Berliner Colloquium für wissenschaftliche Visualisierung

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The Role of Mathematical Optimization in the Visualization of Complex Data

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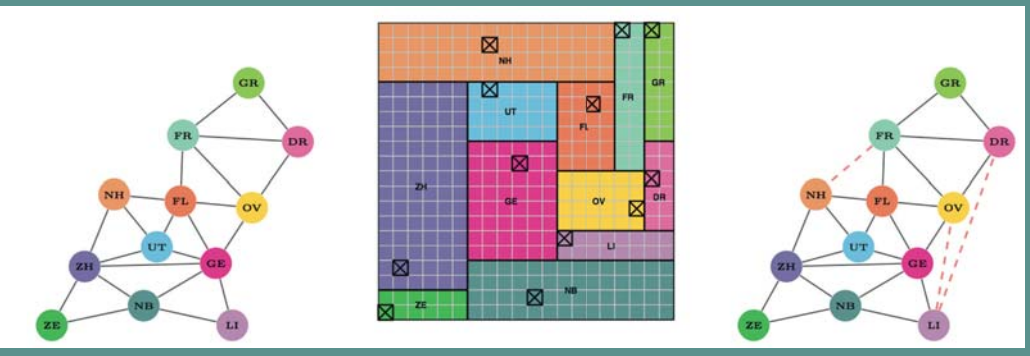
Many tasks in information visualization can be considered as Mathematical Optimization problems, calling for the development of numerical solution procedures. In this presentation, we will illustrate this for a collection of information visualization tasks.



To start with, the complex data consists of a set of individuals with a real positive value ("magnitude") assigned to each individual and a real positive value ("dissimilarity") to each pair of individuals. These values may vary over time. The task is to visualize the individuals together with the magnitudes and the dissimilarities. As visual design, we choose to represent each individual as a 2D glyph, spread over the visualization region, the magnitudes as glyph areas and the dissimilarities as spatial distances between the glyphs. The temporal variation is depicted by the animation of a collection of snapshots. To preserve the mental map during the temporal development we ensure that the movement from one snapshot to the next one in time of the glyph associated with an individual is small. The mathematical optimization problem to build this visual design is approached by means of difference of convex optimization techniques and non-convex quadratic binary optimization.

We will continue with a modification of the setting above, where we consider the "magnitude" assigned to each individual to be normalized, yielding a "frequency". The task is to visualize the individuals together with the frequencies and the dissimilarities is approached by means of a space-filling visual design. The visualization region is now a 2D square, the glyphs representing the individuals are rectangles that form a partition of the visualization region. The mathematical optimization problem to build this visual design is approached by mixed integer linear optimization.

The procedures have been successfully tested on datasets of diverse nature.