Assignment 4	"Data Visualisation Project (DVP) "
Teaching Associate	Mohit Gupta, Applied Mon (4 -6)
Student Details	34051201-Deekshita

Comprehensive Analysis of PSAP Distribution, Distress Call Trends, and Future Forecasting

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01.Introduction

The increasing volume and complexity of distress calls in the United States underscore the critical need for efficient emergency response systems. Public Safety Answering Points (PSAPs) play an essential role in this infrastructure, acting as centralized hubs where emergency calls are received and dispatched to appropriate services. This project aims to analyse and visually present the distribution of PSAPs across states, the trend in distress calls over recent years, and forecast emergency response times to support efficient resource planning and public awareness. Our approach utilizes a structured top-down methodology, beginning with a high-level view of call mediums and their distribution, moving to an analysis of distress types and call volumes, and concluding with a forecasting model to anticipate future response needs.

Project Objective

The objective of this project is to provide a comprehensive, data-driven understanding of emergency call patterns, including PSAP distribution, call mediums, distress types, and forecasted response times. The project emphasizes how these factors vary across states and time, with a particular focus on changes in call trends from 2017 to 2024. By investigating these aspects, the project intends to illuminate patterns in distress calls, helping emergency response teams, policymakers, and researchers identify critical areas for improvement. This information can guide resource allocation, optimize PSAP deployment, and improve community safety measures based on anticipated needs.

Purpose of the Study

The study provides insights into:

1. How citizens across the country use different call mediums (e.g., wireless, VoIP, text) to contact emergency services
2. How PSAPs (Public Safety Answering Points) are distributed across states to handle these emergency calls.
3. The influence of time-based factors (e.g., hour, day, month) on call volume and resolution efficiency.

By incorporating a forecasting model, the project provides a predictive view of future response times, enabling stakeholders to plan more effectively. This layered analysis, transitioning from past and present observations to future projections, allows for a holistic understanding of emergency response dynamics. Through interactive and user-friendly visualizations, we aim to make complex data accessible and actionable.

Visualisation Overview

The first section of the project introduces viewers to the various mediums citizens use to contact emergency services. We begin with a **Hexbin** map that displays the distribution of PSAPs (Primary and Secondary) across states, providing a clear understanding of the resources available in each region. Through the dropdown, users can filter by call mediums such as wireline, wireless, VoIP, and text, observing how distribution varies with medium type. We also study how call mediums have evolved over time, with wireless and text-based calls seeing notable increases post-COVID-19.

Moving from a focus on PSAP infrastructure, the next tab examines distress call trends across the country for this year 2024. Here, we delve into the analysis of distress types, allowing users to observe how call frequencies vary by hour, day, and month. Interactive filters enable users to specify parameters such as time range, distress type, day of the week, and date range, offering a highly customized view of the data based on specific interests.

The final section of the project employs advanced forecasting models to predict emergency response times for the upcoming quarter. Using a combination of Seasonal Autoregressive Integrated Moving Average (SARIMA) and ARIMA models, this section provides a forecast of average response times, helping to anticipate response efficiency. Visualized with a blue line indicating forecasted values and a green line representing actual times, this model gives insights into future trends. An hourly prediction model, powered by ARIMA and linear regression, visualizes expected response times across each hour of the day. The inclusion of a play animation feature enables users to see how response predictions evolve over time, providing a dynamic understanding of how response times may shift in future scenarios.

Intended Audience

The focus audience for this project are:

- **Primary General Audience**: General public interested in understanding emergency response insights and local preparedness. The project uses an intuitive interface and user-friendly terms, making it accessible to non-experts in data analysis
- **Secondary Research Audience**: Researchers and Public Safety Organizations can utilize the data for further studies to improve response times and optimize resource allocation based on call patterns. Data Scientists and Analysts in Public Safety can benefit from the forecasting models to enhance predictive analytics in emergency response planning
- **General Public**: Individuals interested in understanding their own relationships can benefit from the interactive survey component of the project, which provides personalized feedback and practical advice based on their responses

The interactive elements, including sliders, dropdowns, and play animations, cater to audiences with diverse data needs and skill levels. The dynamic presentation—from historical call trends to future forecasts—allows users to explore and interpret emergency response metrics in a format suited to their specific questions. This comprehensive analysis makes distress call trends transparent and actionable, fostering a deeper understanding of the public safety infrastructure across the U.S.

02. Design Process

Design Philosophy

Hexbin Map with PSAP Type Selection

The aim was to show the distribution of Public Safety Answering Points (PSAPs) by state. Initially, I considered a cartogram to scale each state by its PSAP count, thinking it would emphasize differences in PSAP densities. However, due to the limited variance in PSAP counts, the cartogram's effectiveness diminished, making states appear too similar. This led me to switch to a hexbin map with color gradients, which provided clear differentiation without altering geographic consistency.
The hexbin map with a color gradient effectively highlights PSAP density, allowing users to quickly spot high-density areas. A toggle option for Primary and Secondary PSAPs further enhances usability, catering to emergency coordinators needing detailed breakdowns.

Line Chart with Multi-Select and Animation (Call Distribution, 2017-2024)

To depict trends in call distribution from 2017-2024, my first thought was to use a pie chart map with each state showing call types proportionally. The vast difference between call types, such as Wireless vs. Texts, made pie charts ineffective due to disproportionate segment sizes. Additionally, I wanted users to focus on specific call types across all states, so a time-based line chart with multi-select options proved more suitable.
The line chart with year and call type filters provides a clean, temporal view of call trends, emphasizing post-COVID surges in certain mediums like Wireless. This animated approach helps users observe trends dynamically over time.

Choropleth Map (State-Specific Call Distribution)

The initial concept was a pie chart on a U.S. map for each state's call distribution. This would allow comparison of call types within each state. The vast difference in call volumes across types made pie charts cluttered and hard to read. Moving to a choropleth map allowed me to color-code states based on call distribution percentage for a specific call type, enhancing clarity. The choropleth provides a simple, comparative view of call distribution percentages by state, letting users quickly identify high and low-usage areas for each call type. This approach aligns with the project's theme of clear geographic comparison

Incident and Resolution Analysis with Multi-Select Filters

Originally, I focused solely on incident counts for each distress type. However, I realized that including resolution analysis would provide a more complete picture of emergency response efficiency. To improve narrative depth, I introduced a toggle for Incident Overview and Resolution Analysis, allowing users to examine both occurrences and responses over time. The filters add flexibility in exploring specific days, weeks, and distress types.
This dual view balances incident frequency with resolution performance, catering to users interested in response efficiency. The interactive filters make it easy for users to drill down by timeframe and distress type, enriching the data exploration experience.

Hourly Trends Line Chart (Distress Incidents by Hour)

To capture hourly variations, a line chart was chosen for its ability to effectively display changes over time within a single day. The main challenge was representing various distress types on the same scale without overcrowding the chart. I adjusted the colour scheme and line styles to maintain readability across distress types.
This design highlights peak hours for different incidents, giving users a clear view of activity spikes throughout the day. It's ideal for emergency planners monitoring high-demand times and is compatible with user-selected filters for detailed analysis.

Monthly Trends Scatter Bubble Plot (Distress Types by Month)

Initially, I considered a stacked area chart, but it limited the ability to compare distress types individually over months. I switched to a scatter bubble plot, setting unique ranges for each distress type to allow for more distinct monthly trends. This approach also accommodates the varied ranges for incident counts across types.

The bubble plot effectively highlights individual trends per distress type over months, with the size indicating frequency. It's interactive, making it easy for users to track and compare seasonal patterns across incidents.

Forecasting with SARIMA/ARIMA (Response Times, Next Quarter)

For forecasting, I aimed to predict response times using historical data. SARIMA was selected for its capacity to handle seasonal variations. For comparison of actual and predicted response times by hour, I used ARIMA combined with linear regression for enhanced accuracy.
After testing various models, SARIMA emerged as the best fit. I added an animation slider to visualize data progression and predict changes interactively.
This forecasting model, visualized through a dynamic chart, offers insights into future response trends. It's particularly valuable for officials planning for upcoming resource needs, allowing users to adjust the month range interactively.

Visuals for Improved Insights

Hexbin Map for PSAP Distribution by State

Initially, I considered using a cartogram to represent PSAP (Public Safety Answering Point) distribution by state, but I quickly realized it didn't effectively capture the subtleties in count differences across states. After experimenting, I found that a **hexbin** map with a warm-to-cool colour gradient allowed for clearer differentiation between states with high and low PSAP counts. This choice enables users to quickly discern density patterns without overwhelming them with extraneous details, making it ideal for both general audiences and professionals looking for a quick state-wise summary.

