Analyzing US Accident Patterns through Advanced Visual Analytics

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1. Abstract

This project leverages the U.S. Accidents dataset to analyse and visualize trends in vehicular accidents across the United States. By focusing on factors such as accident location, severity, weather conditions, and time of day, this study aims to uncover key insights that can inform public safety strategies and urban planning efforts. Our visualizations will illustrate geographic accident distributions, the influence of environmental conditions, and other contributing factors. This project ultimately transforms complex accident data into accessible visuals, empowering policymakers, safety stakeholders, and the public to better understand and address the factors behind road accidents, supporting efforts to reduce their frequency and severity

2. Introduction

Roads are an integral part of our daily lives, serving as the backbone of travel and commerce across the United States. According to the Federal Highway Administration, the U.S. has over 4 million miles of public roads, supporting nearly 275 million vehicles daily [1]. This extensive network connects people to workplaces, schools, healthcare, and recreation, making it an essential element of modern life. However, this reliance on roads also brings significant risks. The National Highway Traffic Safety Administration reported over 42,000 fatalities and 4.8 million medically consulted injuries due to motor vehicle crashes in 2021 alone [2]. Even minor incidents on the road can disrupt daily routines, cause economic losses, and impact individual well-being. Understanding and addressing the factors contributing to these incidents is essential for ensuring safer travel for everyone.

The motivation behind this project stems from a fundamental need to understand the sheer diversity in factors influencing and the patterns hidden in road safety across the U.S. Each state, with its unique combination of geography, climate, and infrastructure, experiences distinct challenges. States in the northern regions has different challenges compared to the whereas southern states. The traffic complexity in the Urban areas and rural areas have extreme variations. These variations underline the importance of localized insights to design tailored safety interventions that address specific regional needs.

Moreover, road safety is not governed by a single factor but by the intricate interplay of various elements such as weather, time, and infrastructure conditions. Accidents during peak commuting hours highlight the risks of congestion and driver fatigue, while adverse weather conditions like snow, fog, or rain amplify the likelihood of collisions. Infrastructure elements, including road surface quality, lighting, and signage, further complicate these interactions. Analysing these multifaceted dynamics is critical to identifying actionable insights and reducing accidents effectively. A generalized approach to road safety overlooks these nuances, resulting in interventions that may not address the root causes of incidents

The project goal is to uncover various patterns by creating insightful visualizations of data. Using the comprehensive U.S. Accidents dataset [3], which contains over 7.7 million records spanning multiple years, we thoughtfully designed various visualizations to highlight critical aspects and identify underlying problems. The dataset includes detailed attributes such as accident severity, timestamps, weather conditions, location-specific factors, and infrastructure elements like nearby traffic signals and junctions. These visualizations aim to convey actionable insights that can assist officials in proposing targeted solutions to improve road safety. Ultimately, this effort seeks to reduce accidents and save lives by addressing key risk factors and promoting data-driven decision-making.

2.1 Existing works

The existing work about this project has produced few visualizations that contribute to our understanding of the hidden details in accident patterns across the United States.

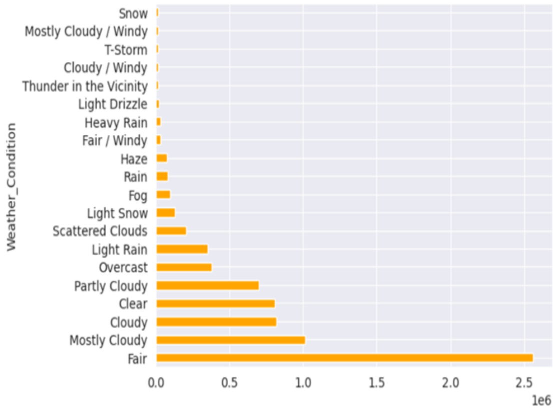

Fig 1. Weather conditions vs Accident

This bar chart in Fig 1 provides a ranking of weather conditions based on accident frequency, highlighting that "Fair" and "Mostly Cloudy" conditions are the most prevalent during accidents. While the chart is simple and easy to understand, the high frequency of these conditions is likely due to their overall occurrence rather than an increased accident risk. However, visualization does not account for accident severity, limiting its usefulness in identifying hazardous weather conditions. Incorporating elements such as severity levels through color-coding or a stacked bar format could enhance the chart by offering more actionable insights into the risks associated with different weather conditions.

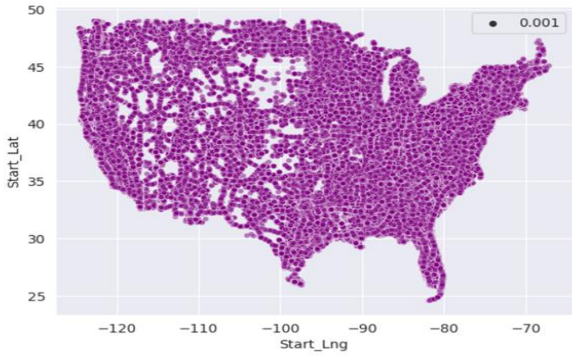

Fig 2. Accident Location density Map

The current scatter plot map provides a clear overview of accident locations across the U.S., effectively illustrating how incidents are distributed geographically. By mapping each accident as a point, the visualization highlights areas of higher density, such as urban centers and major highways. However, the uniform representation of all accidents limits the ability to distinguish variations in frequency and severity. In regions with high accident density, significant overlaps make it challenging to uncover patterns or focus on critical zones requiring intervention.

