CSE598: Data Visualization
Disaster at St. Himark
Personal Reflection Report

Rutwik Krushna Chaudhari
School of Computing and Augmented Intelligence, Arizona State University
rchaud32@asu.edu

I. Introduction

This is a personal reflection report for the project completed in CSE 578 Data Visualization during the Fall 2023 semester. The objective of this project is to address and solve the problems posed by the 2019 VAST (Visual Analytics Science and Technology) Mini Challenge 1 [1]. This entails synthesizing seismic data, citizen feedback, and city insights to refine response strategies in the aftermath of the earthquake in St. Himark. The project aims to employ visual analytics by using D3 to guide emergency planners in prioritizing neighborhoods and identifying the most impacted regions.

The goal of the visual analytics is to provide answers to the following tasks:

- The emergency responders will base their initial response on the earthquake shake map. Use of visual analytics to determine how their response should change based on damage reports from citizens on the ground. Determine, how would they prioritize neighborhoods for response and which parts of the city are hardest hit
- Use visual analytics to show uncertainty in the data. Compare the reliability of neighborhood reports and determine which neighborhoods are providing reliable reports.
- Determine how the conditions change over time as well as how does uncertainty change over time.

II. Solution

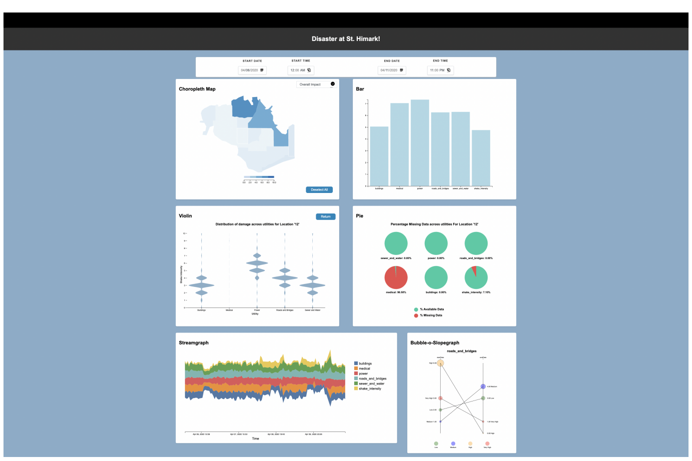

Fig. 1. Complete Dashboard

The solution implemented comprises a dashboard built using JavaScript (JS), a JS visualization library D3 [3], six different visualizations to answer the three questions presented in the VAST MC challenge. As shown in figure 1, it comprises six visualizations: A choropleth map, bar chart, violin chart, pie chart, stream graph and an innovative visualization of bubble-o-slope graph.During the development process, the Five Design Sheet methodology [2] was utilized, which provided a structured approach to conceptualize and refine our visualization strategies. This methodology allowed us to systematically brainstorm, sketch, and iterate through design ideas, ensuring a cohesive and effective visualization framework.

The dataset [5] for Mini-Challenge 1 (MC1) comprises essential files for evaluating the effects of a seismic event in St. Himark caused by an earthquake. The central dataset, *mc1-reports-data.csv*, contains categorical reports detailing shaking/damage in different neighborhoods over time. It includes fields such as **'time'**, denoting a timestamp in the format YYYY-MM-DD hh:mm:ss; **'location'**, serving as a unique identifier for the neighborhood of the report; and categorical fields like **'shake_intensity,' 'sewer_and_water,' 'power,' 'roads_and_bridges,' 'medical,'** and **'buildings.'** These categorical values range from 0 to 10, reflecting the perceived or reported impact, with missing data being permissible across the dataset. The categories encompass various aspects, including earthquake shaking intensity, impact on infrastructure (sewer, water, power, roads, bridges), medical facilities, and building damage.

The initial task of aiding emergency responders to prioritize their response enlightened me about the critical role of visual analytics in crisis management. The choropleth map as shown in figure 2 ,depicts the aggregated impact across the city's regions. The region with the highest color saturation indicates the most impacted region. Understanding how color saturation communicates severity taught me the importance of selecting visual channels for effective communication in data visualization. Moreover, enabling users to interact with the map, providing detailed breakdowns via a bar chart upon clicking, emphasized the significance of user-centric design. This experience underscored the need for intuitive interfaces that empower users to extract nuanced insights effortlessly from visualizations, bridging the gap between complex data and actionable insights.

