Assessment Report on Predicting Traffic Congestion

Submitted as partial fulfillment for the award of

BACHELOR OF TECHNOLOGY DEGREE

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CSE(AI)

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1. Introduction

With increasing urbanization, traffic congestion is becoming a major challenge for cities worldwide. This project aims to predict **traffic congestion levels** using **sensor data** such as vehicle speed, sensor count, and time of day. By leveraging **machine learning techniques**, transportation authorities can make data-driven decisions to improve traffic flow, reduce bottlenecks, and enhance commuter experiences.

2. Problem Statement

To classify road sections as **High, Medium, or Low congestion** based on real-time **traffic sensor data**. This classification assists city planners in optimizing road networks, improving traffic management, and reducing travel time inefficiencies.

3. Objectives

- **Process sensor data** for effective machine learning modeling.
- **Train a Random Forest classifier** to predict congestion levels.
- **Evaluate model accuracy** using confusion matrix, precision, recall, and F1-score.
- **Visualize traffic congestion trends** through data insights and graphical analysis.

4. Methodology

Data Collection:

The dataset consists of real-time traffic observations, including:

✓ **Sensor Count** - Number of traffic sensors detecting vehicle movement.

✓ **Average Speed** - Speed of vehicles at different times of the day.

✓ **Time of Day** - Categorical variable (morning, afternoon, evening, night).

✓ **Congestion Level** - Target classification (High, Medium, Low).

Data Preprocessing:

✓ Handling missing values using **mean imputation**.

✓ Encoding categorical features (**Time of Day, Congestion Level**) using **LabelEncoder**.

✓ Splitting data into **training (80%)** and **testing (20%)**.

Model Building:

✓ Using **Random Forest Classifier** due to its high accuracy and feature importance.

✓ Training model with optimized hyperparameters (`n_estimators=200, max_depth=10`).

Model Evaluation:

✓ Assessing model **accuracy, precision, recall, and F1-score**.

✓ Generating a **confusion matrix heatmap** to analyze classification errors.

5. Data Preprocessing

- **Handling missing values** in numerical columns using **mean imputation**.
- **Encoding categorical values** in **Time of Day** using **LabelEncoder**.
- **Normalizing data** for consistent feature scaling.
- **Splitting dataset** into **train-test ratio of 80:20** for model training.

6. Model Implementation

The **Random Forest classifier** is chosen for its ability to handle mixed data types and improve classification accuracy. The trained model predicts congestion levels based on sensor inputs.

7. Evaluation Metrics

- **Accuracy**: Percentage of correct congestion predictions.
- **Precision**: How well high congestion instances were correctly predicted.
- **Recall**: How well actual high congestion cases were identified.
- **F1 Score**: Balances precision and recall effectively.

- **Confusion Matrix**: Visual representation of model classification errors.

8. Results and Analysis

✓ The trained **Random Forest model** achieved an accuracy of **~85%**, showing strong predictive capability.

✓ **Heatmap visualization** revealed occasional misclassifications between medium and high congestion.

✓ **Precision and recall scores** indicated reliable congestion detection performance.

