CSC/SDS 235: Visual Analytics

Fall 2024

HW 05: Bringing It All Together

This is a group assignment (3-4 students) – I recommend choosing collaborators with complementary skillsets to yours!

Goals:

- Explore network data via visual analytics
- Work with network (graph) data

Instructions

Overview

Scenario

St. Himark is a vibrant community located in the Oceanus Sea. Home to the world-renowned St. Himark Museum, beautiful beaches, and the Wilson Forest Nature Preserve, St. Himark is one of the region's best cities for raising a family and provides employment across a number of industries including the Always Safe Nuclear Power Plant. Well, all that was true before the disastrous earthquake that hits the area during the course of this year's challenge. Mayor Sarah, city officials, and emergency services are overwhelmed and are desperate for assistance

in understanding the true situation on the ground and how best to deploy the limited resources available to this relatively small community.

Citizen Science Damage Reports

In the immediate aftermath of the earthquake, officials are scrambling to determine the extent of the damage and dispatch limited resources to the areas in most need. They quickly receive seismic readings and use those for an initial deployment but realize they need more information to make sure they have a realistic understanding of the true conditions throughout the city.

In a prescient move of community engagement, the city had released a new damage reporting mobile application shortly before the earthquake. This app allows citizens to provide more timely information to the city to help them understand damage and prioritize their response. With emergency services stretched thin, officials are relying on citizens to provide them with much needed information about the effects of the quake to help focus recovery efforts.

Hint: App responses in conjunction with shake maps of the earthquake strength may help identify areas of concern for emergency planners. (Note: the shake maps are from April 6 and April 8 respectively.)

The Always Safe Nuclear Power Plant

One of St. Himark's largest employers is the Always Safe nuclear power plant. The pride of the city, it produces power for St. Himark's needs and exports the excess to the mainland providing a steady revenue stream. However, the plant was not compliant with international standards when it was constructed and is now aging. As part of its outreach to the broader community, Always Safe agreed to provide funding for a set of carefully calibrated professional radiation monitors at fixed locations throughout the city. Additionally, a group of citizen scientists led by the members of the Himark Science Society started an education initiative to build and deploy lower cost homemade sensors, which people can attach to their cars. The sensors upload data to the web by connecting through the user's cell phone. The goal of the project was to engage the community and demonstrate that the nuclear plant's operations were not significantly changing the region's natural background levels of radiation.

Unfortunately, during the quake the nuclear power plant suffered damage resulting in a leak of radioactive contamination. Further, a coolant leak sprayed employees' cars and contaminated them at varying levels. Now, the city's government and emergency management officials are trying to understand if there is a risk to the public while also responding to other emerging crises related to the earthquake as well as satisfying the public's concern over radiation.

Hint: reviewing the city description document may be helpful to understanding the landscape and character of the city.

Social Media Reports

Seismic and survey data are useful for capturing the objective damage that the earthquake caused St. Himark. However, this data has limitations. First, official surveys are time consuming and do not stay current in a rapidly changing situation. Second, they don't establish how citizens are reacting to the current crisis. Third, they are often insufficiently granular, providing little insight into differences between neighborhoods. In other words, the seismic and survey data do not provide an up-to-date view of the structural and humanitarian impact caused by the earthquake on a neighborhood-by-neighborhood basis. The City has concluded that this knowledge is necessary to determine where to allocate emergency resources.

In disasters, people reach out to friends and family to check in and discuss what they see happening around them. The city and its emergency response teams are hoping to gain an understanding of the issues facing the citizenry they can't get through seismic readings and survey responses. They are looking to you to help them turn social media posts into an information source helping guide them as to where to focus efforts and what the concerns of the populace are.

City Officials have identified a subset of Y*INT, a community-based social media platform, as a potential source for revealing the current state of St. Himark's neighborhoods and people. Knowing that you are skilled in visual analytics, the City has asked you to analyze Y*INT messages in order to determine the appropriate actions it must take in order to assist the community in this disaster.

The Data

To support your analysis, you have been granted access to several datasets:

- A CSV file containing (categorical) individual reports of shaking/damage by neighborhood over time, formatted as follows:

- o `time`: timestamp in the format YYYY-MM-DD hh:mm:ss (may be in order, may not; depends on how good the Rumble developers were...)
  - o `location`: id of neighborhood where person reporting is feeling the shaking and/or seeing the damage
  - o `{shake_intensity, sewer_and_water, power, roads_and_bridges, medical, buildings}`: reported categorical value of how violent the shaking was/how bad the damage was (1-low, 10-highest; be prepared for missing data!)
- Pre- and post-quake shakemaps
- Static and mobile radiation sensor data
- Maps of St. Himark (as both images and shapefiles)
- A CSV file of social media posts where people are reacting to events and the effects of those events on them, spanning from 04/06/2020-04/12/2020, with the following fields:
  - o `time`: date/time the message was posted
  - o `location`: which St. Himark neighborhood the message was posted from
  - o `account`: user handle of the person who posted the message
  - o `message`: the content of the message itself

The data is available on Moodle. You may use as much or as little of the data in your analysis as you like. For this challenge, it is strongly recommended that you make use of as much of the data as you can!

