Enhancing Road Safety with AI-Driven Traffic Accident Analysis and Prediction

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# 1. Problem Statement

Road traffic accidents remain a major cause of injury and death worldwide. Traditional approaches to road safety rely on reactive measures rather than proactive prediction and prevention. With increasing urbanization and vehicle usage, there is a pressing need to predict high-risk scenarios and accident-prone zones using AI and data analytics.  
  
This project addresses the problem of predicting road accidents using machine learning, enabling authorities to take timely preventive actions. The problem is primarily a classification and regression problem—classifying accident severity and predicting accident likelihood based on historical and real-time data.

# 2. Project Objectives

- Predict Accident Risk: Develop AI models to predict the probability and severity of traffic accidents.  
- Identify High-Risk Zones: Use geospatial data to locate accident hotspots.  
- Improve Road Safety: Provide insights for urban planners and traffic authorities to implement preventive strategies.  
- Real-Time Monitoring: Enable predictive analytics using live weather, traffic, and time data.  
- Evaluate Model Performance: Measure and optimize model performance using real-world accident data.

# 3. Flowchart of the Project Workflow

1. Data Collection – Gather data from sources like open government accident datasets, weather APIs, and traffic sensors.  
2. Data Preprocessing – Clean and normalize data, handle missing values, encode categorical features.  
3. Exploratory Data Analysis (EDA) – Visualize trends across time, weather, and location.  
4. Feature Engineering – Create features like time of day, weather severity, traffic volume, and road type.  
5. Model Development – Train classification/regression models for accident prediction.  
6. Model Evaluation – Use metrics like accuracy, F1-score, and MAE to assess performance.  
7. Deployment (Optional) – Simulate or integrate with traffic management systems.

# 4. Data Description

- Source: Open datasets from government portals (e.g., UK Road Safety, Kaggle, US DOT), weather APIs.  
- Type: Structured tabular data.  
- Records & Features: ~100,000+ records; features include time, location, weather, vehicle type, etc.  
- Target Variable: Accident severity (e.g., minor, major, fatal).  
- Static/Dynamic: Static historical data with potential for real-time extension.

# 5. Data Preprocessing

- Remove duplicate and inconsistent entries.  
- Impute or remove missing values (e.g., unknown weather).  
- Encode categorical variables like road type and weather condition.  
- Normalize features such as traffic volume and temperature.  
- Detect and handle outliers (e.g., unusually high speeds).

# 6. Exploratory Data Analysis (EDA)

- Univariate Analysis: Frequency of accidents by hour, day, road condition.  
- Bivariate Analysis: Heatmaps showing correlation between accident severity and features.  
- Spatial Analysis: Identify hotspots using geolocation clustering.  
- Temporal Patterns: Accident trends by month, weekday, and rush hour.  
- Insights: Rain and night conditions are highly correlated with severe accidents.

# 7. Feature Engineering

- Time-based features: hour of day, day of week.  
- Weather severity index.  
- Traffic density categories.  
- Distance to nearest hospital or junction.  
- PCA for dimensionality reduction (if needed).

# 8. Model Building

- Models Used: Random Forest, XGBoost (classification), Linear Regression (severity score).  
- Data split: 80% train, 20% test (stratified sampling).  
- Metrics:  
 - Classification: Accuracy, Precision, Recall, F1-Score.  
 - Regression (optional): MAE, RMSE.  
- Hyperparameter tuning using GridSearchCV.

# 9. Visualization of Results & Model Insights

- Confusion Matrix – Visualize classification performance.  
- Feature Importance – Understand key predictors of accidents.  
- Accident Hotspot Map – Interactive map showing dangerous zones.  
- Temporal Graphs – Line/bar plots of accident frequency over time.

# 10. Tools and Technologies Used

* **Languages:** Python
* **Libraries:** pandas, scikit-learn, matplotlib, seaborn, XGBoost, folium (for maps)
* **IDE:** Jupyter Notebook / Google Colab
* **Visualization:** Plotly, Tableau (optional)
* **Data Sources:** Kaggle datasets, government APIs, weather data APIs

# 11. Team Members and Contributions

Data Cleaning , EDA : **Sahana A**

Feature Engineering : **Shanmugapriya S**

Model Development: **Sindhumathi E**

Documentation & Reporting: **Sahana A**