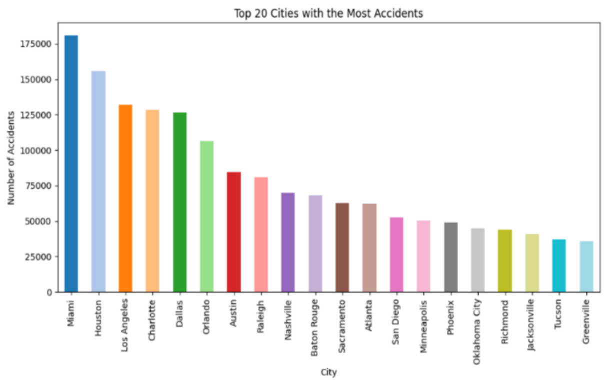

Fig 3. Top 20 cities with most accidents

This visualization in Fig 3 lists the Top 20 U.S. cities with the highest number of accidents. It provides a clear comparison of accident frequencies in these cities, drawing attention to urban centres like Miami and Houston. However, the chart could be enhanced by normalizing the accident count by population size, providing a fairer comparison. Additionally, displaying accident severity as a secondary attribute, either through colour or an overlay, would offer insights into whether these cities also experience more severe accidents.

These visualizations create basic understanding of the existing analytical work providing a significant flow on how to build new visualizations and what ways to think about.

2.2 Contributions

The contributions of this project are intended to un-cover accident patterns and help official to make decisions to improve traffic safety measures. Before exploring into various contributions we could make, we would like to enhance the existing visualizations and make them more useful for decision making. Fig 3 represents the modified representation of the initial visualization in Fig 1.

This improved visualization addresses the shortcomings of the original by incorporating accident severity through a stacked bar chart. It focuses on the top 10 weather conditions, offering a more concise and relevant analysis while avoiding less impactful data.

Similarly, we could also enhance the effectiveness of understanding data from other previously existing visualizations in Fig 2 the density map by converting it into a improved scatter plot addressing the clutter in the original visualization by incorporating transparency, making it easier to identify patterns in densely populated accident areas. A color gradient is added to represent accident severity, differentiating severity levels with a spectrum of colors.

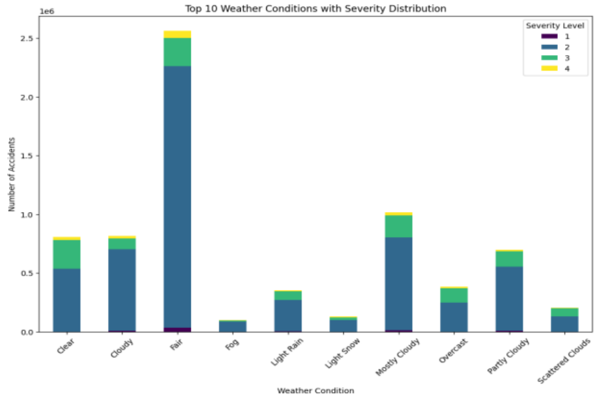

Fig 3 Top 10 Weather conditions

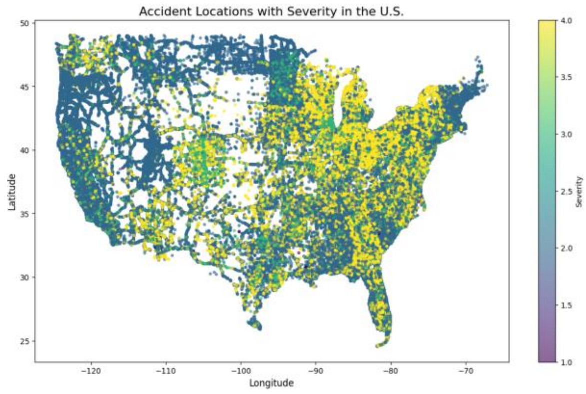

Fig 4: Accident Locations with Severity

This enhancement show in Fig 4 provides dual insights into accident density and criticality, helping prioritize high-severity zones for targeted safety measures.

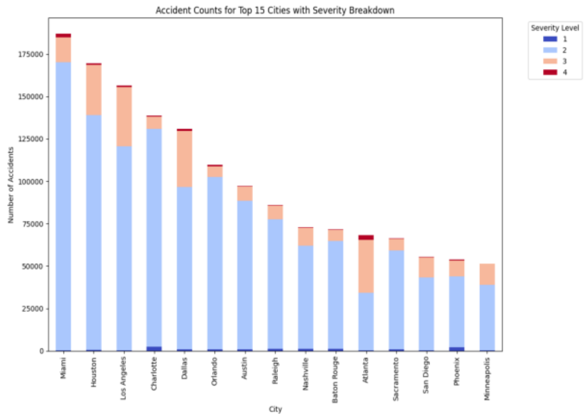

Fig 5: Accident Counts for top 12 cities with severity breakdown

This stacked chart enhances the visualization in Fig 3 by displaying accident counts for the top 15 cities, categorized by severity levels. Miami, Houston, and Los Angeles lead in total accident counts, with most incidents falling under moderate severity (level 2). The inclusion of severity breakdown highlights the variation in risk levels across cities. This detailed view enables better-targeted safety measures in high-risk urban areas.

The following are the contributions achieved through in-depth analysis of the U.S. accident data:

Showing the relation between weather & accidents

By analysing the dataset, we intend to identify correlations between weather conditions, such as rain, fog, or snow, and accident frequencies. Understanding these relationships helps prioritize weather-specific safety protocols and infrastructure improvements, such as better drainage systems or visibility enhancements

Performing spatial analysis to identify accident densities and locations

Geospatial heatmaps and interactive maps will be created to highlight high-density and various severity level accident areas. These visualizations assist policymakers in identifying urban hotspots or rural risk zones, enabling targeted safety measures such as redesigning traffic flow or enhancing road conditions.

Providing state-wise accident risk and solvability analysis metrics.

State-level analyses reveal unique challenges, such as icy roads in northern states or heavy rainfall in southern regions. Tailored strategies derived from these insights support localized safety measures and resource allocation to reduce risks.

Performing temporal analysis to identify trends and patterns of accidents

Temporal analysis uncovered patterns related to peak commuting hours, weekends, or seasonal fluctuations. Such insights help in scheduling traffic enforcement, improving lighting during critical hours, or launching awareness campaigns for high-risk periods.

Highlighting infrastructural inadequacies of various regions and states

Our analysis spotlighted deficiencies such as poor road quality, inadequate signage, or insufficient traffic calming signs in specific regions. Addressing these issues through better infrastructure planning can significantly reduce accidents.

