

Visualizing spatial uncertainty

I. Brief description of topic area

Representing uncertainty is difficult to do in many data visualizations. This is particularly true in spatial data visualizations and cartography, where at least two of the dimensions (x and y) are typically unavailable for representing uncertainty. Despite this, most spatial data have some measure of uncertainty associated with them. This can be *spatial uncertainty* (e.g. gps error, ambiguity in the border between polygons or raster resampling effects) as well as *data uncertainty* (e.g. error terms in modeled data or uncertainty measures that come from survey data). The available literature on uncertainty in spatial visualizations tends to be highly complex and focused on advanced, highly computational techniques, making it a daunting topic for novice or intermediate users.

Despite their importance, discussions of uncertainty are rarely integral parts of early data visualization, cartography or GIS training, instead often being addressed towards the end of a GIS or Data Science program. This does not reach the majority of students and researchers using these tools. Most users are less specialized and (often rightly) treat spatial visualization software as a tool to augment other research techniques. Thus, they are rarely given the tools to critically engage with the visualizations they create. This is especially true at universities like Notre Dame where there is no geography department and the vast majority of GIS and spatial analysis training happens in a library-based digital scholarship center.

II. Plan for addressing/researching the topic area

To address this topic, I propose to work on primarily two tasks:

1). Gain a better understanding of ways of effectively visualizing uncertainty

With a particular focus on spatial uncertainty, this phase will include a literature review, developing a gallery of effective and ineffective ways of visualizing different types of uncertainty and a survey of best practices from other researchers (both Visualizing the Future participants and other colleagues). I can envision the results of this phase being shared publicly as a series of blog posts or on a LinGuide-like platform.

2). Investigate ways to integrate these methods into teaching.

In this phase, I will work to develop scalable lesson plans, workshop outlines, and modules to insert a discussion of spatial uncertainty into introductory training on data visualization and GIS. I plan to test some of this material over the coming year, both in credit bearing classes, guest lectures and as a stand-alone workshop.

III. Relevance to current position

I am integrated into data visualization (both spatial and not) at multiple levels at the University of Notre Dame. As the GIS librarian in the Navari Family Center for Digital Scholarship, I am the primary resource for cartography and GIS at the University of Notre Dame. I assist students, faculty and the community with data analysis and visualization through consultations, workshops and guest lectures. I teach the only full semester Introduction to GIS class on campus. Currently we only touch on uncertainty in a very brief way towards the end of a lecture on spatial modeling. Integrating a better understanding of advanced visualization techniques will give me additional tools to bring to my work and personal research. Also, I am the designer and instructor for a formal Data Visualization class taught through our Master of Data Science Program in the Applied and Computational Mathematics Department. Thus, the results of this research also fit well into my roll as a consultant and instructor for a variety of departments and research projects.

IV. Ideas for the impact this topic will have on visualization instruction

While I fully plan to incorporate a study of spatial (and other types of) uncertainty into the syllabus of my Data Visualization course, that class only reaches 20-30 students a year in an online technical masters program. I am much more excited to find ways to bring an understanding of spatial uncertainty to basic GIS training through the intro class, developing a stand-alone uncertainty workshop and most importantly, finding a more direct way to discuss uncertainty in the context of introductory one hour workshops/guest lectures. This will introduce an important topic early on in students' training. Even if they are not prepared at this early stage to implement more advanced visualization techniques, understanding the necessity and underlying concepts will only make make them most effective producers and consumers of spatial data visualizations.