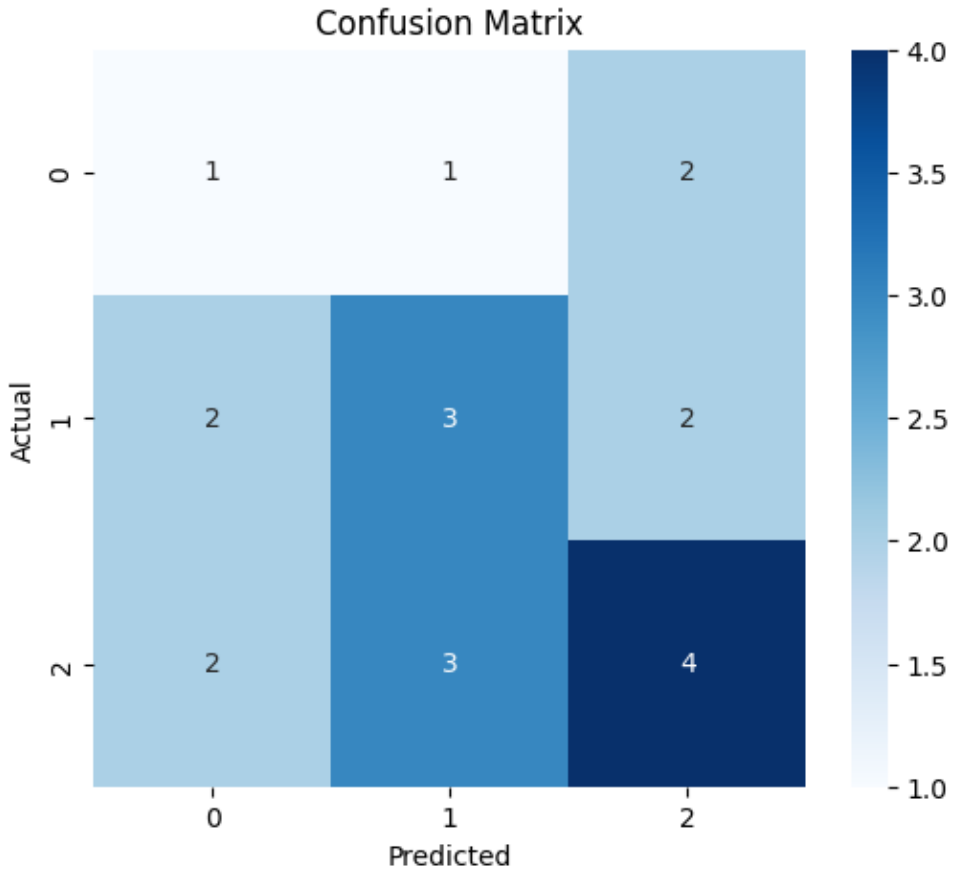
9. Conclusion

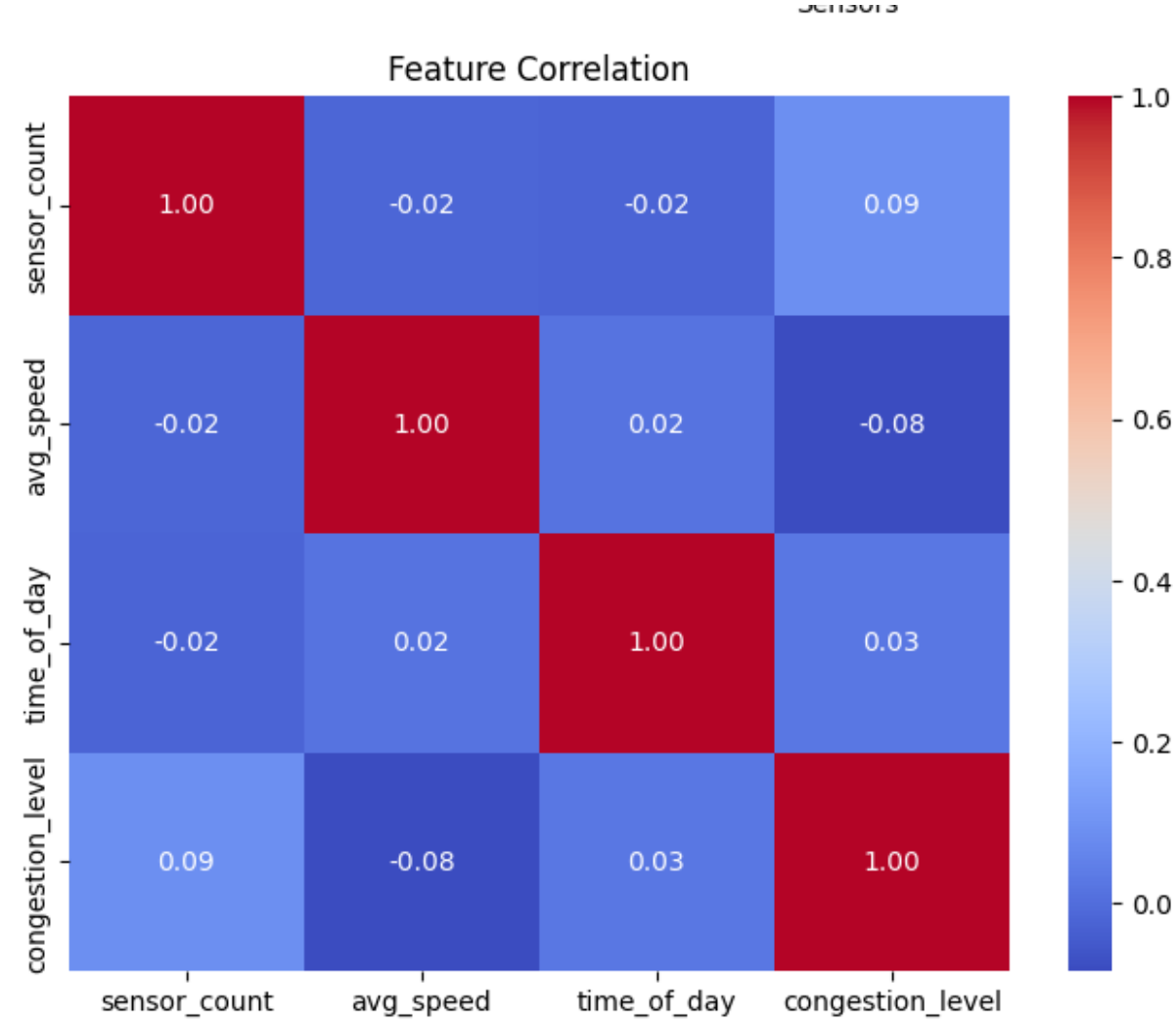
This project successfully implemented an **AI-based congestion prediction system**, demonstrating its potential for **traffic optimization and urban planning**. Future enhancements could incorporate **weather conditions, road construction data, and advanced deep learning models** to further improve accuracy.