Providing insights about emergency response and traffic management situations

Data on response times and traffic management highlighted gaps in emergency services and availability of amenities at accident sight. Optimizing these systems ensures faster responses to accidents, thereby reducing fatalities and injuries.

Providing correlation analysis between different sectors of metrics

Correlation analysis revealed relationships between factors such as infrastructure quality, accident severity, and weather conditions. These findings help in holistic planning and creating multifaceted safety solutions.

Uncovering insights about the sentiments during and after accidents

Sentiment analysis of accident descriptions and public reactions provided a deeper understanding of psychological impacts and societal concerns. These insights can shape public awareness campaigns and improve post-accident support systems.

3. <u>Data and Methods</u>

3.1 Ideas, Sketches and Prototypes

<u>Core Ideas</u>

The Core Idea of this project is to analyse and visualize accident data to uncover actionable insights. By leveraging the U.S. Accidents dataset, we aim to identify patterns and propose solutions for reducing accidents. The core ideas include:

1. Identifying accident hotspots and their contributing factors.
2. Establishing correlations between accidents and external influences like weather, time, and road infrastructure.
3. Designing user-friendly visualizations to communicate findings effectively.

<u>Sketches and Prototypes</u>

1. **Geospatial Heatmap of Accident Density**

Idea: Visualize accident density across regions to identify high-risk areas.

Prototype: An interactive geographical heatmap with gradients indicating accident density. Users can zoom in & out over regions to view detailed metrics.

Design: The map uses intuitive colour coding to highlight urban hotspots and rural risk zones. Layers can be toggled to focus on specific states or metropolitan areas.

Impact: Helps policymakers allocate resources to high-density regions and design targeted safety interventions.

E.g.: The Heat Visualization:

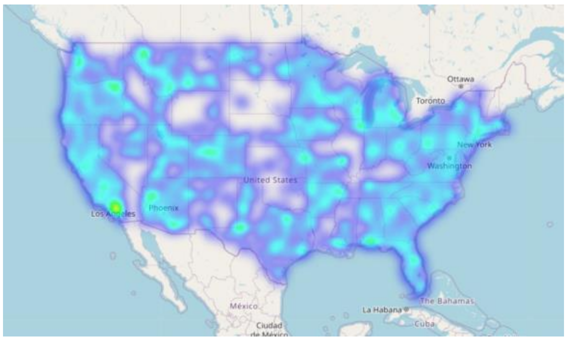

Fig 6. Interactive Heat Map of accident density

This heatmap visualizes accident density across the United States, with brighter regions indicating higher concentrations of incidents.

2. **Temporal Accident Trends**

Idea: Showcase how accidents vary over time (daily, monthly, and yearly).

Prototype: Line graphs and bar charts illustrating accident frequencies during peak hours, seasons, or specific days.

Design: Charts include annotations for significant spikes, such as holiday seasons or extreme weather events.

Impact: Enables traffic management teams to implement strategies during high-risk periods, such as adjusting signal timings or deploying traffic officers.

E.g.: Bar chat visualization of frequency of accidents over hours of a day.

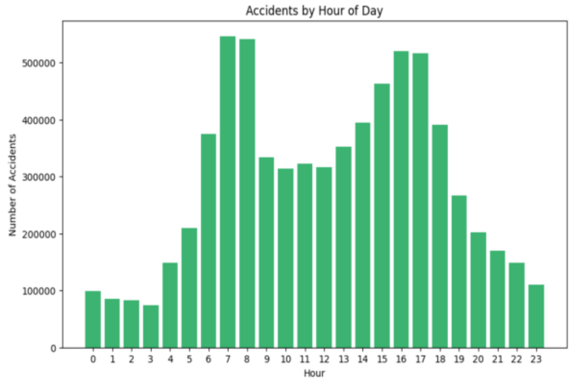

Fig 7. Accident by Hour of Day

This bar chart shows the distribution of accidents by hour of the day, with peaks during morning rush hours (7–9 AM) and evening rush hours (4–6 PM). These spikes correspond to high traffic volumes during commuting periods, potentially influenced by driver fatigue or distractions.

In contrast, accidents are significantly lower during late-night and early-morning hours (11 PM–4 AM) due to reduced road usage. These patterns suggest prioritizing safety measures during peak traffic hours.

3. Weather vs. Accident Frequency

Idea: Relate accident frequencies, severity with weather conditions like rain, snow, fog.

Prototype: A violin chat or correlation plot showing accident distribution across different weather conditions.

Design: Colour difference and legends ensure easy interpretation, while severity breakdowns highlight critical conditions needing intervention.

Impact: Guides infrastructure improvements, such as enhanced drainage systems or better signage for foggy conditions.

E.g.: This violin plot visualizes the distribution of accident severity across various weather conditions.

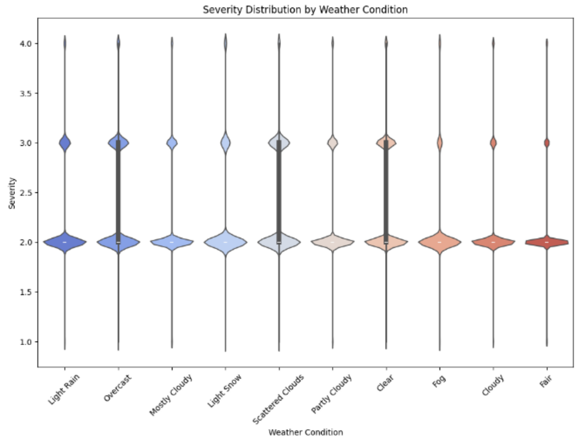

Fig 8. Violin plot based of Severity Distribution.

Most weather conditions, such as "Fair" and "Partly Cloudy," show a concentration of accidents around severity level 2, indicating that most accidents under these conditions are less severe. However, "Scattered Clouds" and "Overcast" stand out with a relatively higher percentage of accidents at severity level 3, suggesting that these conditions may lead to more moderate to severe accidents compared to others. We could also link Fig 1 for this metric both represent the similar idea but on different visualization technique.

