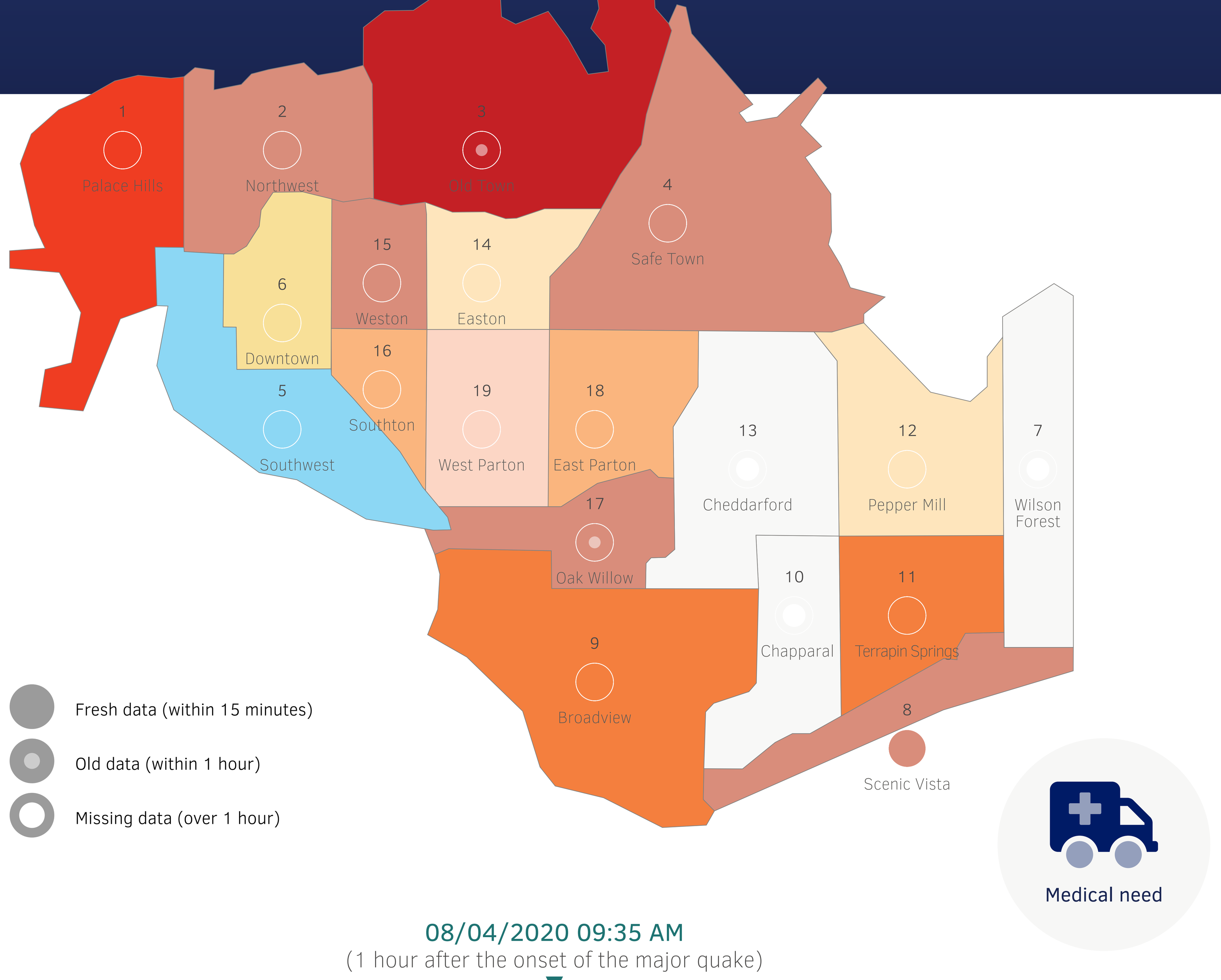
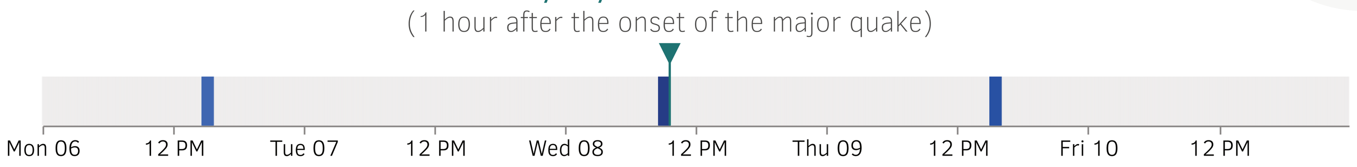
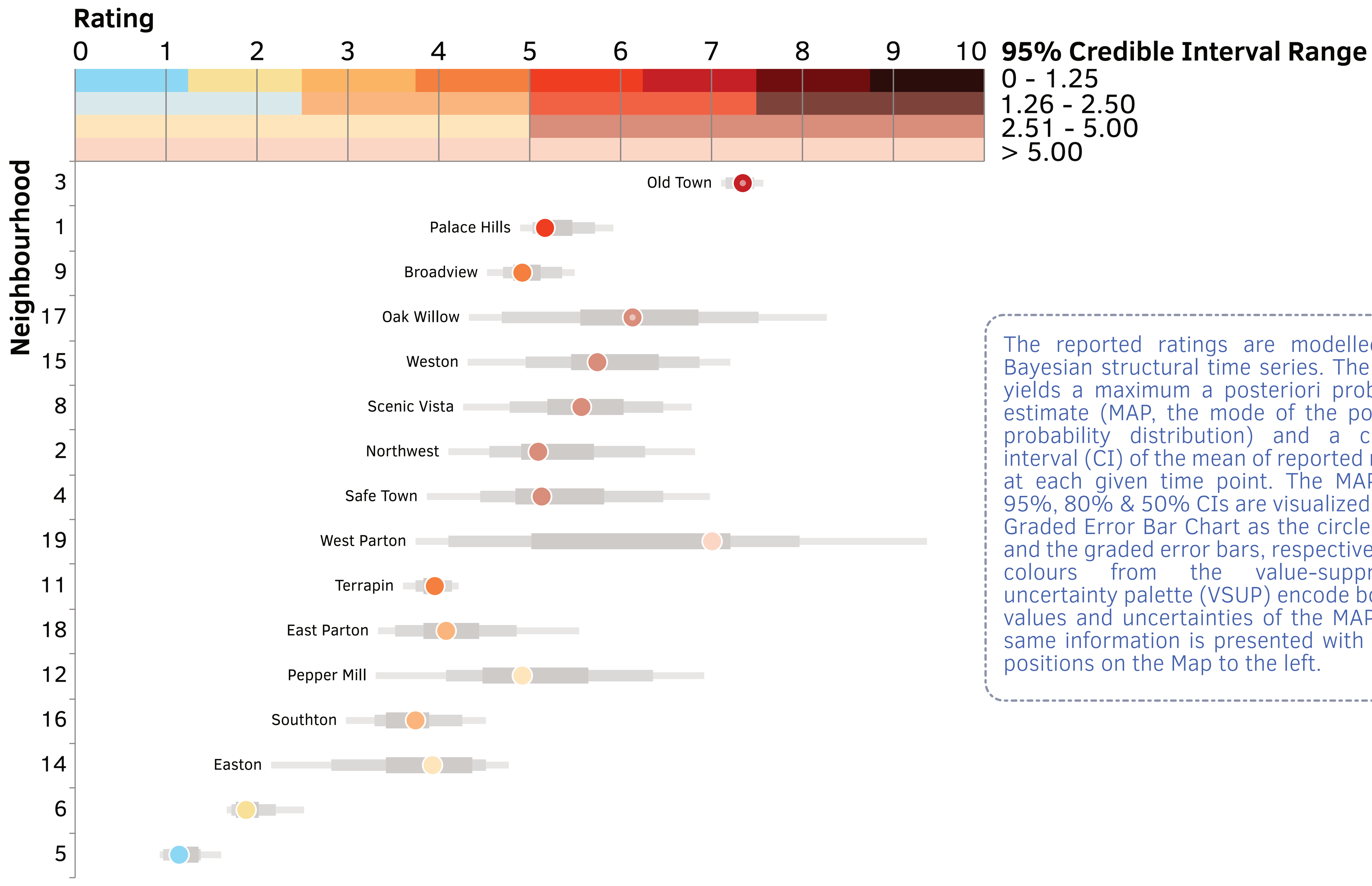
VAST Challenge 2019: Disaster at St. Himark! – IEEE VIS 2019 in Vancouver, Canada

