Phase-2

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GitHub Repository Link:https://github.com/cathrine-d/Cathrine-20.git

Enhancing Road Safety through AI driven Traffic Analysis and Prediction

1. Problem Statement

Road traffic accidents cause significant loss of life and property every year. Despite advancements in

transportation infrastructure, the prediction and prevention of accidents remain a challenge due to complex

and dynamic traffic conditions. This project aims to use AI to analyze traffic data and predict accident-prone

scenarios, enabling authorities to implement preventive measures.

- Problem Type: Classification (Accident vs. No Accident) and/or Regression (Severity Prediction)

- Impact: Enhances road safety by enabling proactive interventions, resource allocation, and informed urban planning.

2. Project Objectives

- Build AI models that predict traffic accidents based on real-time and historical data.

- Achieve high accuracy and recall to minimize false negatives.

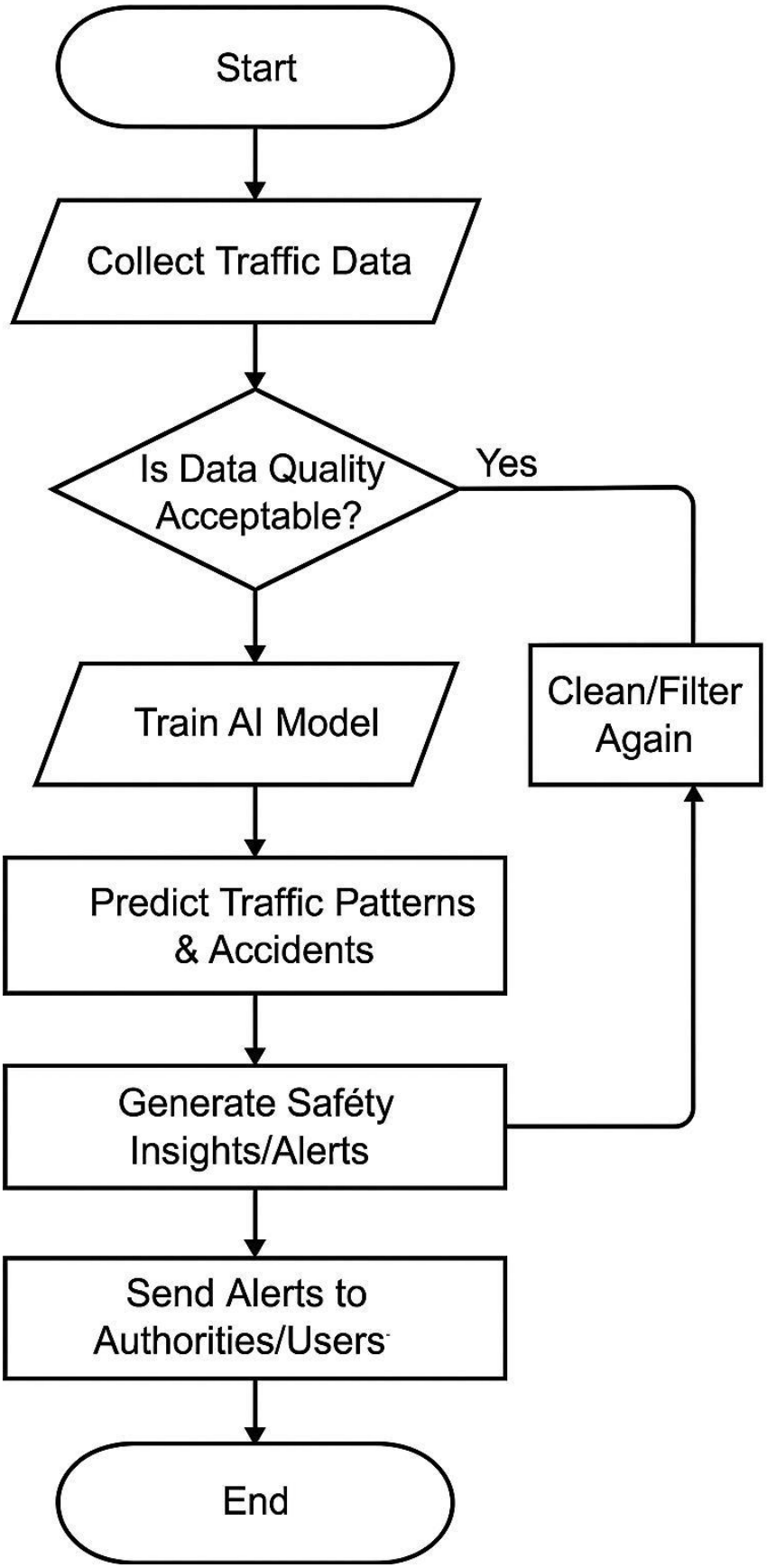
- Provide interpretable insights for authorities to act upon.

- Evolve feature design and modeling based on data exploration outcomes.