4. State-wise Accident Metrics visualizations

Idea: Provide a comparative analysis of accident metrics across states.

Prototype: A base level visualizations like bar charts to show severity levels of accidents across various states

Design: Users can fix data by state or metric (e.g., severity, time to response).

Impact: Facilitates state-level policy planning and resource distribution.

E.g.: Average Accident severity map per each state.

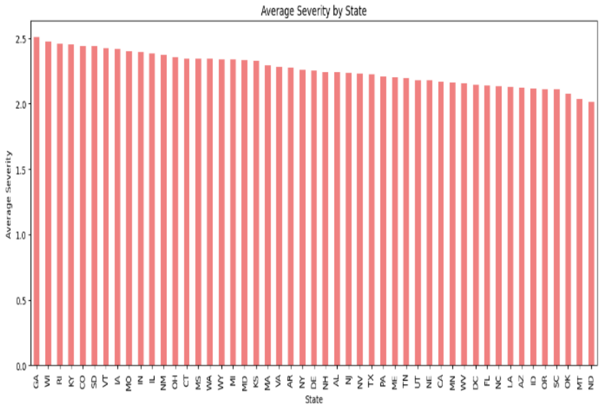

Fig 9 Accident Sevirity by state

This visualization presents the average accident severity by state, allowing for a comparative analysis of how severe accidents tend to be across different regions. States like Georgia and Wisconsin show the highest average severity scores, indicating that accidents in these states are generally more serious.

5. Emergency Response and Infrastructure Analysis

Idea: Analyse gaps in response times and infrastructure adequacy.

Prototype: A heatmap showing accident frequency due to road infrastructure and a scatterplot correlating infrastructure quality with accident rates.

Design: Visualizations talks about infrastructure scores, other visualizations in the project also shows the emergency response time

Impact: Encourages investments in infrastructure and optimizes emergency response systems.

E.g.: Vertical Heat map visualization.

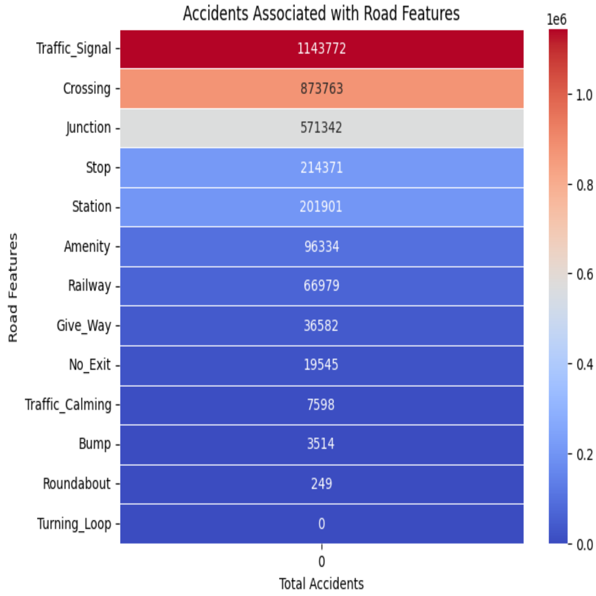

Fig 10 Accidents Associated with Road Features.

This visualization highlights the total number of accidents associated with various road features. Traffic signals account for the highest number of accidents, followed by crossings and junctions, reflecting areas where vehicle and pedestrian interactions are frequent. Features like roundabouts, bumps, and turning loops contribute to significantly fewer accidents, indicating their limited presence or better management in road designs. This analysis emphasizes the need for improved safety measures, particularly at high-risk locations like traffic signals, crossings, and junctions, to mitigate accident occurrences.

Each visualization is designed to provide clarity and actionable insights, ensuring stakeholders can address specific road safety challenges effectively.

3.2 Visualization Method Selection

Candidate Methods

The selection of visualization methods was guided by the need to communicate data insights effectively to stakeholders. Candidate methods included:

1. **Geospatial Heatmaps**

Pros: Provide an intuitive understanding of accident density and location-specific risks. Suitable for identifying hotspots.

Cons: Limited in showing temporal or categorical variations.

Why Selected: Highly effective for spatial analysis to identify regions requiring immediate attention.

2. **Bar Charts and Line Graphs**

Pros: Clear representation of trends over time and categorical comparisons.

Cons: Not ideal for showing multi-dimensional data.

Why Selected: Best suited for temporal trends and highlighting specific time-based patterns.

3. **Stacked Bar Charts**

Pros: Illustrate breakdowns, such as severity levels within weather conditions, effectively.

Cons: Can become cluttered with too many categories.

Why Selected: Ideal for combining categorical and quantitative insights in weather-related analysis.

4. **Word Clouds**

Pros: Effective for visualizing the frequency of key terms in textual data, such as accident descriptions or sentiment analysis.

Cons: Limited in showing quantitative or multi-dimensional data.

Why Selected: Ideal for summarizing and conveying textual data insights in a visually appealing way.

5. **Histograms**

Pros: Useful for displaying the distribution of numerical variables, such as response times or sentiment rating.

Cons: Not effective for comparing multiple categories or dimensions simultaneously.

Why Selected: Perfect for understanding distributions and identifying patterns in numerical data.

6. **Scatterplots and Correlation Heatmaps**

Pros: Excellent for showing relationships and correlations between variables.

Cons: May require explanation for non-technical audiences.

Why Selected: Useful for analysing emergency response efficiency and infrastructure impact on accidents.

By carefully selecting and combining these methods, the visualizations address specific research questions and stakeholder needs effectively.

4. Results

In this section we would like to represent all the possible analysis that was done on this project and express how each visualization gives intuition to make data driven decisions.

Let's initially start with obtaining base level knowledge and later continue to various temporal and spatial analysis.