Earthquake Damage Report Interactive Dashboard Using Bayesian Structural Time Series and Value-Suppressing Uncertainty Palettes

AWARD FOR OPERATIONALIZING VISUALIZATION THEORY
MC1





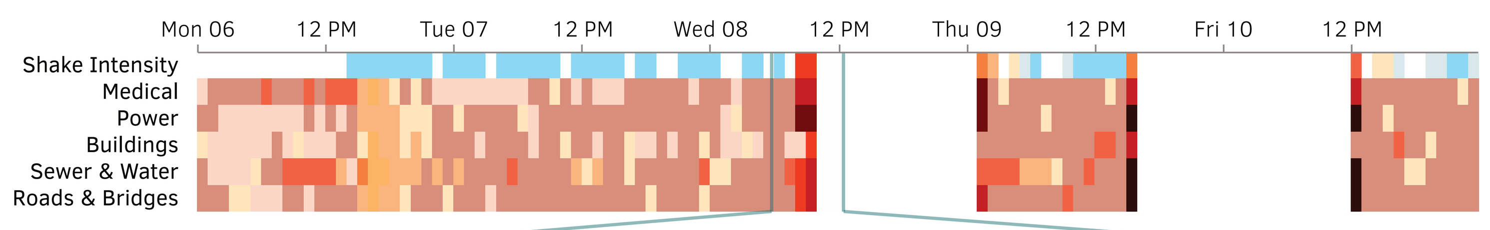


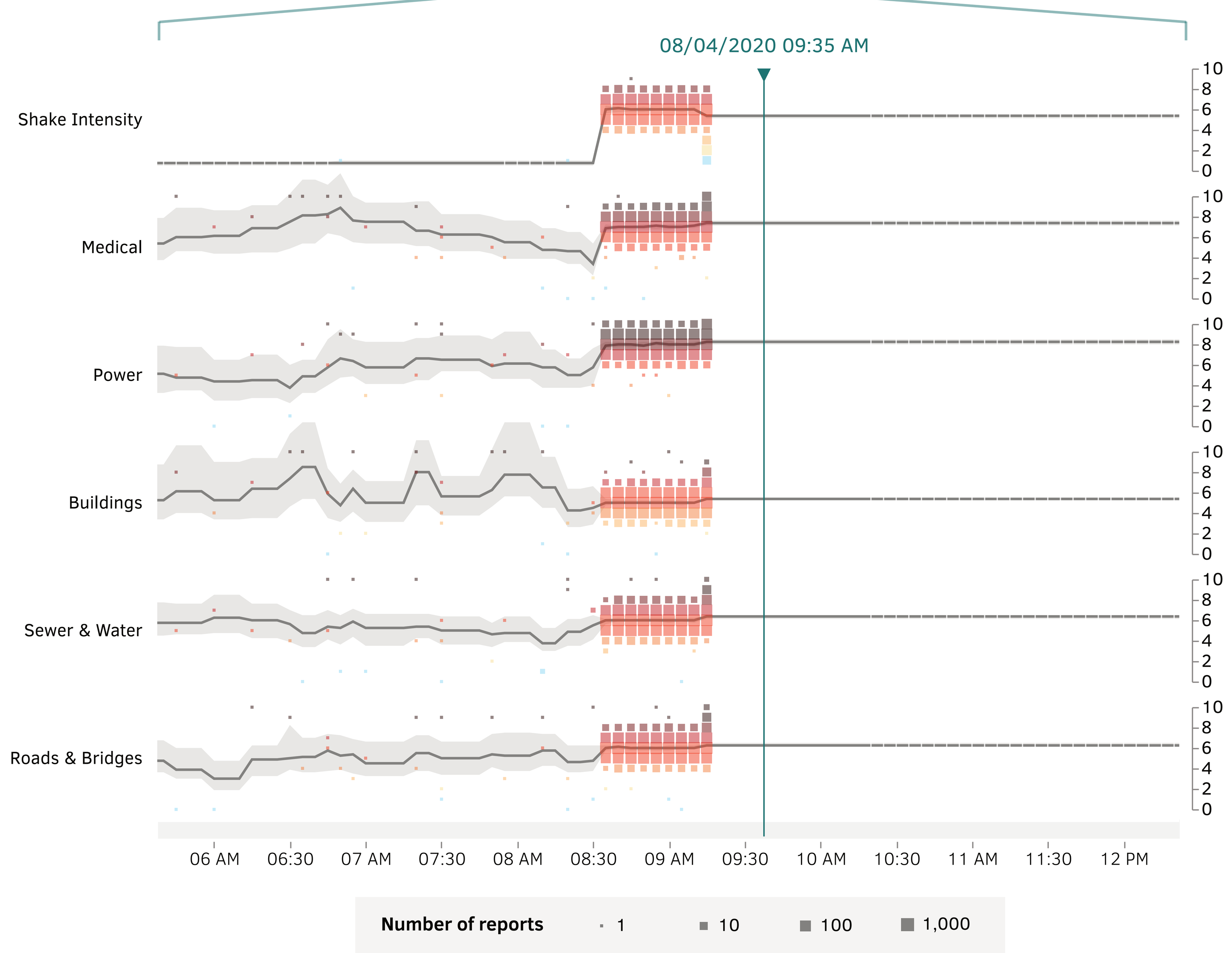
The reported ratings are modelled with Bayesian structural time series. The model yields a maximum a posteriori probability estimate (MAP, the mode of the posterior probability distribution) and a credible interval (CI) of the mean of reported ratings at each given time point. The MAPs and 95%, 80% & 50% CIs are visualized on the Graded Error Bar Chart as the circle marks and the graded error bars, respectively. The colours from the value-suppressing uncertainty palette (VSUP) encode both the values and uncertainties of the MAPs. The same information is presented with spatial positions on the Map to the left.