Choropleth Map for Call Distribution Across States

For analysing how call types vary across states, my initial idea was a pie-chart map for each state to show the distribution of call mediums (wireless, VoIP, text, etc.). However, the vast differences in call volumes made it difficult to achieve a balanced pie chart. After some adjustments, I settled on a choropleth map with adjustable call type filters, allowing users to focus on specific call types while maintaining the thematic consistency of my visualizations. This map also provides an effective way to compare states while offering a clean, state-specific view of call types.

Dynamic Line Chart for Temporal Call Trends (2017-2024)

In exploring the trends in call volumes over time, I realized that a line chart would provide an intuitive view of the progression across years, especially with the impact of events like COVID-19. Initially, I had planned a static representation, but incorporating animation enabled users to better perceive the evolution of each call type, adding depth to the storytelling. The multi-select option for different call mediums allows users to compare call types dynamically, facilitating a layered understanding of trends**.**

Multi-Select Panel for Distress Call Analysis

To enable users to explore distress call data in various ways, I created a multi-select panel that includes options for distress types, date range, and time of day. This approach was a shift from my initial idea of a single filter per distress type, which limited flexibility. With the added multi-select options, users can examine patterns in a highly customized manner, whether looking at hourly trends or comparing incident frequencies on different weekdays.

Consistency in Design

Consistent Design Elements

To support a seamless experience, I maintained a consistent layout across tabs: controls on the left and visualizations on the right. This setup keeps interactive elements within reach, reinforcing a clear structure where the users know where to find filters, sliders, and other controls. This consistency was particularly beneficial for my project because it reduces the learning curve and encourages deeper exploration.

Interaction Mechanisms

I used a combination of sliders, checkboxes, and dropdowns to support interactive data exploration. For example, in the temporal call trends line chart, the animation slider allows users to view the progression year by year. In contrast, the multi-select panel in the distress call analysis tab offers flexibility, allowing users to compare different distress types and explore patterns by hour or day of the week. These interaction points enable users to actively engage with the data, making insights more personalized.

Design Aesthetics and User Interface

Choice of Colour Palette

I chose a warm-to-cool gradient as my primary colour scheme across most visualizations, such as the hexbin and choropleth maps, to intuitively convey density and volume. The consistency in colour helps users quickly understand what higher intensities mean in each context—**darker shades for higher values, lighter for lower**. This alignment with colour perception theory allows users to interpret data patterns naturally, enhancing accessibility without sacrificing the professional look.

Font and Typography Choices

For typography, I opted for a clean, sans-serif font across the visualizations to maintain readability and a modern aesthetic. The font size was carefully adjusted based on feedback from early user testing, ensuring labels are legible even on smaller screens. My choice here balances professionalism with accessibility, ensuring that users of varying technical expertise can easily read and interpret the information.

Design Layout and Structure

Organization of Visual Elements

The project layout was structured to take users from a broad national overview to more specific details. Starting with the PSAP distribution gives a high-level understanding, which then narrows down to call types and distress patterns in subsequent tabs. This logical grouping follows the top-down approach I had envisioned, with each tab building on the previous one to deepen the narrative.

Visual Hierarchy

Key elements, such as the "Total Calls" and "Average Answer Time" metrics, are prominently displayed at the top of each tab. These summaries provide immediate insights and set the context for the more detailed visualizations below. By strategically placing important metrics at the top, I aimed to create a visual hierarchy that prioritizes essential information, supporting quick comprehension before users dive into the interactive components.

Visual Variables and Data Representation

Using Visual Variables

Each visualization leverages visual variables like color, size, and shape to represent data meaningfully. In the scatter bubble plot, for instance, bubble size reflects the frequency of distress calls, and distinct shapes represent different types of incidents. This design helps users quickly differentiate distress types and interpret frequency without needing detailed labels. I incorporated color as a functional variable, with different shades indicating intensity or frequency in a way that users could grasp intuitively

Position and Alignment

In the hourly trends line chart, for instance, hours are aligned along the x-axis to create a clear time progression. This alignment emphasizes trends and makes comparisons easier, especially for patterns like peak times of distress calls. Position and alignment decisions were made to improve clarity, supporting the analysis of time-dependent data, which is crucial for understanding the temporal nature of distress calls

Application of Munzner's What-Why-How Framework

What

The project visualizes data related to PSAP density, call distribution by state and time, and distress call patterns. I chose these specific datasets to address key questions in emergency response effectiveness, such as how resources are allocated and how response times vary across different factors.

Why

The visualizations were designed to inform multiple audiences, including the general public, emergency response coordinators, and policymakers, about how emergency calls are managed and how trends have evolved over time. My goal was to use data to provide insights that can support better resource planning and highlight areas where response times might need improvement.

How

Using **hexbin** maps, **line charts**, and **choropleth** maps, I represented data in formats that encourage both overview and detail-oriented analysis. The tools allow users to examine patterns on a broad scale, then zoom in for a more focused look at specific types of distress calls or time periods. The multi-layered interaction (sliders, dropdowns, multi-select panels) empowers users to explore the data at various levels of detail.

Choice of Genre and Narrative Style

Genre

I approached this project with a demographic analysis genre, focusing on patterns in emergency response across U.S. states. The narrative style is largely exploratory, guiding users from one layer of information to the next to uncover insights at their own pace.

Narrative Style

The storytelling approach is designed to encourage users to start with a high-level understanding and progressively dive deeper into specifics. For example, beginning with PSAP distribution allows users to first understand the infrastructure, then move to call patterns and distress types for more granular insights. This layered exploration supports both broad overviews and specific inquiries, catering to a diverse audience.

Human Visual System Considerations

Attention to Visual Cues

Throughout the design, I used colour and position to leverage pre-attentive processing, making patterns and anomalies stand out immediately. For example, the colour gradient in the PSAP density map enables users to identify high-density areas quickly, while changes in line thickness or bubble size in other charts help convey intensity without overloading the user.

Cognitive Load

By breaking down complex data into digestible visualizations, I aimed to minimize cognitive load. For instance, the use of dropdowns and sliders enables users to control the volume of data they interact with, allowing them to gradually explore without feeling overwhelmed. This modular approach helps keep users engaged without exhausting their attention.

Influence on Audience based on Design Choices

Audience Consideration in Visual Complexity

I designed the project with multiple audience layers in mind, from general users to technical experts. For example, the interactive features allow general users to explore without deep statistical knowledge, while the layered filters in the distress call analysis tab enable deeper insights for researchers and analysts.

Tailored Interaction Options

The use of multi-select filters, especially in the distress call analysis, caters to diverse user needs. While general users may focus on the overall trends, professionals can analyse specific patterns across distress types or time ranges. This flexibility reflects my intent to make the project accessible yet thorough.

Reflections and Justifications

Reflecting on this design process, each choice—whether related to **color**, **layout**, or **interaction**—was guided by a commitment to creating a user-friendly experience. By balancing design aesthetics with functional insights, I believe the project effectively communicates complex data in an accessible format. The iterative design process, influenced by both theoretical frameworks and practical feedback, allowed me to refine the visualizations to better serve the intended audiences.

03.Implementation

Technical Implementation

The technical implementation of this project involved integrating various libraries and data processing techniques to handle complex visualizations, enhance user interactivity, and manage large datasets. Below is a high-level overview of the implementation, including the libraries used, external resources, and the challenges encountered during the project.

Libraries and Tools

Data Visualization Libraries:

ggplot2, plotly, and highcharter: Used to create various interactive visualizations, including line charts, choropleth maps, hexbin maps, and scatter plots. Each of these libraries provided unique features for enhancing interactivity and visual appeal.

viridis and RColorBrewer: Employed for color palette generation to ensure accessibility and aesthetic cohesion across all visualizations, particularly in differentiating categories and scales in maps and charts.

Data Wrangling and Transformation:

dplyr, tidyverse, and lubridate: Utilized for efficient data manipulation, filtering, and transformation. These libraries were particularly helpful in handling the large datasets and preparing the data for visualizations, such as grouping data by time and aggregating distress call frequencies.

tsibble and fable: Used for time-series analysis, enabling decomposition and forecasting of average response times. Tsibble helped manage temporal data as a structured time series, while Fable provided advanced forecasting capabilities using SARIMA models.

Spatial Data and Mapping:

sf (Simple Features) and readxl: The sf package was used to load, manipulate, and visualize spatial data, specifically a U.S. states hexbin map for PSAP distribution. Additionally, readxl facilitated reading data from Excel files, including PSAP distribution data, and merging it with spatial data for the hexbin map.

GeoJSON File: A U.S. hexagonal grid geoJSON file was imported to create a hexbin map, which visually represented PSAP distributions across states. This file was essential for accurate spatial representation and added a non-tabular data source component to the project.