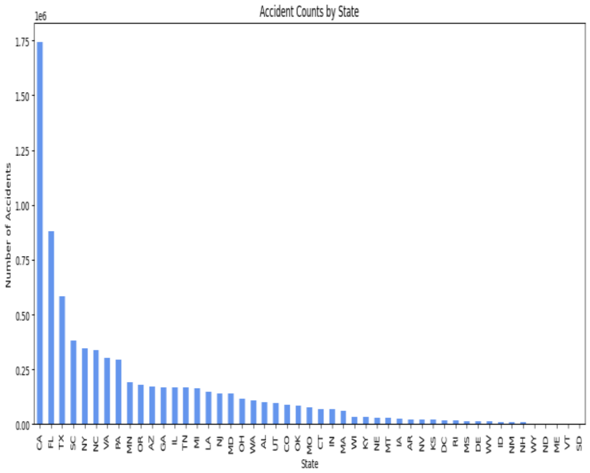

Fig 11. Accident count by state

The bar chart in Fig 11 shows the distribution of accident counts by states, highlighting the states with the highest number of reported incidents. California, Florida, and Texas lead with the highest accident frequencies, likely due to their large populations, extensive road networks, and heavy traffic. The steep drop-off in counts for other states emphasizes a significant disparity in accident occurrences. These trends suggest that high-traffic states may require more targeted safety measures to address their elevated accident rates.

This bar chart in Fig 12 depicts the distribution of accidents by severity level, showing that most accidents are classified as severity level 2, followed by level 3. Levels 1 and 4 account for a much smaller proportion of accidents.

This suggests that while most accidents are moderate in impact, severe accidents (level 4) are relatively rare. These insights emphasize the importance of targeting moderate-severity accidents to improve overall road safety.

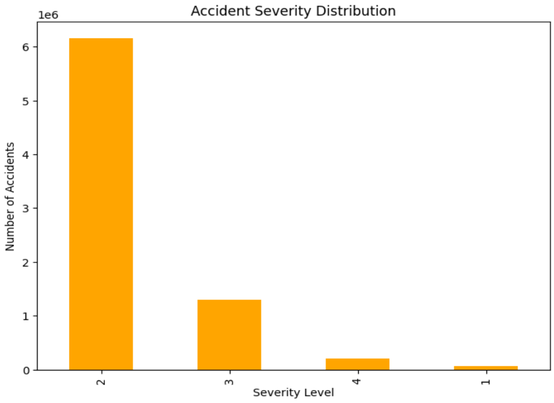

Fig 12 Accident Severity Distribution

Now, let's dive into temporal analysis to see how things change over time. This type of analysis helps us uncover trends, patterns, and seasonal shifts that might not be obvious at first glance. By understanding how the data evolves, we can gain valuable insights to make smarter, time-sensitive decisions.

Temporal Analysis:

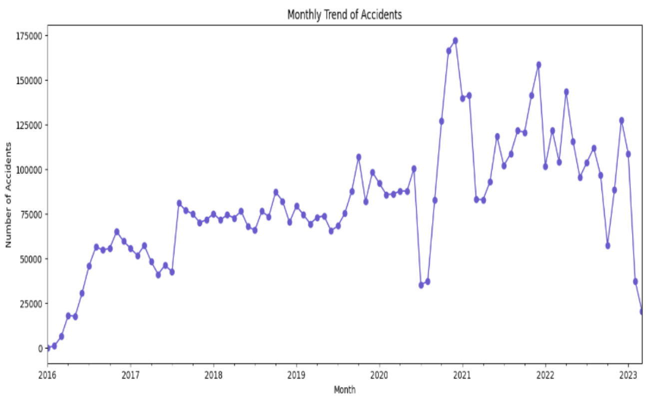

Fig 13. Monthly Trend of Accidents

This line chart in Fig 13 displays the monthly trend of accidents from 2016 to 2023, highlighting fluctuations over time. A sharp drop is observed around 2020, followed by a significant increase, possibly linked to changes in travel patterns during the COVID-19 pandemic. The general upward trend in earlier years reflects increasing road activity. These insights emphasize the influence of external factors on accident rates over time.

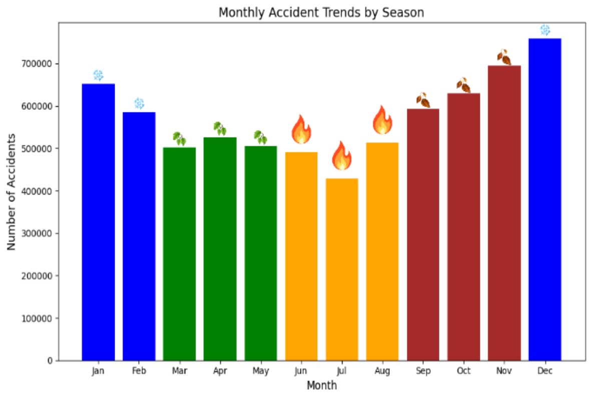

Fig 14. Monthly Accident Trend by season

This Graphical bar plot in Fig 14 illustrates monthly accident trends categorized by season, showing peaks in December, January, and February during winter months. The higher accident counts in winter may be attributed to hazardous conditions like snow and ice. Summer months show relatively lower accident rates, likely due to favorable weather and improved road conditions. These insights emphasize the importance of seasonal-specific safety measures, particularly in winter.

This plot in Fig 15 shows the distribution of accidents by day of the week, with weekdays experiencing significantly higher accident counts compared to weekends. Friday records the highest number of incidents, likely due to increased traffic as people commute and prepare for the weekend. In contrast, Saturday and Sunday see fewer accidents, reflecting reduced commuter traffic. These patterns suggest a focus on weekday traffic management that could effectively reduce accidents.