The Heat Map displays the maximum values of hourly aggregated MAPs of ratings and their respective 95% CIRs. We can zoom into specific portions of the Heat Map to visualize a section of the temporal data on the Line Charts underneath.

The Line Charts display the MAPs and 95% CIs of reported ratings. The square marks show the counts of the reports at each time point. When there is no report within the last hour, the Line Charts are marked with white stripes.

Neighbourhood:
3 Old Town





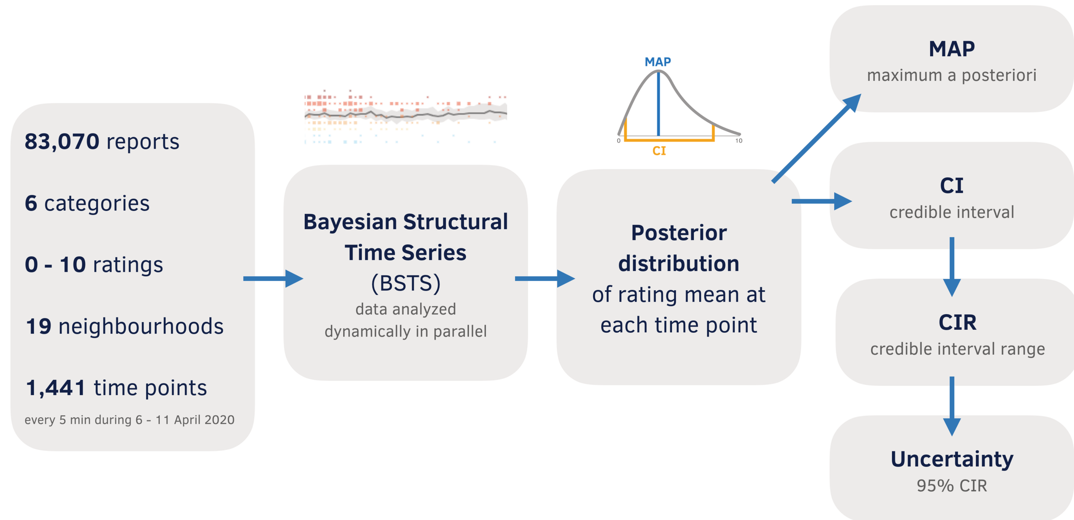
1 Domain Situation

Emergency responders have damage intensity reports from citizen over time. They need to find neighbourhoods that certainly need help the most in real time.

Crowdsourced data may vary markedly, especially when the reports are based on subjective measurements. Therefore, the emergency responders should be informed about the uncertainty in the reports.