User Interface and Interactivity:

Shiny and shinyWidgets: Shiny served as the backbone for creating an interactive web-based user interface, allowing for dynamic data exploration. shinyWidgets enhanced the UI with customized elements like sliders, checkboxes, and action buttons, improving usability.

htmlwidgets: Enabled interactive tooltips and hover effects on visual elements, helping users gain insights from detailed data points in charts and maps without cluttering the visuals.

Project Complexity and Challenges

Sophisticated Use of Data Sources:

Non-tabular Data: The project incorporated spatial data in the form of a hexagonal grid geoJSON file, which was then enriched with PSAP data. The non-tabular nature of this data required transformation and mapping to integrate it effectively into the hexbin visualization, showcasing the distribution of PSAPs by state.

Large Datasets: The project handled datasets containing daily and hourly distress call records across multiple states. These datasets needed to be efficiently wrangled and summarized for different visualizations without causing performance issues, especially when rendering dynamic charts and maps in Shiny.

Advanced Use of R and D3 Technologies:

Time Series Forecasting with SARIMA: The project implemented a SARIMA model to forecast response times over a 60-day period. This involved decomposing the time series data to isolate seasonal, trend, and remainder components. The SARIMA model was fine-tuned to capture temporal patterns accurately, making it a sophisticated use of R's time series analysis capabilities.

Dynamic Choropleth and Hexbin Maps: The creation of interactive choropleth and hexbin maps to display PSAP distributions and call volumes across states required advanced use of sf and ggplot2, especially in handling the custom color palettes and tooltips for user engagement.

Sophisticated User Interactions and Animations:

Animated Line Chart for Call Trends: To help users explore call volumes across different years, an animated line chart was implemented using highcharter, allowing users to play, pause, and adjust the year range dynamically. This animation provided a clear view of temporal changes in distress call volumes, enhancing user understanding of trends.

Customizable Hourly Analysis: The "Actual vs Predicted Response Time" line chart enabled users to explore hourly response times interactively. Using a slider, users could examine response patterns by the hour, with real-time animation highlighting variations. This complex implementation involved custom data filtering and one-hot encoding for accurate hourly predictions.

Dynamic Filtering and Tooltips: The interactive hexbin map for PSAP data allowed users to filter by primary and secondary PSAP counts and provided custom tooltips that displayed data for individual states. This feature leveraged Shiny's reactivity and plotly's interactivity to enable a seamless exploration experience.

Design Justifications and Refinements:

Several design adjustments were made to improve usability and readability, such as refining color choices to be colorblind-friendly and enhancing tooltips to provide contextual insights. Additionally, based on user testing, initial design elements like static maps were replaced with interactive versions to better serve the project's narrative goals.

Interactive Narrative Visualisation Implementation

Hexbin Map of PSAP Distribution

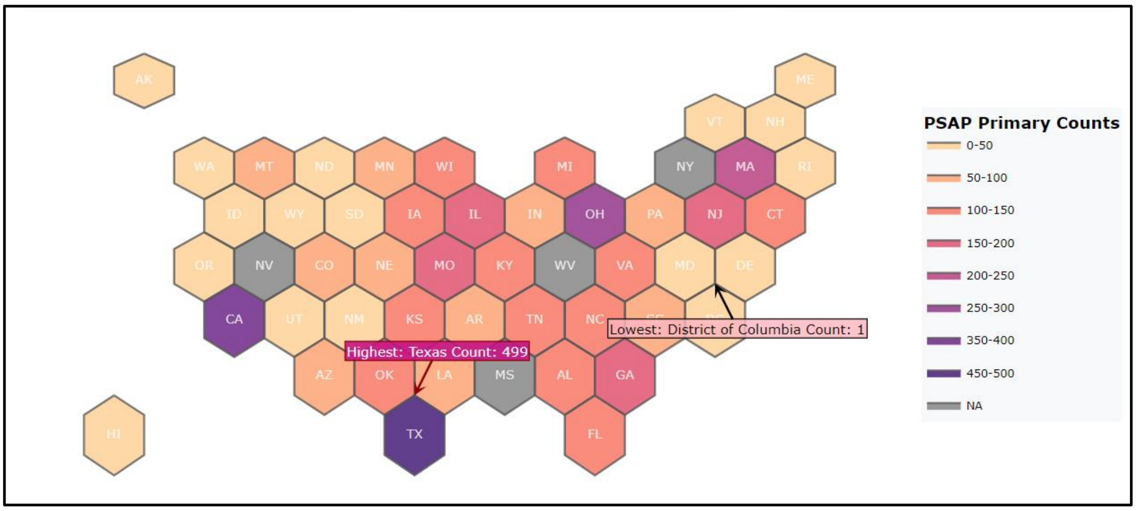


Figure 1:Hexbin Map of PSAP Distribution

This hexagonal bin map visualizes the distribution of Primary and Secondary Public Safety Answering Points (PSAPs) across U.S. states. Each hexagon represents a state, and the color gradient illustrates the count of PSAPs, with annotations for the highest (Texas) and lowest (District of Columbia) counts. This visualization helps identify regions with significant variations in PSAP coverage

Trends in Call Volumes Over Time (Line Chart)

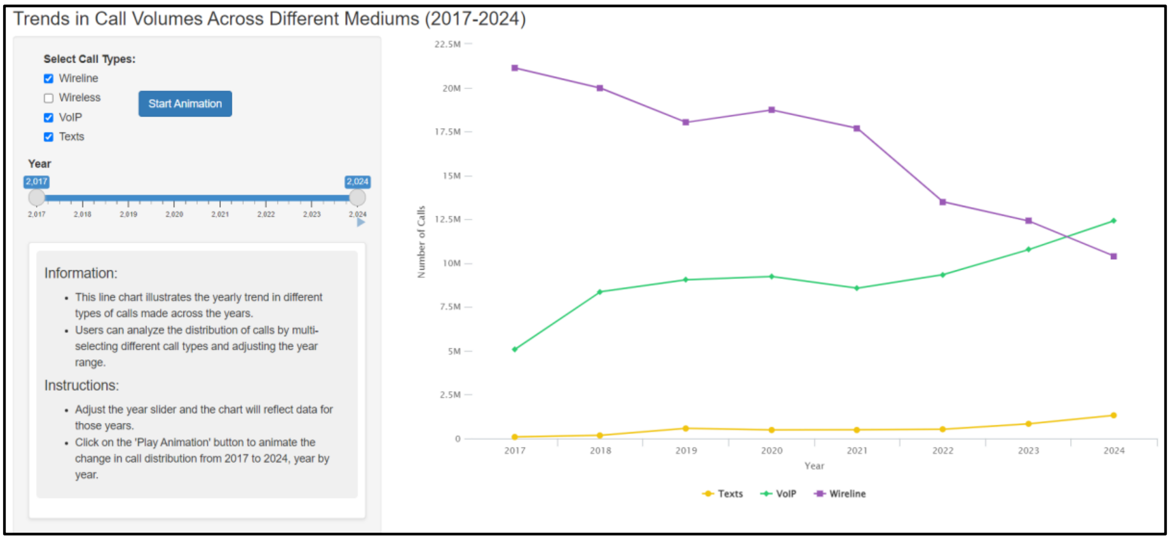


Figure 2:Trends in Call Volumes Over Time (Line Chart)

The line chart showcases the yearly trends in different types of emergency calls (e.g., Wireless, VoIP, Wireline) from 2017 to 2024. Users can filter by call type and animate the trend year-by-year to observe fluctuations in call volumes over time. This visualization helps in identifying trends and shifts in preferred communication channels for distress calls