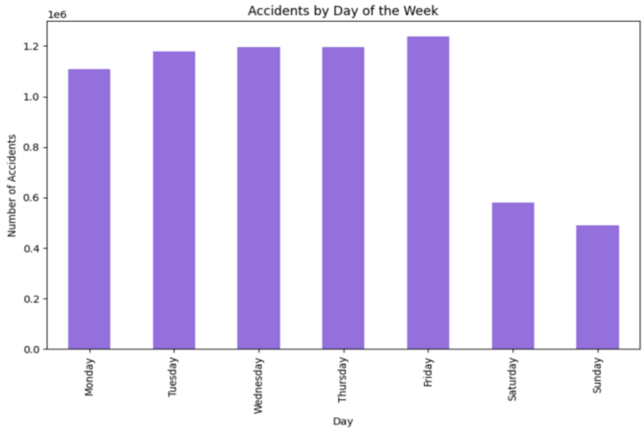

Fig 15 Accidents by Day of the week

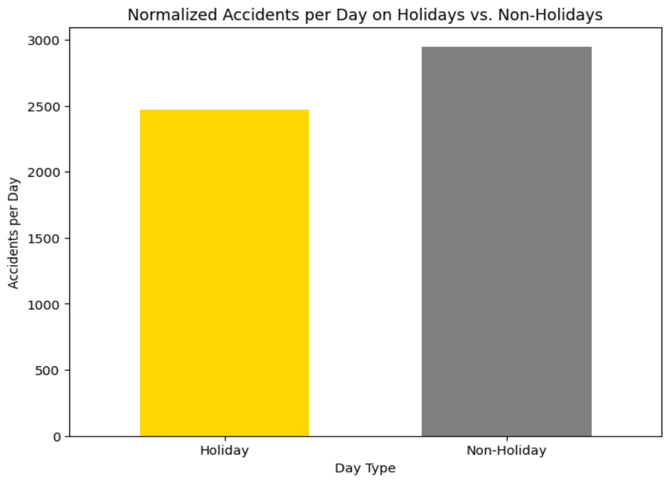

Fig 16. Normalized Accident per Day on Holiday vs non-holidays

Non-holidays account for most accidents, with over 7 million occurrences compared to significantly fewer on holidays. This disparity is likely due to the higher number of non-holiday days. So, for better understanding we normalized the data split, when normalized for the number of respective days, holidays show slightly fewer accidents per day compared to non-holidays. Holidays experience approximately 2,500 accidents per day, while non-holidays see over 3,000.

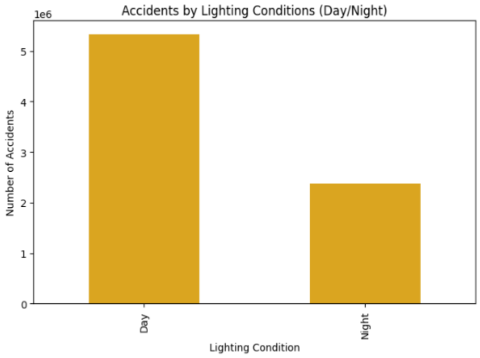

Fig 17 Accident by light conditions

This visualization compares the number of accidents occurring during the day and night based on lighting conditions. It shows that significantly more accidents happen during the day than at night, which could be attributed to higher traffic volumes during daylight hours. However, nighttime accidents, although fewer, may involve different factors such as reduced visibility or fatigue.

Spatial Analysis:

Now, let's shift our focus to spatial analysis to explore how the data varies across different locations. We've already introduced some spatial maps in the earlier sections of this report, but here we'll dive deeper to uncover more patterns, regional differences, and location-based trends. By visualizing the data, we can gain insights into how location influences outcomes and make decisions tailored to specific regions or areas.

Fig 18 Interactive map represents accident density, severity and intensity

This interactive map in Fig 18 visualizes the distribution of accidents and severity across major U.S. cities using clustered markers, with color intensity reflecting accident frequency. High accident concentrations are observed in densely populated areas like Los Angeles, New York City, and Chicago, emphasizing the role of urban density in accidents. Conversely, regions with lower population densities, such as Montana and Kansas, exhibit significantly fewer accidents. This insight highlights the potential for targeted urban planning and resource allocation to mitigate risks in high-density zones.

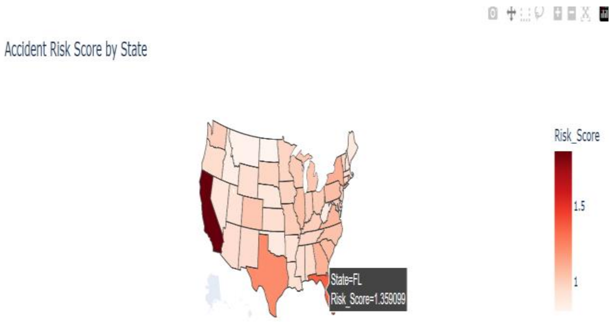

Fig 19 Accident Risk Score by state

This interactive choropleth map visualizes accident risk scores by state, calculated by normalizing the average accident severity and total accident counts. States like California and Florida show the highest risk scores, highlighting areas with both frequent and severe accidents. The darker shades on the map pinpoint regions requiring immediate attention for road safety improvements. This method provides a comprehensive view of risk by combining accident frequency and impact, offering actionable insights for targeted interventions.

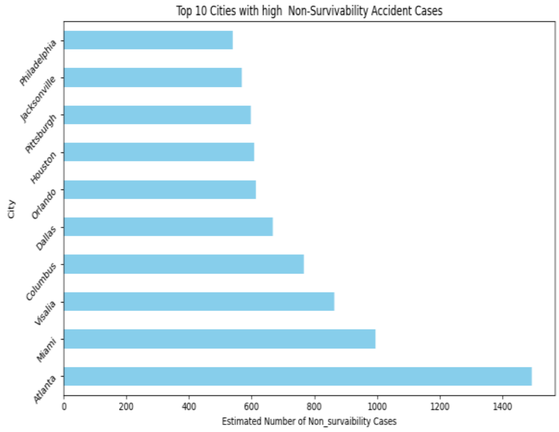

Fig 20 Top 10 cities with high non-survivability cases

This bar chart highlights the top 10 cities with high non-survivable accident cases, calculated based on accidents lasting over an hour, with severity levels above 3, and without nearby amenities. Atlanta and Miami lead the list, indicating areas with significant challenges in accident survivability.

The lack of amenities and extended accident durations likely contribute to lower survival rates in these cities. These insights underline the importance of improving emergency response infrastructure and amenities to enhance survivability in high-risk locations.