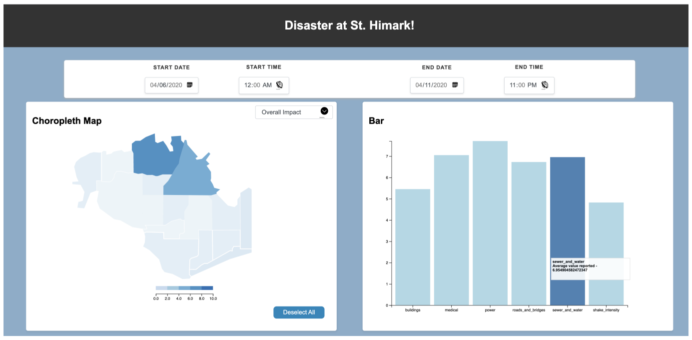

Fig. 2. Choropleth map and bar chart

Solving the task of illustrating uncertainty in seismic data and evaluating neighborhood report reliability involved the implementation of a violin plot[6], which served as an enlightening learning experience. As shown in figure 3, the violin plot displays the distribution of shake intensity across 19 locations. This task emphasized the importance of incorporating comparative perspectives within visualizations to provide nuanced interpretations, strengthening my capability to convey complex insights effectively.

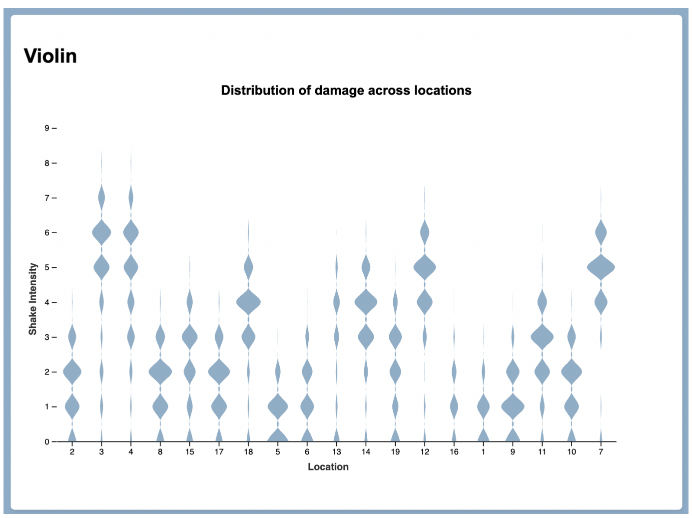

Fig. 3. Violin Chart

Furthermore, enhancing user interaction, clicking on one of the violins triggers the display of a secondary violin plot showcasing the distribution of reports across various utilities within that neighborhood. Simultaneously, six accompanying pie charts appear in the adjacent card, aiding users in comprehending missing data patterns for specific utilities within the selected neighborhood. Both of these visualization can be seen in figure 4. Implementing this interactive feature not only provided a deeper exploration into neighborhood-specific data distributions but also highlighted the significance of contextual insights derived from linked visualizations. This task reinforced my understanding of the importance of interactive elements in visual analytics, emphasizing the value of providing users with comprehensive, interconnected views to extract nuanced information from complex datasets.

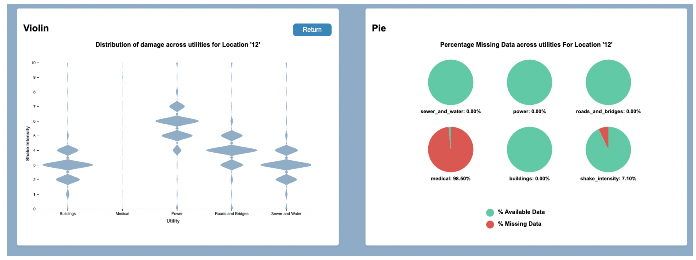

Fig. 4. Violin Chart (Utilities) and Pie Chart

Addressing the final task involved visualizing temporal changes in post-earthquake conditions, culminating in the creation of a stream graph which can be seen in figure 5. This visual representation depicted each stream as a utility over a selected timeframe, allowing emergency responders to discern insights from abrupt spikes in the streams. Additionally, clicking on any stream triggered the display of a complementary visualization – a bubble-o-slope graph. This innovative visualization combined elements of a slope graph and a bubble chart, presenting two axes denoting start time and end time, with four circles representing impact levels (low, medium, high, very high) for a utility. Implementing these visualizations enhanced my grasp of temporal data representation and interactivity in visual analytics. It underscored the significance of providing layered insights through linked visualizations, empowering users to extract comprehensive insights from dynamic datasets.

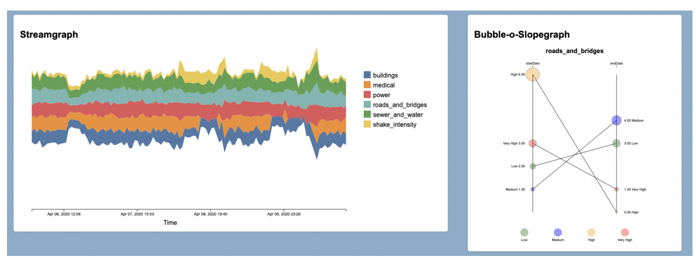

Fig. 5. Violin Chart (Utilities) and Pie Chart

III. Results

The project's visual analytics provided crucial insights for emergency response planning after the St. Himark earthquake. The choropleth map and bar chart offered a comprehensive view of heavily impacted regions, aiding in resource allocation for prioritizing response efforts. Furthermore, the violin plot revealed shake intensity distributions, distinguishing reliable data sources and supplemented with pie charts to highlight missing data. The stream graph illustrated temporal changes in utilities, identifying trends and spikes post-earthquake. Additionally, the bubble-o-slope graph offered a unique comparison of reported impacts, enhancing understanding of utility changes over time. Collectively, these visualizations delivered actionable insights, empowering responders with comprehensive earthquake impact data for informed decision-making in the aftermath.