Choropleth Map of Call Distribution by Type

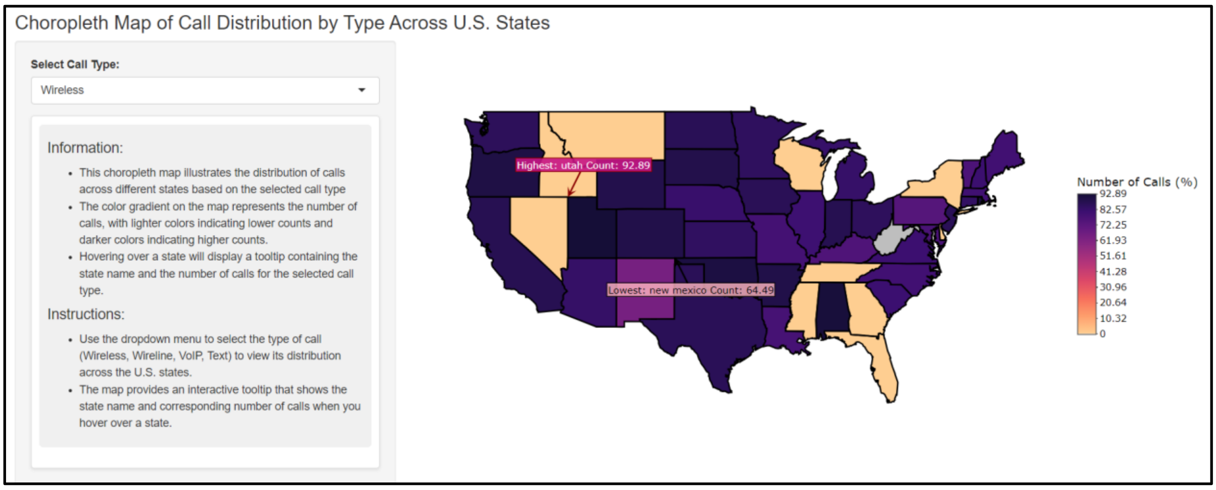


Figure 3:Choropleth Map of Call Distribution by Type

The choropleth map displays the distribution of selected call types (Wireless, Wireline, VoIP, Text) across U.S. states, with colors representing the density of calls in each state. Interactive tooltips highlight the state name and call count, enabling users to explore call distribution patterns geographically

Incident Overview/Resolution Overview by Distress Type (Bar Chart)

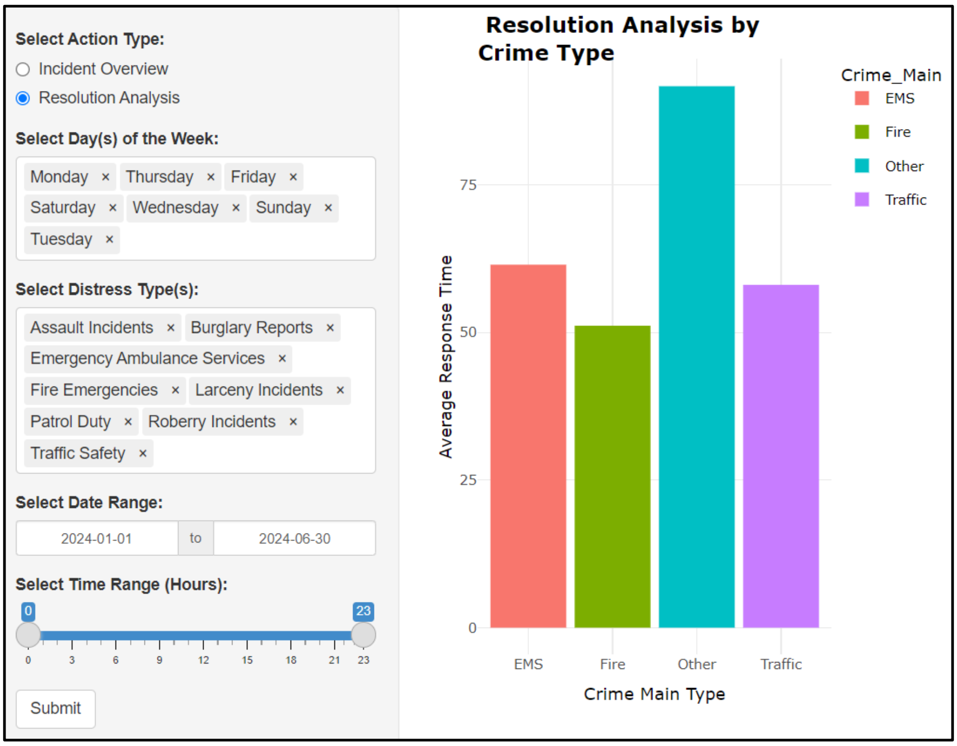


Figure 4:Incident Overview/Resolution Overview by Distress Type (Bar Chart)

This bar chart presents the total number of incidents grouped by distress type (e.g., EMS, Fire, Traffic). The chart is adjustable based on the selected days of the week, distress types, and time range, providing an overview of the most frequent distress types within the chosen parameters

Resolution Efficiency by Weekday (Heatmap)

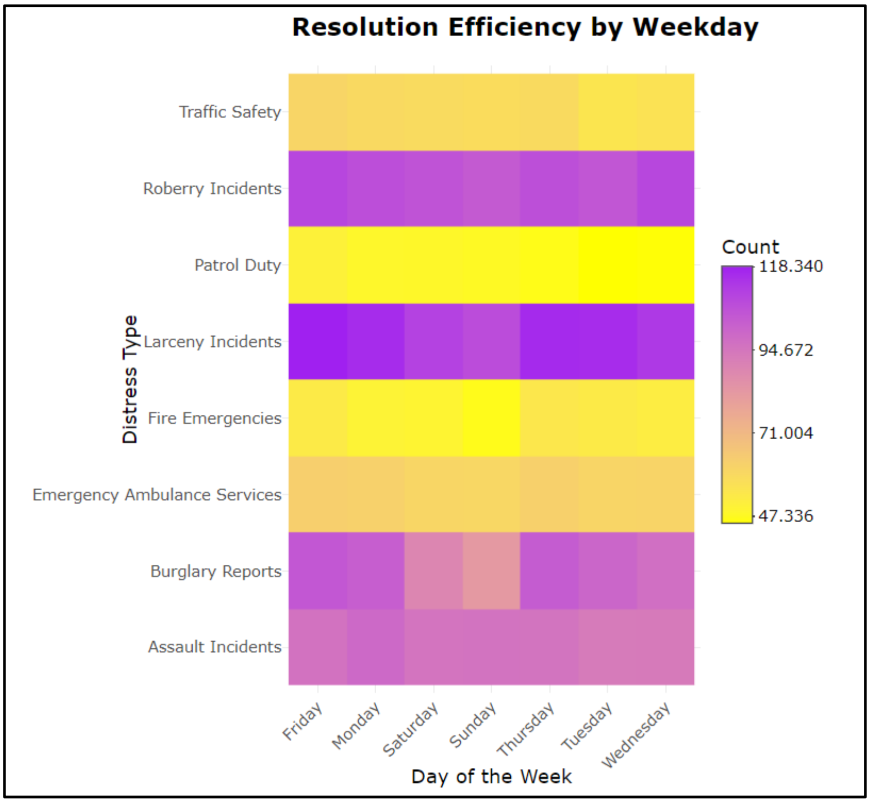


Figure 5:Resolution Efficiency by Weekday (Heatmap)

The heatmap visualizes the average resolution time for various distress types across different weekdays. The color intensity represents the count of resolved incidents, allowing users to assess efficiency patterns and peak resolution times for different distress types over the week.

Hourly Trends in Resolution Analysis (Line Chart)

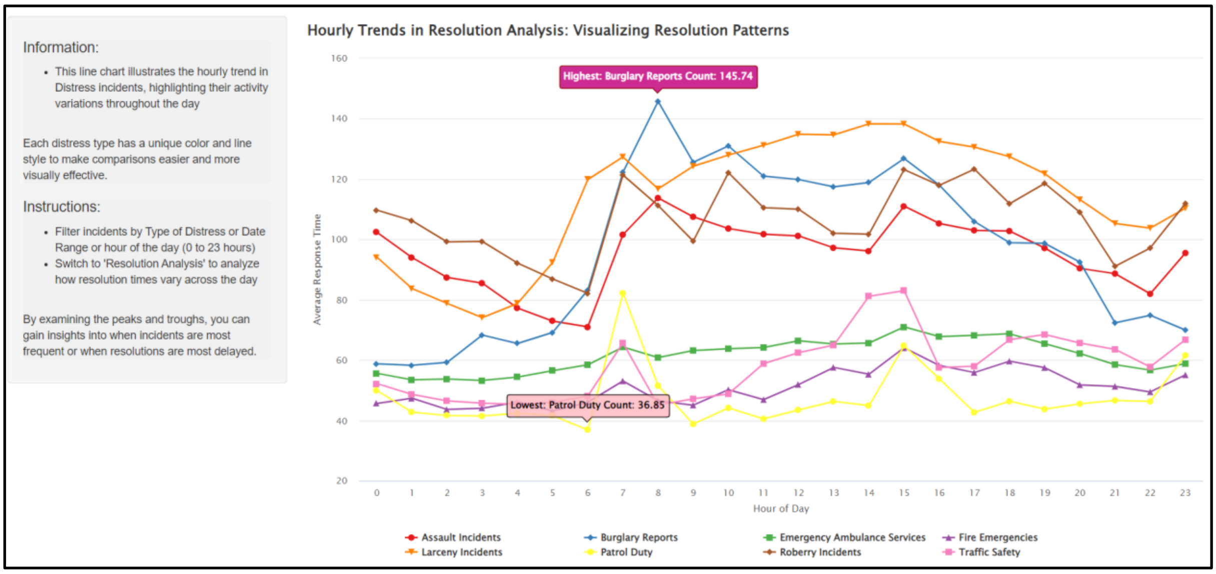


Figure 6:Hourly Trends in Resolution Analysis (Line Chart)