Road Features Analysis:

Let's now dig in and see the few more visualizations that uncover patterns in road Features with respect to accidents severity and intensity.

The heatmap and radar chart in fig 21 and fig 22 illustrates the proportion of severe accidents (severity > 2) associated with various road features. Junctions show the highest proportion of severe accidents (27%), followed by Give Way and Railway, indicating that these features are more prone to accidents with higher severity. Conversely, features like Roundabouts and Turning Loops exhibit much lower proportions of severe accidents, reflecting their typically safer design or limited exposure.

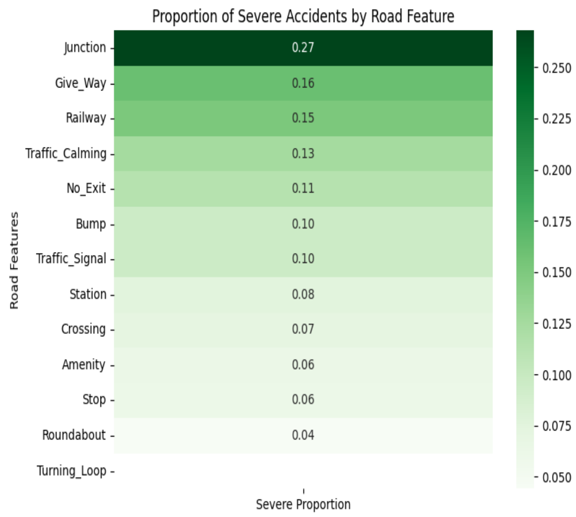

Fig 21. Proportion of severe Accident by Road Feature

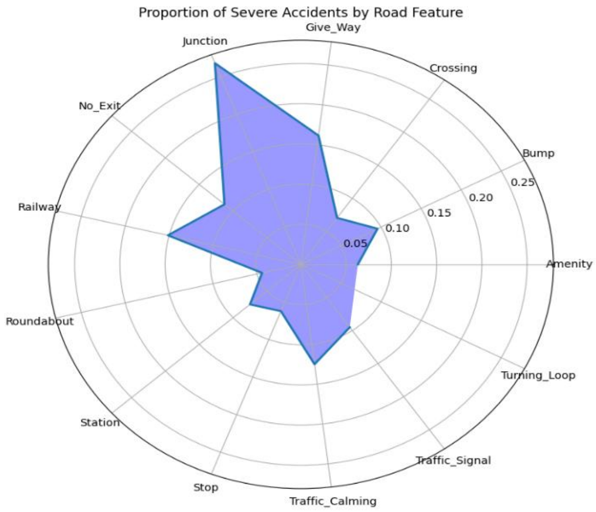

Fig 22. Radial Chat represenatation of fig 21

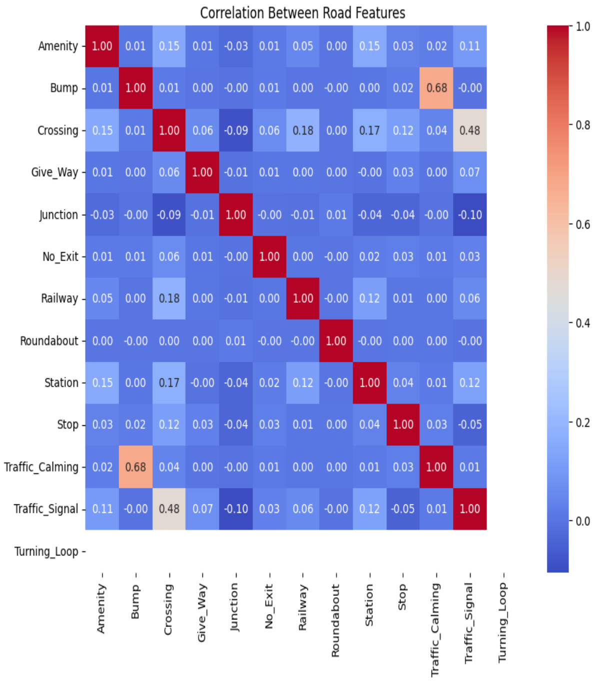

Fig 22 Correlation Between Road Features

This heatmap visualizes the correlation between various road features in relation to accidents. Most correlations are weak or negligible, indicating that the presence of one feature does not strongly predict the presence of another. However, notable exceptions include a strong positive correlation between Traffic Calming and Bumps (0.68), as well as a moderate correlation between Traffic Signals and Crossings (0.48). These relationships are likely due to their common co-occurrence in urban settings designed to regulate traffic flow and enhance safety.

Impact of Environmental Factors:

Lets understand the more about the correlation behind various environment Factors and accidents.

Fig 23 Corr B/w environmental Factors and severity

This correlation heatmap in fig 23 shows the correlation between environmental factors and accident severity. Most correlations are weak, indicating that environmental factors like temperature, visibility, wind speed, humidity, and precipitation have minimal direct impact on accident severity. However, there is a strong correlation between Temperature(F) and Wind Chill(F) (0.99), reflecting their intrinsic relationship rather than their effect on severity.

Fig 24 Corr b/w Environmental Factors and No. of accidents

This heatmap in Fig 24 illustrates the correlation between environmental factors and the total number of accidents. Like severity, most correlations are weak. However, Temperature(F) (0.08) and Pressure(in) (0.10) show small positive correlations with the number of accidents, possibly indicating moderate conditions lead to more traffic and hence more accidents.

