2018-00618 - Post-doctorant(e) Glyph-based geovisualization of temporal data

Level of qualifications required: PhD or equivalent
Fonction: Post-Doctoral Research Visit

About the research centre or Inria department

Located at the heart of the main national research and higher education cluster, member of the Université Paris Saclay, a major actor in the French Investments for the Future Programme (Idex, LabEx, IRT, Equipex) and partner of the main establishments present on the plateau, the centre is particularly active in three major areas: data and knowledge; safety, security and reliability; modelling, simulation and optimisation (with priority given to energy).

The 450 researchers and engineers from Inria and its partners who work in the research centre's 31 teams, the 100 research support staff members, the high-level equipment at their disposal (image walls, high-performance computing clusters, sensor networks), and the privileged relationships with prestigious industrial partners, all make Inria Saclay Île-de-France a key research centre in the local landscape and one that is oriented towards Europe and the world.

Context

The volume of geolocated data has grown dramatically in the last few years, as a consequence of the variety and number of producers of such data: geolocated posts on social networks, remote sensing devices, vehicles and transportation networks, etc. Those data often feature a temporal dimension, that is an essential piece of information for researchers and analysts who study, e.g., disease outbreaks, meteorological patterns and climate change, viral marketing and social behavior, online news propagation.

Visualizing geographical data that evolves over time helps detect interesting patterns and understand the data. But designing effective visualizations of temporally-evolving geolocated data remains challenging. The two most common approaches rely on animation on one side, and small multiples on the other side. Animations display time frames for different time steps in sequence, allowing the user to observe the data's evolution as that evolution gets played back, typically at a user-controlled pace. Small multiples take a different approach: all time frames are displayed simultaneously, juxtaposed on screen. Animations will usually better convey the dynamics of the evolution, but require users to remember previous states when making comparisons as only one frame is visible at a time. Small multiples better support comparisons across time steps, but fail to convey the dynamics and do not scale well, as the size of each frame on screen decreases as the number of frames increases so that they can all be accommodated on the user's display. The problem becomes even more complex when more than one geographical variable needs to be analyzed.

Glyph-based representations offer an interesting alternative to the two above strategies. The concept of glyph can be defined as a set of small, independent visual objects that depict a data record. They are commonly used to represent multivariate data. Glyphs have been used in prior work for the visualization of geo-temporal data, but mainly as a means to symbolize one or more variables at a specific geolocation that does not vary over time.

Assignment

The goal of this project is to evaluate the potential of glyphs as a means to visually encode geographical data that evolves over time, not only in the attribute values, but also in the location of the entities these attributes are associated with.

More specifically, the research questions to be considered include:

- the design of glyph-based visual encodings that effectively convey variations in attribute values and geolocation of entities;
- the empirical evaluation of these designs and geo-temporal analysis tasks, to identify which tasks are best supported by these encodings;
- a study of the scalability of this approach (how many locations can a given glyph effectively convey, in relation to the total number of entities/glyphs);
- can simplification methods (e.g., aggregation) applied to location information make the approach scale to a larger number of entities/locations without adversely impacting users' understanding of the data?
Main activities

The above research questions will be investigated by the postdoc, focusing on the following aspects:

- Design of glyph-based visual representations
- that convey the evolution of one attribute value as well as changes in position over time;
- and then investigate the possibility to support more than one attribute value;
- as well as the possibility to aggregate data over the time dimension by, e.g., switching layouts to group similar frames, the end goal being to favor the discovery of emergent patterns, while preserving the user's perception of the data's distribution over time (as it will no longer be linear).

- Empirical evaluation of these designs
- which requires first identifying meaningful user-driven analysis tasks supported by such visualizations and then proposing operationalizations of those tasks;
- and eventually comparing the new designs to the state-of-the-art in geo-temporal visualization, gathering both quantitative and qualitative empirical data in terms of performance and subjective preferences.

The project is part of ILDA's research on interactive, multi-scale geo-visualization, that represents a significant part of the team's scientific output since 2015 (see references below for a representative set of publications). The post-doc is expected to contribute to this research axis by: designing novel visualization techniques, implementing them using the language and API of her choice, comparing them empirically to the state-of-the-art through user studies.

- M.-J. Lobo, E. Pietriga, C. Appert, An Evaluation of Interactive Map Comparison Techniques, CHI '15: Proceedings of the 33rd SIGCHI conference on Human Factors in computing systems, pages 3573-3582, April 2015, Seoul, South Korea

Skills

Candidates should have a PhD in the field of data visualization, interactive cartography or visual analytics.

- Coding skills are important, as the post-doc will be fully in charge of the implementation of the proposed interactive visualizations. Web-based visualization toolkits are preferred (e.g., D3.js), but the candidate remains free to use the language and API of her choice for implementation purposes.
- Fluency in written and spoken English is a requirement.

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration

Monthly gross salary 2,653 euros