This line chart illustrates the hourly resolution trends for different distress types throughout the day. Each line represents a specific distress type, highlighting hourly peaks and troughs. This helps identify times when certain distress incidents are most common or when resolution times tend to increase

Monthly Trends of Distress Types (Bubble Chart)

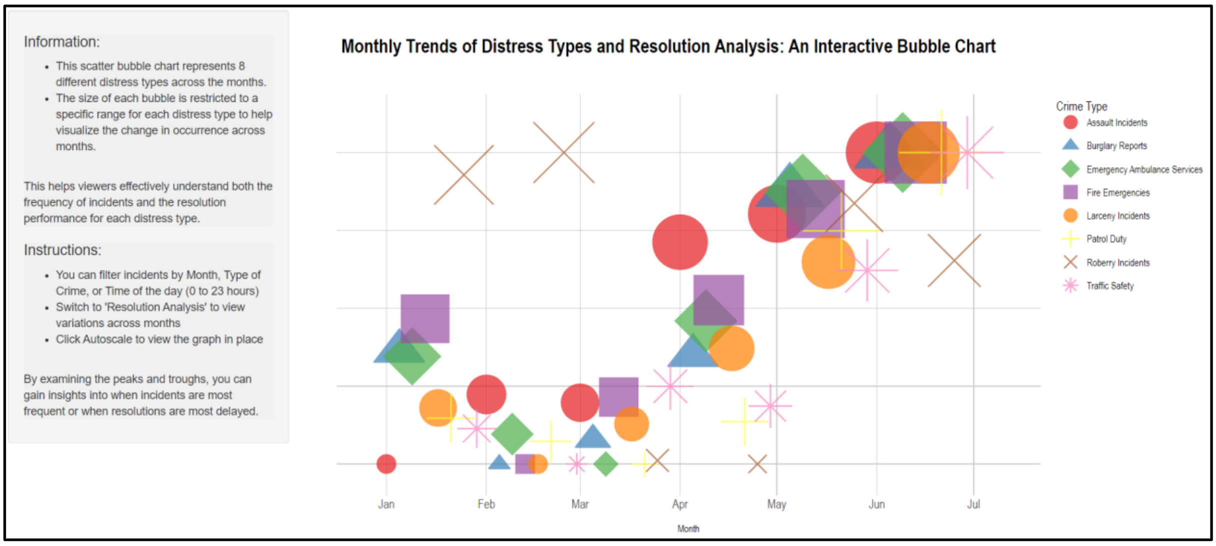


Figure 7:Monthly Trends of Distress Types (Bubble Chart)

The bubble chart displays monthly occurrences of different distress types, with each bubble's size corresponding to the frequency of that incident type. The color and shape of the bubbles represent different distress types, offering an intuitive overview of incident trends by month.

SARIMA Forecasting for Response Times (Line Chart)

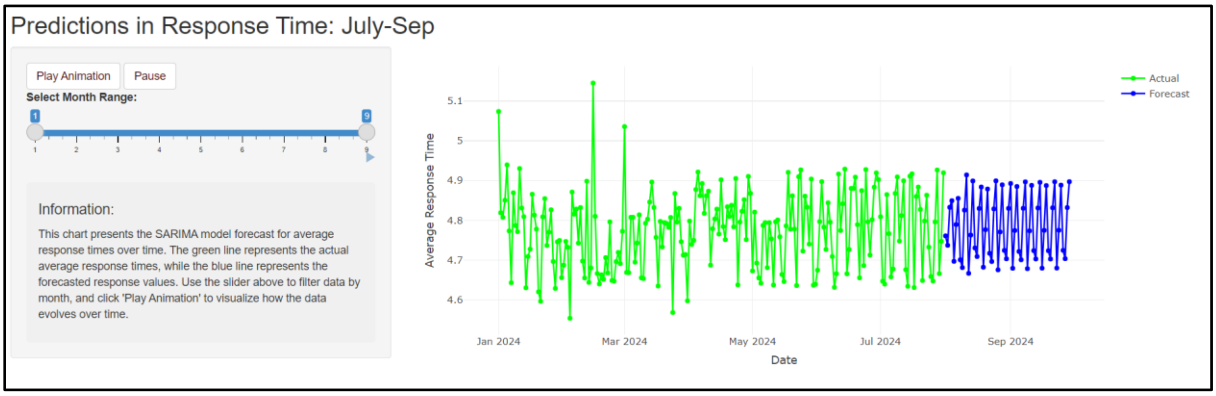


Figure 8:SARIMA Forecasting for Response Times (Line Chart)

This line chart presents SARIMA model-based forecasts for average response times from July to September. The green line represents actual historical response times, while the blue line forecasts future trends. This visualization enables users to anticipate changes in response efficiency over the coming months

Hourly Predictions of Actual vs Predicted Response Time (Line Chart)

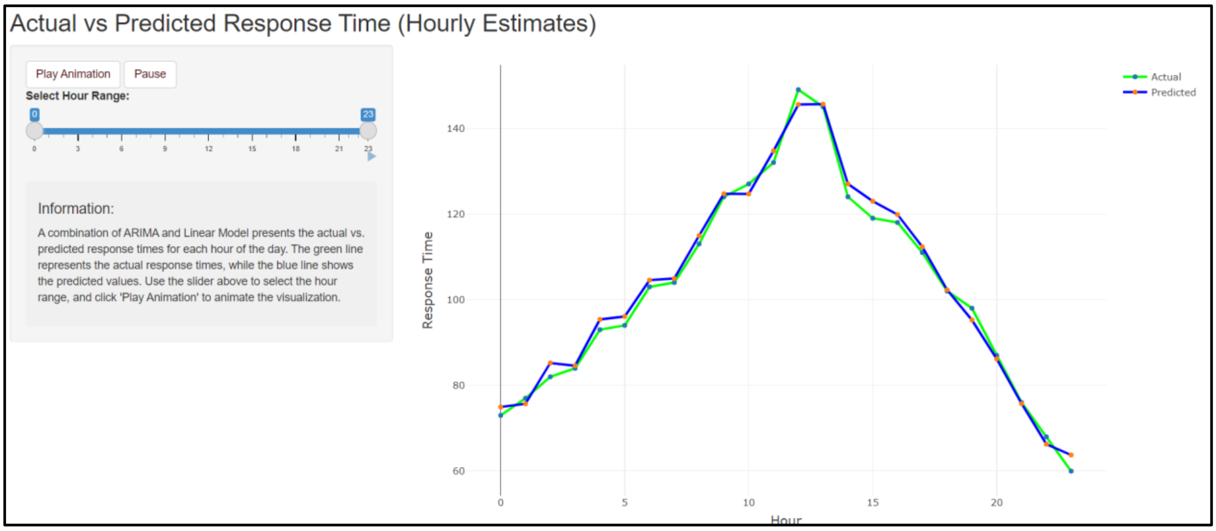


Figure 9:Hourly Predictions of Actual vs Predicted Response Time (Line Chart)

This interactive line chart compares actual vs. predicted hourly response times, allowing users to examine forecast accuracy on an hourly basis. The chart includes an animation feature to visualize data across different time periods, providing insights into response time variability by hour.

Using the Implementation

This section provides step-by-step instructions for navigating and interacting with each part of the narrative visualization. Each visualization is designed to be intuitive, but the following details highlight some unique features and interactions that may not be immediately visible.

PSAP Distribution Hexbin Map

<u>Purpose:</u> Visualizes the density and distribution of Primary and Secondary Public Safety Answering Points (PSAPs) across the United States.

<u>Instructions:</u>

- Use the **Primary/Secondary radio butto**n on the left panel to toggle between viewing Primary and Secondary PSAP distributions.
- **Hover** over individual hexagons to see tooltips displaying the PSAP count for each state, with highlights for the highest and lowest counts.
- The colour gradient (legend on the right) indicates PSAP density, helping users compare states at one glance.

Trends in Call Volumes (2017-2024) - Line Chart with Animation

Purpose: Shows the yearly trends in different types of emergency calls from 2017 to 2024.

Instructions:

- Select specific call types (e.g., Wireless, Wireline, VoIP, Texts) using the **checkboxes** in the left panel to compare different call mediums.
- Adjust the **Year slider** to control the range of years shown in the line chart.
- Click the Start Animation button to see a year-by-year progression of call volume trends, observing the impact of events like COVID-19 on call distribution over time

Call Type Distribution Across States - Choropleth Map

Purpose: Illustrates the percentage distribution of different call types (e.g., Wireless, Wireline, VoIP, Texts) across states.