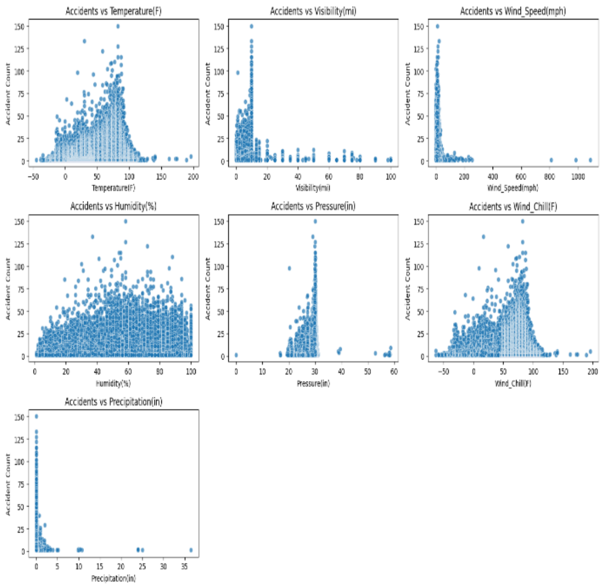

Fig 25. Scatter plot Analysis

These scatter plots in fig 25 analyse the relationship between environmental factors and accident frequency. Accidents are most frequent at moderate temperatures (20°F to 80°F) and minimal precipitation (under 1 inch), likely due to higher traffic volumes during such conditions. On the other hand, accidents are also common at low visibility levels (below 10 miles), where, despite lower traffic, the risk of accidents increases significantly due to reduced visibility. This highlights how both traffic volume and hazardous environmental conditions play distinct roles in influencing accident frequency.

Textual Insights from Accident Descriptions:

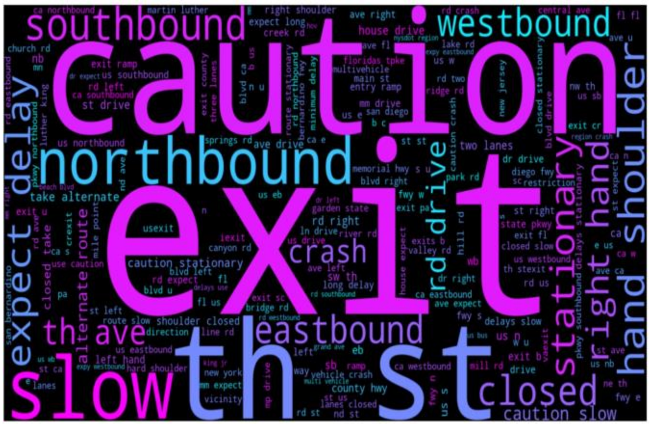

Fig 26: word cloud representation on Accident description

This word cloud in Fig 26 visualizes the most frequently used terms in accident descriptions, generated by normalizing text, removing punctuation, and excluding common stop words and irrelevant words like "road" and "traffic." Prominent words such as "caution," "exit," and "northbound" suggest recurring themes of warnings, specific directions, and critical areas. The visualization highlights areas like ramps, exits, and directional flows as frequent contexts for accidents. These insights can guide targeted improvements in road signage and traffic management to address common accident scenarios.

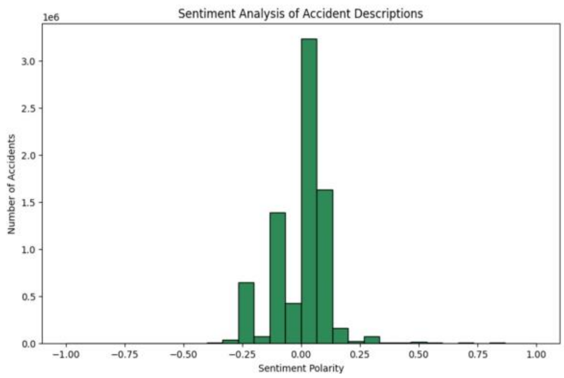

Fig 27: Sentiment Analysis of Accident Description

This histogram in Fig 27 visualizes the sentiment polarity of accident descriptions, where values range from -1 (negative sentiment) to 1 (positive sentiment). Most descriptions cluster around neutral sentiment (0), indicating a lack of strong emotional language.

There is a slight skew towards negative sentiment, reflecting the nature of accident-related descriptions. These insights could be useful for understanding public reactions or highlighting critical incidents.

This detailed analysis on the US accident data did end up uncovering many hidden patterns and formulated key takeaways which could be discussed in the following section of the report.

5. Discussion

After detailed Analysis on all the possible metrics and combinations the following are the key take ways or the discussion points that are obtained.

Urban hotspots such as Los Angeles and Miami are characterized by high accident rates due to their dense populations and complex road networks. These areas require targeted urban traffic solutions to address congestion and improve road safety. Seasonal and daily patterns, such as increased accidents during winter months and weekday rush hours, highlight vulnerabilities in commuter traffic management and weather preparedness, emphasizing the need for adaptive strategies.

Critical zones like junctions and traffic signals account for most severe accidents, underscoring the necessity for infrastructure upgrades. Additionally, delayed emergency response times in cities like Atlanta expose gaps in emergency infrastructure, calling for enhanced medical and response facilities. Environmental factors, including poor visibility and extreme weather, further amplify risks, making weather-responsive safety protocols essential.

State-level analysis reveals California and Florida as high-risk regions due to frequent and severe accidents. Tailored interventions, such as state-specific infrastructure improvements and traffic enforcement measures, are vital to mitigating risks. Sentiment analysis of accidents also highlights public awareness of safety concerns, which can be leveraged to design effective educational campaigns.

6. Conclusion

So, ultimately the analysis of U.S. accident data reveals a multifaceted interplay of environmental conditions, infrastructure gaps, and human behavior contributing to road safety challenges. From severe accident hotspots in key cities to weather-induced risk patterns and infrastructure deficiencies, the data tells a compelling story of vulnerabilities that demand strategic interventions. Addressing these issues requires a holistic approach, enhancing infrastructure, optimizing emergency response systems, and fostering weather-resilient safety measures. By leveraging these insights, stakeholders can craft targeted solutions that not only reduce accident frequency but also improve survivability and overall traffic safety, paving the way for safer roads nationwide.

7. References:

[1] Federal Highway Administration. (2021). Traffic Safety Facts.

[2] U.S. Department of Transportation. (2023). Road Safety Statistics

[3] Sobhan Moosavi. U.S. Accidents Dataset. Kaggle. Retrieved from https://www.kaggle.com/datasets/sobhanmoosavi/us-accidents/data.