

## What Do You See? Perception, Algorithms, and Statistical Graphics

Statistical graphics are powerful and efficient tools to convey numerical information for human decision making. However, research on graphical perception is a patchwork of inconsistent methods, and most recommendations are based on opinion rather than empirical study. As a result, many scientific communications may be sub-optimal or ineffective. My long-term career goal is to research statistical graphics and data visualization, *helping humans and algorithms work together more efficiently and effectively* and applying this research to educate a new generation of data scientists as well as the wider community.

My **research goal** is to advance our understanding of the use and perception of data displays, and how the design of graphics impacts our ability to use them successfully. To address this goal, I will develop multi-modal methods for testing charts, examining effectiveness across different tasks, such as comparison, prediction, and estimation. I will empirically validate guidelines for graphical creation, assessing the effect of design decisions on the utility of charts across different uses. I will also develop new statistical features that mimic human performance in visual examination of forensic evidence, producing validated, empirical, quantitative tools forensic scientists can use for reproducible decision-making.

My **education goal** is to develop tools and curricula to support statistical learning and scientific decision making in society. I will address this goal in three ways: I will develop and implement experiential learning activities in graphics for undergrad intro statistics courses. I will also create and implement OER lessons on reproducible science and open-source software for use in statistical programming courses at the graduate and undergraduate level. I will also work with graduate students to engage with forensic scientists, lawyers, and judges, evaluating the scientific support for forensic disciplines and promoting the importance of open, reproducible forensic science.

### Intellectual Merit

Graphical research will expand our understanding of applied perception and scientific communication in general, expert, disabled, and neurodivergent populations. New methods for graphical study will produce new directions for research in InfoVis and new tools for evaluating scientific communication. My research in forensic perception will advance our understanding of visual evidence comparisons, produce better error rate estimates, and approach explainable machine learning in a new way. Incorporating experiential learning and graphics research into intro stats courses will inform new course design and barriers to interest and engagement in STEM. Finally, assessing the OER curricula developed for reproducibility and open-source science will allow us to measure and explore the development of students' attitudes toward ethical science and responsible conduct of research.

### Broader Impacts

The statistical graphics research will produce empirical guidelines for better science communication. Applying our improved understanding of visual perception, we will develop algorithms for quantitative, reproducible evaluation of forensic pattern evidence. Engaging with the justice system will emphasize the failings of current subjective evaluation methods, motivate the importance of these algorithms, and facilitate conversations between grad students in quantitative fields and judges, lawyers, law students, and forensic scientists. Experiential learning and research engagement will produce students who are more engaged in STEM coursework and less averse to STEM careers (while also facilitating more research productivity). Incorporating reproducibility and open-source software development into statistical coursework will produce scientists with the ability to contribute to the open-science community and emphasize the importance of reproducible, open science, producing students who are engaged and equipped to build new infrastructure while conducting better science.