Instructions:

- Select a specific call type using the **dropdown menu** at the top left.
- Hover over each state to display tooltips with the state name and the percentage of calls of the selected type, offering a quick comparison across states.
- The colour gradient represents the percentage, with darker colours indicating higher call volumes, allowing users to immediately spot regions with higher call activity for each call type.

Incident Overview and Resolution Analysis - Multi-Select Panel

Purpose: Provides a breakdown of distress call incidents and their resolutions by time, distress type, and day of the week.

Instructions:

- Use the **Action Type radio button** to toggle between Incident Overview and Resolution Analysis.
- Select specific days of the week and distress types using the multi-select panels to customize the display according to user interests.
- Set a **Date Range** using the calendar widget and a Time Range using the hour slider, allowing in-depth analysis for specific time periods.
- The visualization will update based on selected filters, showing patterns in incident types and response resolution across different times and days.

Hourly Trends of Distress Calls - Line Chart

Purpose: Shows hourly trends in distress calls, highlighting peak times for different distress types.

Instructions:

- The **Hour slider in the left panel** enables users to view hourly trends for distress calls.
- Line colours differentiate distress types, and hovering over each line reveals tooltips with specific incident counts.
- Combine with filters from the **multi-select panel** to narrow down specific times, distress types, or days, offering a deeper look into when peak call volumes occur throughout the day.

Monthly Trends of Distress Calls - Scatter Bubble Plot

Purpose: Depicts monthly trends for various distress types, showing frequency changes in distress incidents over time.

Instructions:

- Each distress type is represented by a distinct shape and color for easy differentiation. The bubble size reflects the frequency or range of incidents.
- Use the Month slider or the multi-select panel to filter by specific months or distress types.
- Hover over each bubble to view the distress type and monthly count, gaining insights into patterns across months for various incident types

Forecasting Average Response Time - SARIMA Model with Animation

Purpose: Provides a forecast of average response times for the upcoming quarter (July-Sept) using the SARIMA model.

Instructions:

- Adjust the **Month slider** to view forecasted response times for different months, while the green and blue lines represent **actual and predicted response times** respectively
- Click **Play Animation** to watch the forecasted response times unfold over time, helping users see projected variations month-by-month

04.Conclusion

This project effectively provides a comprehensive narrative visualization that explores the complexities of distress calls, PSAP distributions, and incident response times across the United States. Through hexbin maps, choropleth maps, line charts, and forecasting models, it captures historical trends, current challenges, and future projections within emergency response systems. Each visualization is crafted to make emergency data accessible and actionable for both general audiences and public safety professionals.

Working on this project provided valuable insights into creating interactive, cohesive dashboards that balance aesthetics with functionality. The iterative design process underscored the importance of aligning visual choices with user needs, leading to more effective tools like hexbin and choropleth maps over initial concepts such as cartograms and pie charts.

In hindsight, adding more advanced filtering options to allow simultaneous exploration of distress types, call volumes, and response times could have enhanced user experience for multi-dimensional analysis. In future iterations, I'd like to experiment with machine learning models beyond SARIMA, like neural networks, to improve forecasting accuracy for response times.

Overall, this project has deepened my understanding of narrative visualization and data-driven storytelling. Moving forward, expanding this work to integrate real-time data would add immediacy and relevance, enabling users to monitor live emergency response trends across states

05.Bibliography

Sl.No	References
1	*Create an interactive crime map using shiny*. Doctrine of the Mean. (2016, November 2). https://shu-wan.github.io/r/crime-map/
2	*R Shiny Highcharts - How to create interactive and animated Shiny dashboards*. (n.d.). https://www.appsilon.com/post/r-shiny-highcharts
3	*R Shiny Highcharts - How to create interactive and animated Shiny dashboards*. (n.d.). https://www.appsilon.com/post/r-shiny-highcharts
4	https://www.911.gov/assets/2021-911-Profile-Database-Report_FINAL.pdf

06.Appendix

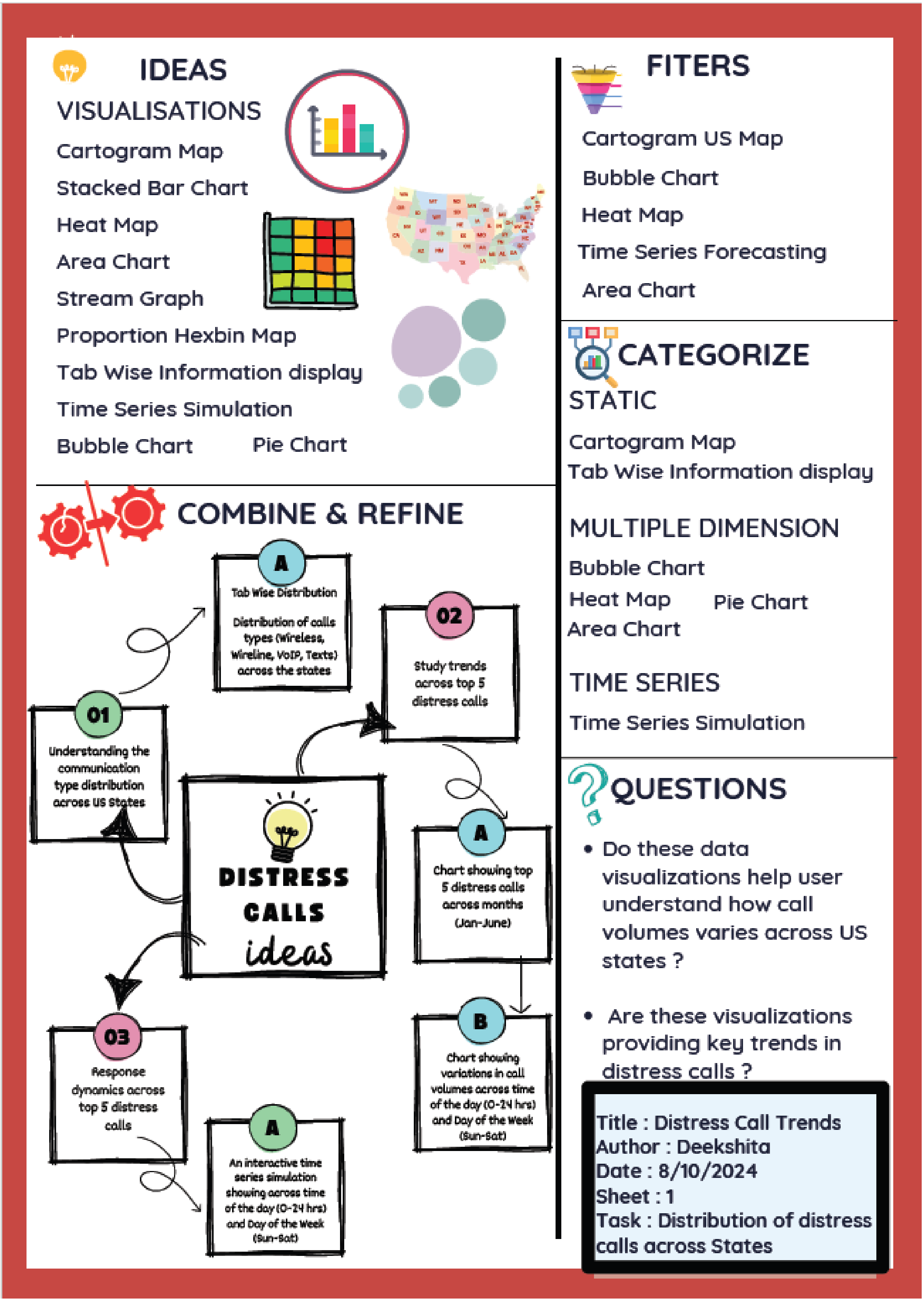
MONASH University

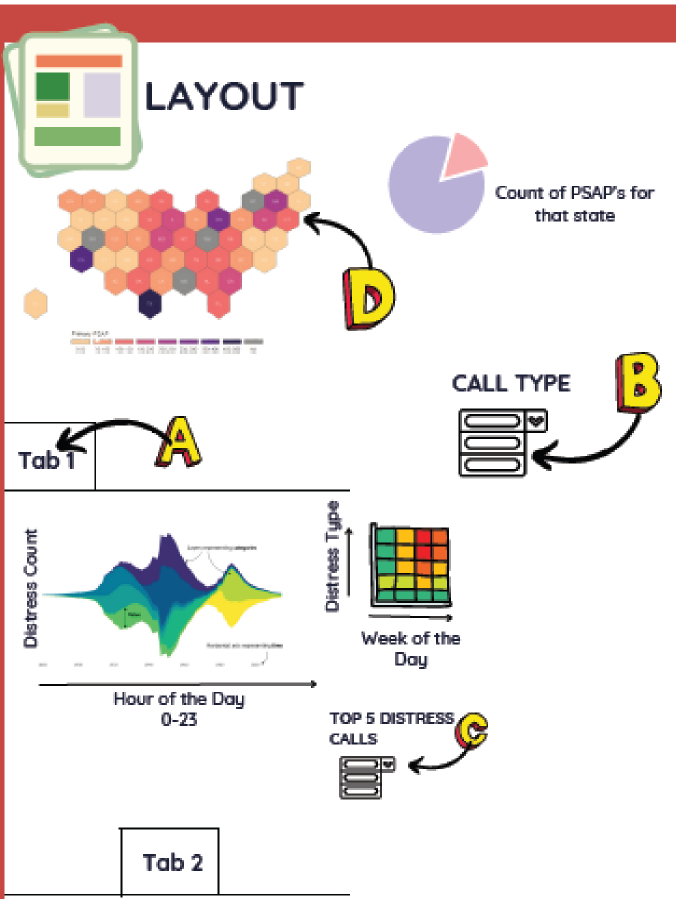
FIT5147 Data Exploration & Visualisation

