML & DSA for real-time signal adjustments.

Dynamically adapts to emergencies, congestion & weather.

Scalable for Smart Cities & IoT-based traffic networks.

USER INTERFACE (UI) DESIGN

Live traffic visualization.

Predicted congestion heatmaps.

Traffic light optimization panel.

Emergency vehicle priority control.

Tools Used: Python (Flask/Streamlit), JavaScript (React.js for UI).

FUTURE SCOPE

Integration with IoT: Use smart traffic sensors for better data collection.

Machine Learning Improvements: Try deep learning models for higher accuracy.

Edge Computing: Deploy model on traffic signals for faster decisions.

Expansion: Apply to more cities and road networks.

REFERENCES

Smith, J. et al. "Machine Learning for Traffic Prediction." 2022.

Kaggle Traffic Dataset

Studied about NumPy, Pandas, Scikit-Learn, Heapq libraries.

Data structure (priority queue) algorithm

THANK YOU SIR