Situations and incoming reports are dynamic. Is the uncertainty dynamic too?

2 Data Abstraction



3 Visual Encoding and Interaction Idiom

There are four visual representations: 1. Error Bar Chart 2. Map with Choropleth and Circle Marks 3. Heat Map and 4. Line Charts. All representations are assembled together. They are in sync and interacting with one another.

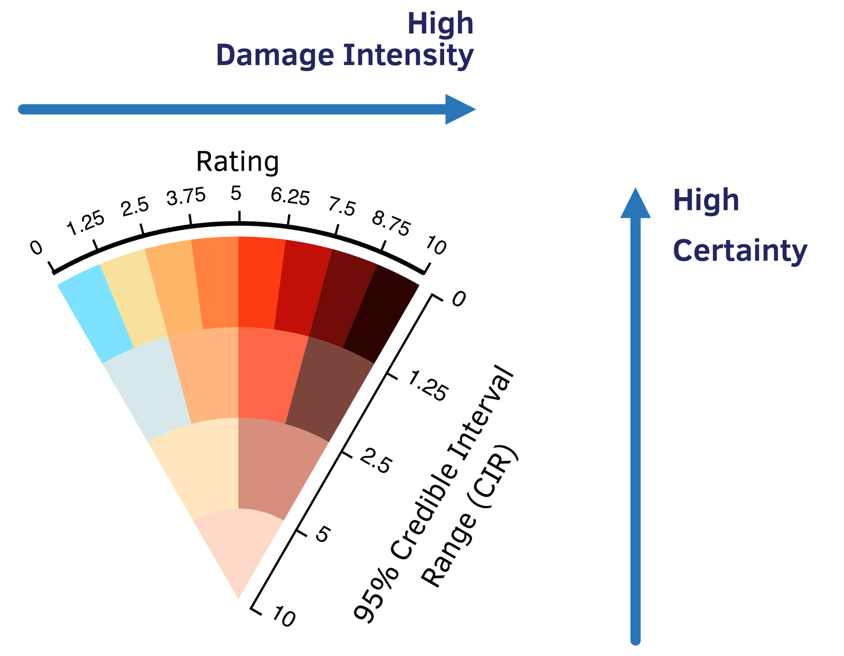
On this dashboard, the values and uncertainties of the MAPs are encoded with colours from the value-suppressing uncertainty palette (VSUP) [1].

The VSUP compresses two data attributes into one visual channel. This has at least three main benefits to this dashboard.

1. Compared to two channels, a single channel demands less cognitive load from the viewer. They no longer need to mentally gauge the credibility of the values, which also facilitates comparisons between spatial locations or between temporal points.

2. The more certain a value is, the more vibrant its colour is. Colour vibrance is a pre-attentive visual attribute that draws attention. This is beneficial for detecting damaged locations with high certainties.

3. As represented by a single channel, the colour can combine with other channels to compose scalable visualization, such as positions in Heat Map.



4 Algorithm

To perform data analysis, aggregation and transformation, we used R with several libraries, namely bsts [2], tidyverse, coda, bayestestR, doFuture, and zoo. To reduce the loading time, we ran this analysis prior to the visualization creation on Google Cloud Platform, and used the processed results for the visualization.

All visual elements and interactions are rendered and handled by Vega [3] with customized specification JSON files. The web interface was made with VueJS, NuxtJS, VueX, and Element UI.

To find further insights from the processed data, we used Tableau Desktop to create interactive dashboards. Please find more Visual Analytics exploration in the project submission.

References

[1] Correll M, Moritz D, Heer J (2018), "Value-Suppressing Uncertainty Palettes," in Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18, vol. 272, no. 7286, pp. 1–11, doi:10.1145/3173574.3174216.

[2] Scott S L, Varian H R (2013), "Predicting the Present with Bayesian Structural Time Series," SSRN Electron. J., pp. 1–21, doi:10.2139/ssrn.2304426.

[3] Satyanarayan A, Russell R, Hoffswell J, Heer J (2016), "Reactive Vega: A Streaming Dataflow Architecture for Declarative Interactive Visualization," IEEE Trans. Vis. Comput. Graph., vol. 22, no. 1, pp. 659–668, doi:10.1109/TVCG.2015.2467091.

Tools

Project submission

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