DVP Part 1: Design (Presentation)

STUDYING DYNAMICS IN DISTRESS CALL

STUDENT NAME	Deekshita
STUDENT ID	34051201
TEACHING ASSOCIATE	Mohit Gupta, Applied 01


IDEAS
VISUALISATIONS
Cartogram Map
Stacked Bar Chart
Heat Map
Area Chart
Stream Graph
Proportion Hexbin Map
Tab Wise Information display
Time Series Simulation
Bubble Chart
Pie Chart
FITERS
Cartogram US Map
Bubble Chart
Heat Map
Time Series Forecasting
Area Chart
CATEGORIZE
STATIC
Cartogram Map
Tab Wise Information display
MULTIPLE DIMENSION
Bubble Chart
Heat Map
Pie Chart
Area Chart
TIME SERIES
Time Series Simulation
COMBINE & REFINE
01
Understanding the communication type distribution across US States
A
Tab Wise Distribution
Distribution of calls types (Wireless, Wireline, VoIP, Texts) across the states
02
Study trends across top 5 distress calls
A
Chart showing top 5 distress calls across months (Jan-June)
B
Chart showing variations in call volumes across time of the day (0-24 hrs) and Day of the Week (Sun-Sat)
DISTRESS CALLS ideas
03
Response dynamics across top 5 distress calls
A
An interactive time series simulation showing across time of the day (0-24 hrs) and Day of the Week (Sun-Sat)
QUESTIONS
• Do these data visualizations help user understand how call volumes varies across US states ?
• Are these visualizations providing key trends in distress calls ?
Title : Distress Call Trends
Author : Deekshita
Date : 8/10/2024
Sheet : 1
Task : Distribution of distress calls across States



FOCUS

CALL TYPE
- Wireless
- Wirline
- VoIP
- Texts

DISTRESS CALLS
- Fire
- Medical
- Traffic Safety
- Patrol Duty
- Crime Investigation

Title : Distress Call Trends
Author : Deekshita
Date : 8/10/2024
Sheet : 2
Task : Distribution of distress calls across States

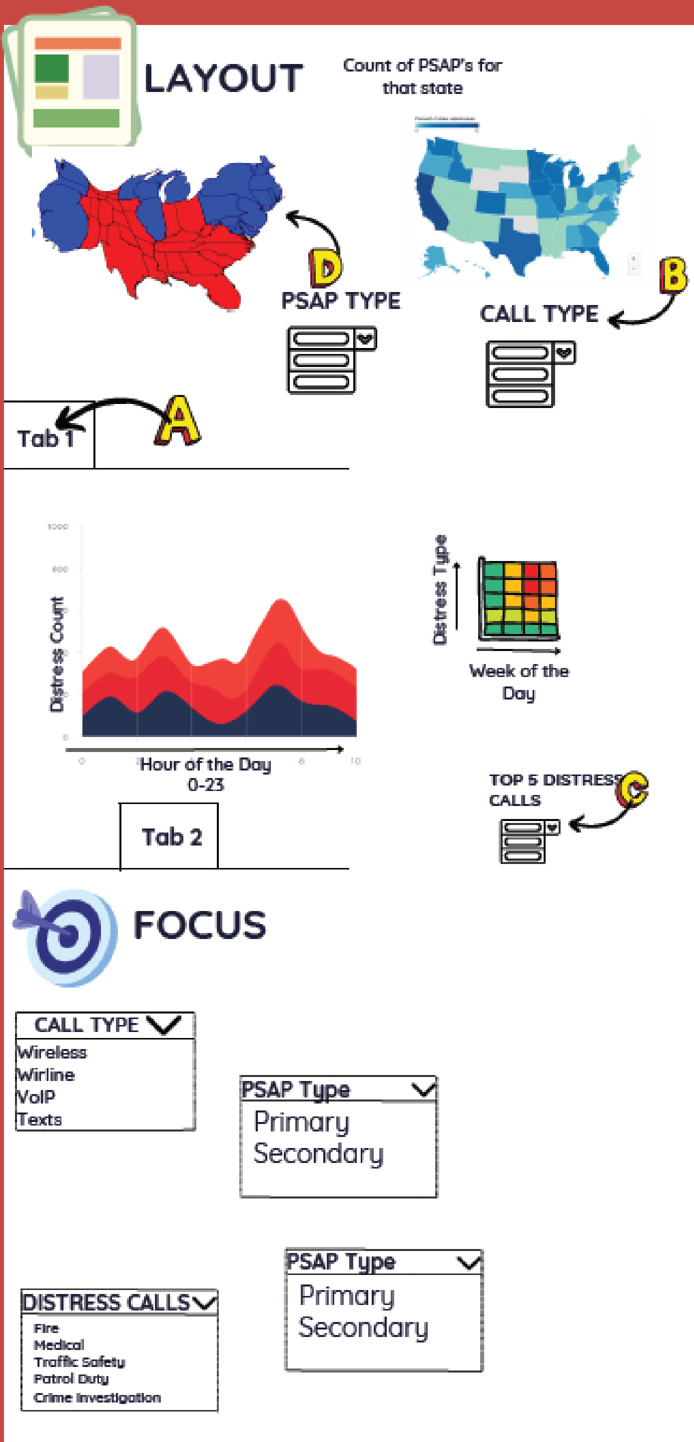
OPERATIONS

- A. Users can switch between tabs. Tab 1 will give a distribution of call types across US states. Tab 2 is based on the distress trends analysis across different points in a day (Hourly, Weekly, Monthly)
- B. Users can choose call type. There are 4 types - Wireless, Wireline, VoIP, Texts. Based on these types, all states are displayed with aggregated values of call types.
- C. Users can choose from 8 distress call type. Each distress type will show the count of Incidents in the graphs mentioned
- D. On selection of a state, pie chart displays PSAP information related to that state

DISCUSSIONS

Pros
- User interaction is convenient.
- There is a story line created between different charts
- Precise choice is made between the distress calls and call type

Cons
- Variations in charts Tab 2 is required to make it more factual
- Include more information in Tab 1



Title : Distress Call Trends
Author : Deekshita
Date : 8/10/2024
Sheet : 3
Task : Distribution of distress calls across States

OPERATIONS

- A. Users can switch between tabs. Tab 1 will give a distribution of call types across US states. Tab 2 is based on the distress trends analysis across different points in a day (Hourly, Weekly, Monthly)
- B. Users can choose call type. There are 4 types - Wireless, Wireline, VoIP, Texts. Based on these types, all states are displayed with aggregated values of call types.
- C. Users can choose from 8 distress call type. Each distress type will show the count of incidents in the graphs mentioned
- D. Count is divided between Primary /Secondary. Based on counts, the graph shows color gradient

