**Concept Paper on Weather Impact on Accident severity**

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**Introduction:**

In congested cities like New York, car accidents threaten public safety. Snow, fog, rain, and ice affect accident severity. Weather lowers visibility, road grip, and driver response times, increasing crash risk (Ahmed & Ghasemzadeh, 2020). The Motor Vehicle Collisions - Crashes dataset is being used to study how weather affects New York City motor vehicle accidents (Data.gov, n.d.). Location, weather, and time of day predict accident severity from the dataset. This research helps municipal planners and traffic managers reduce weather-related incidents and improve road safety (Pisano, Goodwin, & Rossetti, 2008).

**Problem Statement:**

Many extrinsic factors affect urban motor vehicle accidents, but weather is key. Despite enhanced road safety infrastructure and traffic management systems, major accidents still occur, especially in severe weather. Traffic authorities can reduce accidents by issuing timely weather advisories or enhancing road infrastructure (Tefft, 2016).

**Hypotheses:**

**H1:** Serious accidents (injury or death) are far more likely in bad weather than in clear weather.

**H2:** Incidents during rush hours and bad weather tend to have worse repercussions.

**H3:** Intense rain or snowfall worsens accidents more than milder weather.

**H4:** Unfavourable weather and driving activities like speeding or distraction raise catastrophic accident risk (Singh, 2015).

**Data Source:**

The **NYCDOT and NYPD's Motor Vehicle Collisions - Crashes** dataset from Data.gov was used for this investigation. This dataset provides detailed insights into 1.4 million New York City motor vehicle incidents for trend research.

**No. of Observations:** The collection is updated and comprises 1.4 million recordings from 2016 to the present.

**Variables:** 29 independent variables provide crucial information, including:

1. **Weather Conditions:** Clarity, precipitation, snowfall, fog, and other elements during the incident.
2. **Crash Severity:** The severity of each crash, including injuries and deaths.
3. **Time and Date:** Detailed time and date marks for each incidence allow study across different times of day, weeks, and seasons.
4. **Location:** Geographic coordinates (latitude and longitude), borough, and street junctions of occurrences, allowing spatial analysis of high-risk regions.
5. **Contributing Factors:** Driving inattention, speed, intoxication, and road conditions may have caused the collision (National Highway Traffic Safety Administration, 2020).

**Research Questions:**

We have developed 10 research questions as a team of five to do research on.

1. How do rain, snow, fog, and other tough weather conditions affect New York City motor vehicle accidents?
2. How do rush hour and bad weather affect motor vehicle accidents?
3. How does weather affect accident severity in New York City, and which boroughs and crossings are more at risk?
4. Can machine learning models predict motor vehicle accident intensity by assessing weather, geography, time of day, and driver actions?
5. How does weather affect truck, car, and bicycle accidents? Are some vehicles more likely to have catastrophic accidents in bad weather?
6. How much do speeding, inattentive driving, and alcohol intake, together with bad weather, affect New York City motor vehicle accidents?
7. How do seasonal weather patterns like winter storms or severe summer rains affect the severity of motor vehicle accidents in New York City? Are some weather conditions riskier for driving?
8. How does the severity of weather-related accidents affect emergency service response times and efficiency, and do poor weather conditions delay or worsen accident outcomes?
9. Does bad weather affect the incidence and severity of multi-vehicle incidents, and do chain-reaction accidents occur more often?
10. Can road infrastructure upgrades like traffic lights and road design reduce motor vehicle accidents in inclement weather, and which ones work best?

**Potential Issues and Concerns:**

1. **Data Quality:** Weather and accident records may be incomplete. For accurate analysis, data cleaning and preprocessing are essential.
2. **Imbalanced Data:** Accidents may cause more property damage than significant injuries or deaths. Building exact models may require data resampling, either oversampling or undersampling.
3. **Model Interpretability:** Although sophisticated machine learning models might improve prediction accuracy, policymakers and traffic authorities must ensure that these models are intelligible to gain useful information.

**Analytical Approach:**

This method will look at how weather affects the gravity of an accident:

1. **Exploratory Data Analysis (EDA)**: EDA will give patterns and correlations between bad weather and accident severity. Summary statistics, histograms, scatter plots, heatmaps, and geospatial analysis will show where accidents are most likely to happen in New York City.
2. **Feature Engineering:** We will add variables for heavy rain vs. light rain, rush hour vs. non-rush hour, and weather-contributing factor relationships to make the dataset better.
3. **Machine Learning Models:**

**Logistic Regression:** Using weather and other data, Logistic Regression is a new way to predict crashes that end in death.

**Random Forest:** The Random Forest Classifier is a strong classification method which shows complicated links between weather conditions and accident intensity.

**Gradient Boosting:** We focus on Gradient Boosting to fix cases that were wrongly labeled and make our model better at handling complex interactions.

1. **Model Evaluation:** We look at the F1 score, recall, accuracy, and precision. Cross-validation makes model extension certain, as we've found.
2. **Visualization and Geographic Analysis:** Spatial heatmaps and accident intensity maps show places where there is a high chance of bad weather. Time-series analysis will be used to look into patterns in accidents, especially when it comes to the weather.

**Expected Results:**

This study looks at how bad motor vehicle accidents are based on weather, area, and time of day. Our police and community leaders can use this information to make roads safer when it rains or snows. Timely weather alerts, better emergency reactions, and better transport infrastructure could have a huge effect on places that are dangerous. Data are used in New York City's traffic and safety plans to stop accidents caused by bad weather.

**References**

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