IV. Contributions to the Project

- **Visualization Strategy:** Contributed significantly by brainstorming diverse visualization techniques to address project challenges effectively. Played a pivotal role in devising initial visualization ideas that shaped the project's visual framework.
- **Design Sheets Development:** Crafted two out of the five design sheets in adherence to the project's methodology, contributing to the initial project proposal. These sheets laid the groundwork for the project's visualization architecture and guided subsequent development.
- **Data Sourcing and Visualization:** Identified and sourced datasets crucial for plotting choropleth maps. Executed the creation of choropleth maps using D3.js, accentuating the impact across various neighborhoods based on utility data. Delved into data filtering to showcase average impacts across utilities within city neighborhoods, enhancing data representation.
- **Tooltip Implementation:** Led the implementation of interactive tooltips, a pivotal feature of the visualization. The tooltips dynamically displayed average utility impact for selected time frames when hovering over specific neighborhoods, enriching user interaction.
- **Temporal Constraints:** Implemented constraints within dropdown menus for start and end times. These constraints ensured users selected valid time frames, thereby enabling exploration only within available temporal boundaries, enhancing data accuracy.
- **Data Cleaning and Processing:** Engaged actively in data cleaning and processing phases, ensuring the integrity and quality of the visualized information. Contributed expertise in optimizing data for accurate and insightful visual representation.
- **Debugging and Troubleshooting:** Provided crucial assistance to team members in debugging and troubleshooting various issues encountered during the project's development stages, ensuring smooth progress and functionality.
- **Project Deliverables and Quality Assurance:** Played a pivotal role in completing project milestones, including biweekly reports, the final project report, and the creation of the project poster. Conducted meticulous sanity checks, fixed bugs, and ensured the quality of implementation met project standards.

By actively participating in various facets of the project, from conceptualization to execution and quality assurance, I contributed significantly to achieving project objectives while upholding data integrity and user-centric visualization design.

V. New Skills Acquired

Throughout the completion of this project, I acquired several new skills, contributing to an enriched understanding of data visualization and its practical applications:

- **D3.js Implementation:** I gained proficiency in utilizing D3.js for creating interactive and dynamic visualizations, allowing for a deeper exploration of data and user interaction.
- **Statistical Visualization Techniques:** I also acquired knowledge and practical experience in employing statistical visualization techniques such as choropleth maps, violin plots, and stream graphs to represent complex data patterns effectively.
- **Data Cleaning and Processing:** The project helped me to develop skills in data preprocessing, cleaning, and filtering to ensure data integrity and improve the quality of visual representations.
- **Interactive Dashboard Development:** I learned to create comprehensive dashboards comprising multiple interconnected visualizations, enabling users to derive nuanced insights from complex datasets.
- **Debugging and Troubleshooting:** Finally, I also acquired proficiency in identifying and resolving issues encountered during the development phase, enhancing problem-solving abilities in a project environment.

These new skills helped me to significantly contribute to the successful completion of the project and will serve as a valuable asset in my future endeavors in the field of data visualization and analysis.

VI. Conclusion

The project focused on addressing challenges outlined in the 2019 VAST Mini Challenge 1, consolidating seismic data, citizen feedback, and post-earthquake insights for St. Himark. Employing D3-powered visual analytics, it produced a comprehensive dashboard with diverse visualizations aiding emergency planners in neighborhood prioritization, damage assessment, and temporal analysis following the earthquake. Contributions involved visualization strategy, design sheet development, data sourcing, and cleaning, ensuring dashboard integrity. Overall, the project's varied visualizations provided critical insights into damage reports, data reliability, and temporal shifts post-earthquake, serving as an essential decision-making tool for emergency responders and highlighting user-centric design and robust data representation.

References

[1] VAST 2019 Mini Challenge 1. [Online] Available at: https://vast-challenge.github.io/2019/MC1.html

[2] Roberts, J. C., Headleand, C., & Ritsos, P. D. (2015). Sketching designs using the five design-sheet methodology. *IEEE Transactions on Visualization and Computer Graphics, 22*(1), 419-428.

[3] Bostock, M., & Observable, Inc. (2023). D3.js Documentation. [Online] Available at: https://d3js.org/

[4] The D3 Graph Gallery. (2018). Choropleth Map. [Online] Available at: https://d3-graph-gallery.com/choropleth.html

[5] VAST 2019 MC1 Dataset [Online] Available at: https://visualdata.wustl.edu/varepository/benchmarks.php

[6] Wikipedia. Violin plot [Online] Available at: https://en.wikipedia.org/wiki/Violin_plot