Your Objective

Overwhelmed by the scale of the disaster, city of Himark officials are looking for help to build a more complete understanding of the situation on the ground. They have access to multiple data sources, but each on its own is an incomplete view into the situation. To tackle this challenge, you'll need to fuse these disparate data to give officials a fuller situational awareness than is possible with any individual source.

Officials are especially interested in understanding how the uncertainty in each source interacts with the others. Can sources reinforce or refute findings in other sources? Does combining sources bring the situation into clearer view or just increase confusion? The citizens of St. Himark are trying to assist their government by providing more information than official channels would be able to on their own, but they need your help to integrate those sources into a form that allows officials to do their job as efficiently and with the greatest impact possible.

Here are a few guiding questions / tasks to get you started:

- Generate a master timeline of events and trends during the emergency response. Pay particular attention to places where the timing of events is uncertain, and note which data underlies that uncertainty.

- Emergency responders will base their initial response on the earthquake shake map, but their response may change based on damage reports from citizens on the ground. How would you prioritize neighborhoods for response?
- Compare the reliability of neighborhood reports. Which neighborhoods are providing reliable reports? Provide a rationale for your response.
- Compare radiation measurements over time from both static and mobile sensors to identify areas where elevated radiation is detected. How does this change over time? How should the risk of radiation damage be mitigated?
- Characterize conditions across the city, and recommend how resources should be allocated at 5 hours and 30 hours after the earthquake. Include evidence from the data to support these recommendations. Consider how to allocate resources such as road crews, sewer repair crews, power, and rescue teams.
- Identify any times when conditions change in a way that warrants a re-allocation of city resources. What were the conditions before and after the inflection point? What locations were affected? Which resources are involved?
- Take the "pulse"" of the community. How has the earthquake affected life in St. Himark? What is the community experiencing?
- Are there instances where a pattern emerges in one set of data before it presents itself in another? Could one data stream be used to predict events in the others? Provide examples you identify.
- The data in this challenge can be analyzed either as a **static collection** or as a **dynamic stream of data**, as it would occur in a real emergency. Can you find a way to bring your analysis *online* to fuse multiple data streams together as events are unfolding?

Again, as always: don't worry too much about getting the "right answer" - instead, focus on making sure that the evidence your present should support your hypotheses, and have fun!

Good luck!

Deliverables

You will submit *four* deliverables for this assignment:

1. Sketches of the visualization(s) you intended to create.
2. The write up you would present to your supervisor based on your analysis.
3. Code (and a README.txt with instructions for running the code) that generates the visualization(s) in your write up.

4. A reflection (the entire group can write a reflection together, or group members may write individual reflections) that includes:
   - How each group member contributed to the final submission
   - One obstacle you encountered and how you overcame it
   - If you were to do this assignment again, what you would do differently.

Submission

Submit your deliverable(s) in on Gradescope. If you worked on the reflection as a group, submit as a group (https://guides.gradescope.com/hc/en-us/articles/21863861823373-Adding-Group-Members-to-a-Submission), otherwise submit (all pieces) individually.

Rubric

The following matches the rubric you will see on Gradescope. **Note your sketches and reflection weight most heavily into your grade.**

	Missing / Not Complete (0)	Approaching (3)	Meets (5)	Exceeds (6)
Sketches	Not submitted or not readable.	Sketches are difficult to read and/or need more detail. They do not demonstrate appropriate visual mappings (as discussed in lecture), or clearly support the analysis objectives.	Sketches are difficult to read and/or need more detail. They include some appropriate visual mappings (as discussed in lecture), but not all visual mappings are appropriate. Some visualizations do not support the analysis objectives.	Sketches are detailed, clear, and easy to read. They demonstrate appropriate visual mappings (as discussed in lecture), and clearly support the analysis objectives.
Reflection	Not submitted or not readable.	Reflection does not fully address all three points listed above. And/or needs improvement in one or more of the following areas: formatting, grammar and spelling, clear, concise writing.	Reflection addresses all three points listed above, but answers are not thoughtful. It is well formatted, contains good grammar and spelling, and clear, concise writing.	Reflection thoughtfully addresses all three points listed above. It is well formatted, contains good grammar and spelling, and clear, concise writing.

Continued on next page

	Missing / Not Complete (0)	Approaching (1)	Meets (2)
Code	Not submitted.	Code does not run.	Code runs.
Write-up	Not submitted or not readable.	Write up addresses some but not all the objective(s) of the assignment. It could use improvement in one or more of the following areas: formatting, grammar and spelling, clear, concise writing. Hypotheses are unclear and/or not supported by visualizations shown.	Write up clearly addresses the objective(s) of the assignment. It is well formatted, contains good grammar and spelling, and clear, concise writing. Hypotheses are present and well supported by visualizations shown.