Supporting understanding of complex spatio-temporal relationships with multi-perspective visualizations linked through smooth display transitions

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Abstract:

Data and information structures of a wide range of specialist areas are increasingly comprehensive and complex. In response, the development of approaches for explorative and communicative visualization of such complex content is a topical and dynamic field of research. While, for example, we can fall back on bar charts for simple quantity visualizations, such 'go-to' visualization methods are harder to identify for complex hierarchical and multidimensional spatial or spatio-temporal data. Our ongoing work aims at identifying existing methods that offer guidance and proposing and testing additional generic approaches to support the spatial visualization of complex spatio-temporal data and structures and their interrelationship. The methods should be generic in the sense that they guide the development of visualizations and are transferable to different data and topics, without hindering adjustments and expression of the specific topics.

For data and application examples, we collaborate with researchers of the project 'Building Cultures of Switzerland 1945-1975. Contexts - Strategies - Perspectives', where key buildings as well as infrastructure networks (like transportation or telecommunication networks) are analysed through time. We have identified three generic spatio-temporal visualization challenges: a) the relationship between one or several built objects and a network, i.e., the development of the highway network in relation to signature bridge constructions; b) the relationship between different built networks, i.e., the mutual influence of the concurrent development of the highway and energy network; and c) the relationship between a built and an intangible network, i.e., the development of the highway network in relation to the network of architects and main suppliers.

In the three mentioned visualization challenges, the underlying difficulty are the characteristics of spatial data and suitable visualizations thereof. Space is usually displayed using the available display space and spatial data is typically denser in areas of higher interest. Approaches such as generalization (e.g., SGK 2002), focus+context methods (e.g., Hollenstein & Bleisch 2022) or aspatial representations of spatial data (e.g., a bar chart showing population values of different countries) are very valuable. Interdisciplinary brainstorming and discussions of the identified visualization challenges have shown that, in all the available cases and examples, different perspectives are important (cf. the example of 'Powers of Ten') and that spatial displays are generally irreplaceable for understanding the exact concepts that also cause the representation challenges. Showing visualizations of different perspectives of the same data on a large screen concurrently is often used. Making the same views available on smaller screens is more difficult. Thus, we build a first approach on the proposal of smoothly transitioning one display of information to another (Tominski et al. 2021). As hypothesized, we may need to stage the transition considering the data dimensions (Tominski et al. 2021) and potentially create intermediate explanatory displays. Employing different displays of the same data that are interactively connected to show relationship also allows creating simpler visualizations for each display, relying on established visualization methods.

Currently, implementation and testing of the smooth transition approach between different perspective views for several example data sets is ongoing. We are exploring and testing the approach regarding its implementation, its usefulness as guiding principle and the utility of intermediate explanatory displays. Also, the ease of understanding as well as the potential and limitations of the approach in communicating the different complex relationships, such as the development of infrastructure networks, its spatial effects and the interactions between infrastructure buildings, are evaluated.

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