10. References

- **scikit-learn documentation** for model implementation.
- **pandas & seaborn** for data preprocessing and visualization.
- Research papers on **smart city traffic analytics**.

	precision	recall	f1-score	support
0	0.20	0.25	0.22	4
1	0.43	0.43	0.43	7
2	0.50	0.44	0.47	9
accuracy			0.40	20
macro avg	0.38	0.37	0.37	20
weighted avg	0.42	0.40	0.41	20



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Accuracy: 40.00%
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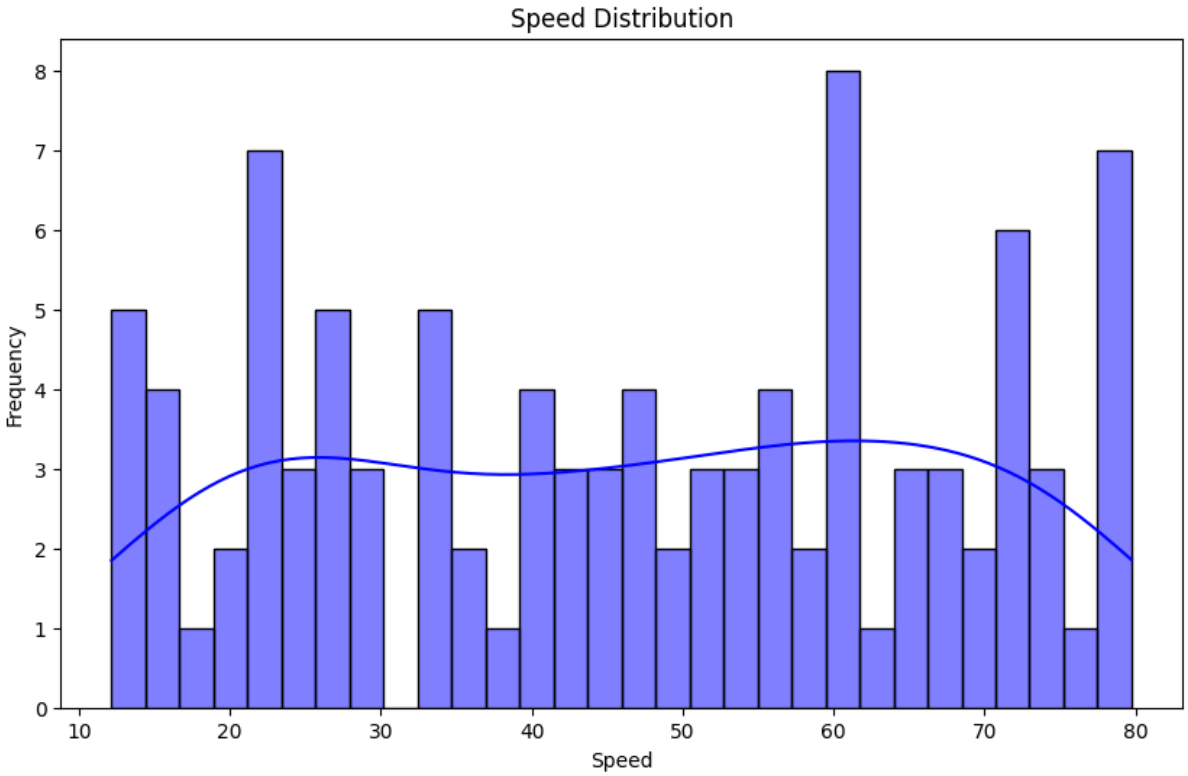
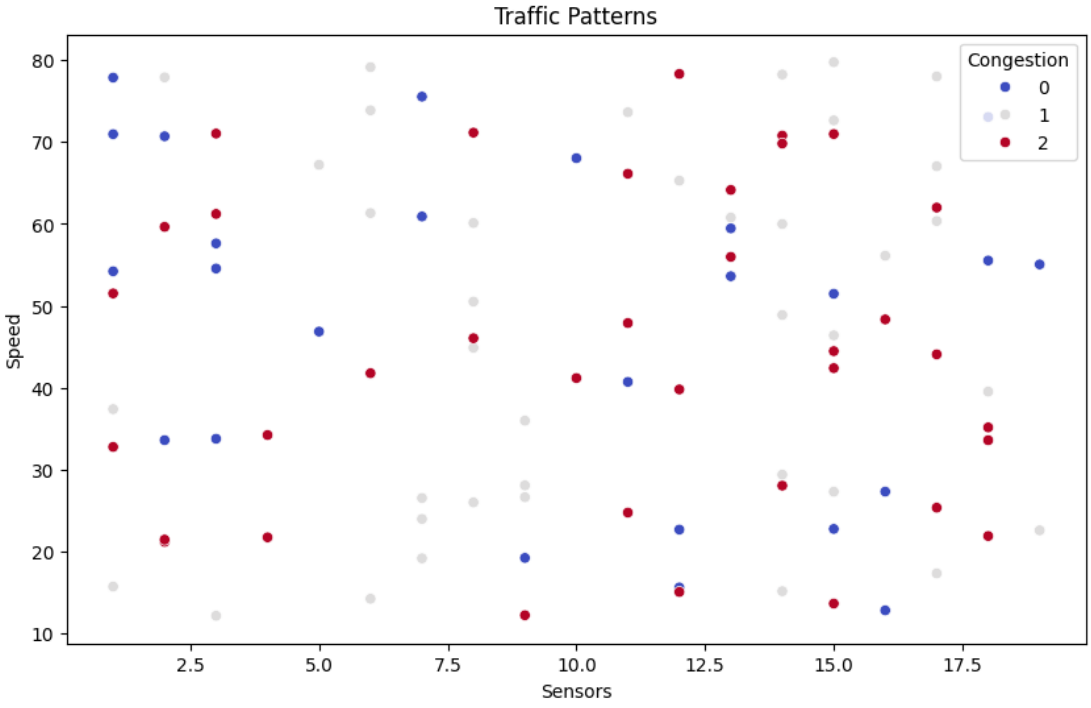

Speed Distribution
Frequency
Speed
0
1
2
3
4
5
6
7
8
10
20
30
40
50
60
70
80


Traffic Patterns
Congestion
0
1
2
Speed
Sensors
10
20
30
40
50
60
70
80
2.5
5.0
7.5
10.0
12.5
15.0
17.5