3. Flowchart of the Project Workflow

The diagram below represents the workflow of the AI-driven movie recommendation system:

Start → Data Collection → Data Preprocessing → User Profile Building → Model Selection → Model Training → Recommendations Generation → User Feedback Collection → Model Evaluation and Tuning → End (Loop)


Start
Collect Traffic Data
Is Data Quality Acceptable?
Yes
Clean/Filter Again
Train AI Model
Predict Traffic Patterns & Accidents
Generate Saféty Insights/Alerts
Send Alerts to Authorities/Users
End

4. Data Description

- Dataset Name: Road Traffic Accidents Dataset

- Source: Kaggle / Open Government API / UCI

- Type: Structured, Time-Series

- Size: ~200,000 records, 25+ features

- Static/Dynamic: Dynamic

- Target Variable: Accident Occurrence / Severity

5. Data Preprocessing

1.Data Collection

Sources: CCTV footage, traffic sensors, GPS data, social media feeds, weather reports, and traffic apps.

Formats: Images, video, tabular logs, JSON, etc.

2. Data Cleaning

Removing Noise: Eliminate irrelevant or redundant data (e.g., blurry images, corrupted GPS points).

Handling Missing Values: Imputation (mean/mode), removal, or interpolation.

Outlier Detection: Identifying anomalies in speed, volume, or travel time data.

3. Data Integration

Combining Multiple Sources: Merging GPS, sensor, and weather data for a unified view.

Synchronization: Aligning data based on time stamps and location.

4. Data Transformation

Normalization/Scaling: Bringing data into a standard range for machine learning models.

Encoding Categorical Variables: Converting data like road types or weather conditions into numerical format.

5.Data Annotation (for AI models)

Manual or Semi-Automated Labeling: For tasks like object detection in videos (e.g., vehicles, pedestrians).

Labeling Events: Accidents, congestion, or rule violations.

6. Exploratory Data Analysis (EDA)

1. Data Overview

Dimensions: Number of records and features (e.g., time, vehicle count, speed, location)

Data Types: Numerical (speed), categorical (road type), temporal (timestamp)

Missing Values: Identify and visualize missing or null values

->Unvariate analysis is

Histograms & Boxplots: Vehicle speed, traffic volume, accident frequency

Distribution Checks: Normality and skewness of features

->**Bivariate Analysis**

Scatter Plots: Speed vs. accident count

Correlation Matrix: Identify relationships between variables (e.g., congestion vs. weather)

->Time Series Analysis

Traffic Trends: Daily, weekly, and seasonal traffic patterns

Peak Hours: Time-of-day analysis for congestion

->Geospatial Analysis

Traffic Hotspots: Map visualizations of high-accident or high-congestion zones

GPS Data Clustering: Identify patterns in vehicle movement

->Outlier Detection

Visual & Statistical Methods: Z-score, IQR, boxplots for spotting anomalies

7. Feature Engineering

Creating New Features: Time of day, day of the week, average vehicle speed, congestion index.

Dimensionality Reduction: PCA or t-SNE for handling high-dimensional datasets.

8.Model Building

1. Define the Problem

Types:

1. Classification: Accident vs. non-accident

2.Regression: Predict vehicle count, speed, or delay

3.Time Series Forecasting: Predict future traffic flow

Clustering: Group similar traffic patterns (e.g., using GPS data)

2.Data Preparation

Train-Test Split: Usually 70/30 or 80/20

Cross-Validation: Ensures model generalization

Feature Selection: Choose relevant features using correlation, importance scores

2. Model Selection

Traditional ML Algorithms:

Linear Regression

Decision Trees / Random Forest

Support Vector Machines (SVM)

K-Means / DBSCAN (for clustering)

Deep Learning Models:

CNNs (for video/image data)

RNNs / LSTM (for time series traffic data)

Autoencoders (for anomaly detection)

4. Model Training

Input: Cleaned and structured dataset
Tools: Scikit-learn, TensorFlow, PyTorch, Keras
Hyperparameter Tuning: Grid search, Random search

5. Model Evaluation

Metrics:

Accuracy, Precision, Recall (classification)

MAE, RMSE (regression)

F1 Score, AUC-ROC

Visualization: Confusion matrix, prediction plots

6. Model Optimization

Techniques:

Feature scaling

Regularization

Ensemble methods (e.g., XGBoost, Bagging)

9. Visualization of Results and Model Insights

Model Performance:

Confusion matrix, accuracy, MAE/RMSE, ROC curve.

Feature Importance:

Bar charts, SHAP/LIME for explainability.

Trend Analysis:

Line plots for traffic flow, anomaly detection.

Geospatial Maps:

Heatmaps for accident/congestion zones.

Cluster & Dimensionality Visuals:

K-Means clusters, PCA/t-SNE plots.

Dashboards:

Real-time traffic, predictions, filters using Tableau/Power BI.

10. Tools and Technologies Used

1. Machine Learning & Deep Learning

ML: Random Forest, SVM, XGBoost

DL: CNNs (for images), LSTM/RNN (for time series)

2. Data Processing & Analysis

Libraries: Pandas, NumPy, Scikit-learn

EDA & Visualization: Matplotlib, Seaborn, Plotly

3. Geospatial Analysis

Tools: QGIS, Folium, GeoPandas

Techniques: Heatmaps, GPS clustering

4. Time-Series Forecasting

Techniques: ARIMA, Prophet, LSTM

Use: Predict future traffic volume, speed

5. Big Data & Real-time Processing

Tools: Apache Spark, Kafka, Hadoop

6. Deployment & Dashboarding

Tools: Flask, Dash, Tableau, Power B

Team members:

Cathrine rejina mary.J-*data preprocessing,model training*

Aswini.K- deployment

Bakkiyalakshmi.P-EDA

Gowri.J-report preparation