Department of Computer Science & Information Technology

CT-354 Machine Learning

Complex Computing Activity (CCA) through Problem Based Learning (PBL)

Course Learning Outcome:
CLO 3 (C3): Apply machine learning techniques on given cases.

Complex Computing Activity Attributes:

- **CA-1 Range of resources:** Involves the use of diverse resources.
- **CA-2 Level of interactions:** Requires resolution of significant problems arising from interactions among wide-ranging or conflicting technical, computing, contextual, or other issues.
- **CA-3 Innovation:** Identification of a requirement or the cause of a problem is ill-defined or unknown.
- **CA-4 Consequences to society and the environment:** Has significant consequences in a range of contexts.

Problem Statement:
Urban traffic congestion continues to be a major challenge, leading to increased travel time, fuel consumption, and environmental pollution. There is an urgent need for an AI-powered system that can monitor traffic conditions, predict congestion, and provide meaningful insights to city authorities and commuters.

Problem Description:
Urban traffic congestion is a growing problem due to increasing vehicle density, unplanned road expansions, and unpredictable driving patterns. Traditional traffic monitoring systems rely on static cameras and human analysis, which are inefficient in handling large-scale real-time traffic data. These limitations lead to delays in identifying congestion hotspots, predicting traffic build-ups, and responding to potential roadblocks.

Your task is to design and implement an AI-powered Smart Traffic Monitoring and Congestion Prediction System that utilizes machine learning and real-time data analytics to provide detailed traffic insights. This system should integrate live traffic feeds, historical congestion trends, weather conditions, and road incident reports to forecast congestion levels and improve traffic monitoring.

Assumptions & Constraints:

- You are required to complete the task in your designated groups.
- There are several publicly available datasets which can be utilized; groups should not use the same combination of datasets.
- Traffic data may be noisy, inconsistent, or missing due to various reasons.
- The system can monitor multiple types of vehicles.
- External factors such as weather conditions (rain, fog) and road hazards (accidents, construction) can impact traffic patterns.
- The system must adhere to local traffic laws and regulations when providing recommendations or alerts.
- The system must comply with data privacy regulations, ensuring that sensitive information (e.g., vehicle license plates, personal location data) is anonymized.
- The performance of real-time monitoring depends on network availability.

Deliverables:

- **Python Code Implementation:** ***Construct*** a fully functional AI-based traffic monitoring and prediction system that detects traffic congestion, incidents, and unusual traffic patterns, sends alerts, and recommends alternate route. It should predict potential disruptions due to road hazards, construction, or natural events (including weather conditions). All modules must be included.
- **Visualization:** ***Implement*** a user-friendly map-based interface that visualizes live traffic conditions, congestion levels, and incidents and potential disruptions.

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Complex Computing Activity Assessment Rubrics
CT-354 Machine Learning

Student Name: _____ Student Roll No.: _____

Criteria and Scales		
Satisfactory (2)	**Average (1)**	**Unsatisfactory (0)**
Criterion 1: Use of Diverse Resources: To what extent has the student utilized the resources? **(CA1: *Range of Resources*)**		
Effectively integrates multiple data resources and tools.	Uses multiple resources but lacks full integration of technologies.	Uses a limited set of resources, missing key computational and technological aspects.
Criterion 2: Handling of Technical Issues: To what extent has the student resolved arising from diversity, compatibility, and complexity? **(CA2: *Level of Interactions*)**		
Successfully resolves technical challenges involving large-scale traffic data, ML model training, real-time processing, and multi-source data fusion.	Addresses some interactions between technical and contextual elements but struggles with handling large-scale data or real-time processing.	Fails to address significant technical interactions, leading to incomplete or ineffective system functionality.
Criterion 3: Innovation: To what extent has the student been able to formulate a progressive solution? **(CA3: *Innovation*)**		
Demonstrates novel use of ML, predictive analytics, and automation for intelligent traffic monitoring and congestion management.	Uses computing principles appropriately but lacks originality in applying ML and data-driven approaches.	Minimal application of computing principles, relying on standard methods without creative problem-solving.
Criterion 4: System Usability: To what extent has the student made the solution understandable and beneficial? **(CA2: *Level of Interactions*)**		
System is intuitive, well-structured, and successfully handles high-complexity interactions such as real-time traffic data fusion, anomaly detection, and live updates.	System is functional but has usability issues, such as a non-intuitive interface or inefficient handling of real-time interactions.	System lacks usability considerations, making it difficult to navigate. Poor handling of real-time traffic interactions results in inaccurate or delayed responses.
Criterion 5: Impact of Solution: To what extent has the student rationalized the solution? **(CA4: *Consequences to Society & Environment*)**		
Provides significant benefits in reducing congestion and minimizing environmental impact through smart traffic insights.	Provides significant benefits in reducing congestion and minimizing environmental impact through smart traffic insights.	Provides significant benefits in reducing congestion and minimizing environmental impact through smart traffic insights.

Total Marks: _____/10____

Teacher's Signature: _____