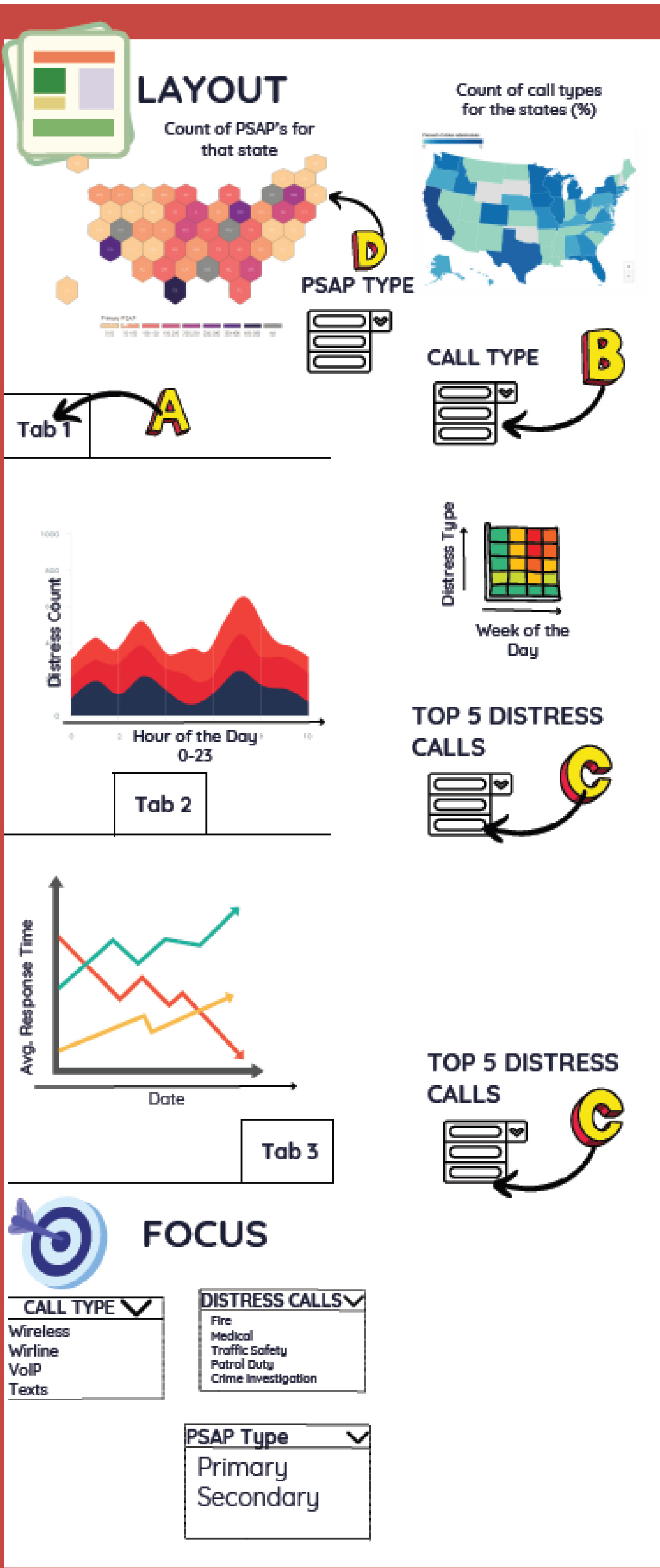
DISCUSSIONS

Pros

- Changing the design to cartogram could give more proportioned information
- Including percentage in pie chart is easier to read
- Using a stacked area chart is easier for a user to read information from a chart

Cons

- Variations in charts Tab 2 is required to make it more factual



Title : Distress Call Trends
Author : Deekshita
Date : 8/10/2024
Sheet : 4
Task : Optimizing Emergency Response Strategies

OPERATIONS

- A. Users can switch between tabs. Tab 1 will give a distribution of call types across US states. Tab 2 is based on the distress trends analysis across different points in a day (Hourly, Weekly, Monthly)
- B. Users can choose call type. There are 4 types - Wireless, Wireline, VoIP, Texts. Based on these types, all states are displayed with aggregated values of call types.
- C. Users can choose from 8 distress call type. Each distress type will show the count of incidents in the graphs mentioned
- D. Count is divided between Primary /Secondary. Based on counts, the graph shows color gradient

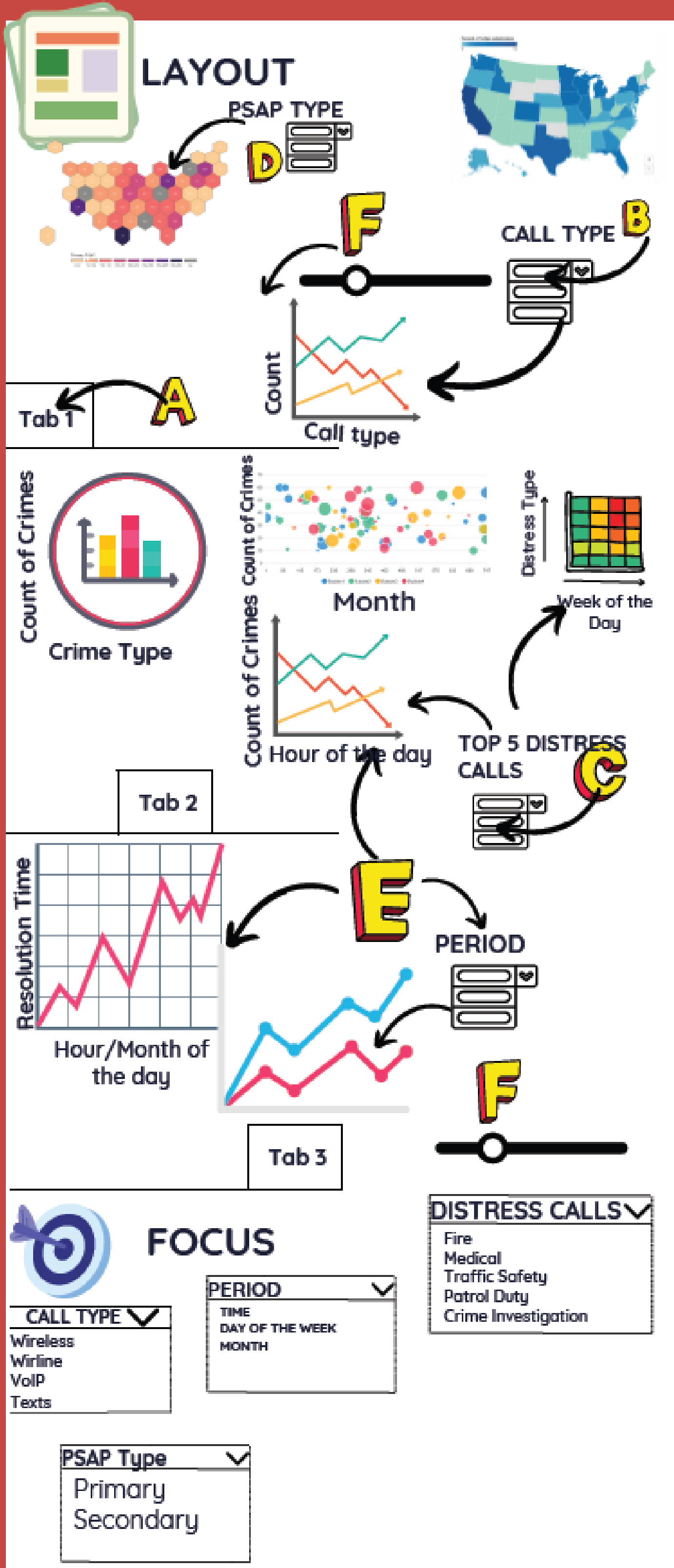
DISCUSSIONS

Pros

- As difference in counts are very less, using hexbin with color gradient is a better approach
- HAving another map giving the % of calls received per state based on call types
- Introducing a time series forecasting for Tab 3 will show predictions in variations of response for top 5 distress calls

Cons

- Having more charts in Tab 2 related to a distress call will make it more factual
- Variations in charts Tab 3 is required to make it more factual



Title : Distress Call Trends
Author : Deekshita
Date : 8/10/2024
Sheet : 5
Task : Optimizing Emergency Response Strategies

OPERATIONS

- A. Users can switch between tabs. Tab 1 will give a distribution of call types across US states. Tab 2 is based on the distress trends analysis across different points in a day (Hourly, Weekly, Monthly)
- B. Users can choose call type. There are 4 types - Wireless, Wireline, VoIP, Texts. Based on these types, all states are displayed with aggregated values of call types.
- C. Users can choose from 8 distress call type. Each distress type will show the count of Incidents in the graphs mentioned
- D. Count is divided between Primary /Secondary. Based on counts, the graph shows color gradient
- E- Period Drop down will have values to choose - either Daily, Weekly, By Month. They can aggregate the incident count and view based on these parameters.
- F- An animation slider for years 2017 to 2024. USers cans elect desired year period and see the how numbers in call types have evolved through time

DETAILS

This dashboard now provides a diverse array of charts with interactive visualization. The presence of dropdowns fosters a customized flow of information along with user engagement. Tab1 captures the flow of information and the other 2 tabs speaks about how this information is handled. Tab2 focuses on the different trends that influence the resolution time, while Tab3 attempts to forecast resolution time trends . This dashboard aims at providing valuable insights for optimizing emergency response strategies