Augmented-Reality Storylines Visualizations
Master 2 Internship

Vanessa Peña-Araya (vanessa.pena-araya@inria.fr)
Anastasia Bezerianos (anastasia.bezerianos@universite-paris-saclay.fr)
Dr. John Samuel (john.samuel@cpe.fr)
Prof. Gilles Gesquière (gilles.gesquiere@univ-lyon2.fr)

Internship period: starting in March/April 2024, 5 or 6 months duration.
Supervisors: Vanessa Peña-Araya & Anastasia Bezerianos (ILDA team), and John Samuel & Gilles Gesquière (virtually from LIRIS, Lyon)
Location: ILDA, Université Paris-Saclay, building 660, Gif-sur-Yvette.
website: `https://ilda.saclay.inria.fr/`

Heritage documents (e.g., videos or photos) allow historians to understand the evolution of a place like, for example, a historical building. The main goal of this internship is to explore effective means to visualize the evolving links of such cultural documents in their 3D geographical context.

The relationships between entities of any number can be modeled as hypergraphs, and visualizing these datasets is an emerging research field [2]. Our HyperStorylines [5] tool is one of the most recently published visualization techniques to explore them. It is based on Storylines visualizations where people are represented by lines that evolve over the horizontal axis that represents time. HyperStorylines generalizes Storylines visualizations by allowing users to create custom views and see the relationships of any two types of entities, instead of just people over time. Additionally, a third type of entity can be visible by using interaction. Figure 1 shows some examples of custom views of HyperStorylines and GeoStorylines [4], a design that includes geospatial context.

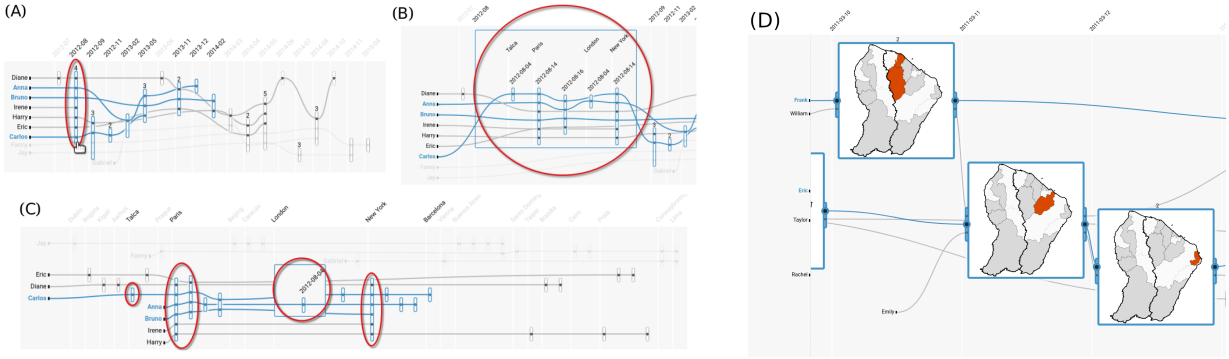

Figure 1: (A-C) HyperStorylines visualization with three views of a dataset. (A) Shows a view of people (represented by lines) that evolve along the horizontal axis, that here represents time (aggregated by months). Small vertical bars are relationships, positioned in the intersection of both axes of the entities that compose them. Relationships can have zero or more internal nested entities (a third type of entity), which can be seen by interactively expanding them (B). (C) Shows the stories of people related by locations instead of time (time is the nested entity). The red circles across images indicate where the entities that contribute to the highlighted relationship in (A) appear in the other views. (D) Shows an example of GeoStorylines, a visualization that shows the geographical context of these relationships.

However, these 2D visualizations do not allow users the evolution of the links of documents that describe 3D urban elements, like the representation of a city as shown in Figure 2.

Figure 2: 3D representation of Lyon using Py3DTilers. More examples can be found in: `https://projet.liris.cnrs.fr/vcity/demos/`

Internship goal:

The main goal of this internship is to explore effective means to visualize the evolving links of cultural documents in their 3D geographical context in an immersive environment As inspiration, Figure 3 shows two immersive analytic systems that show different ways to link data across views.

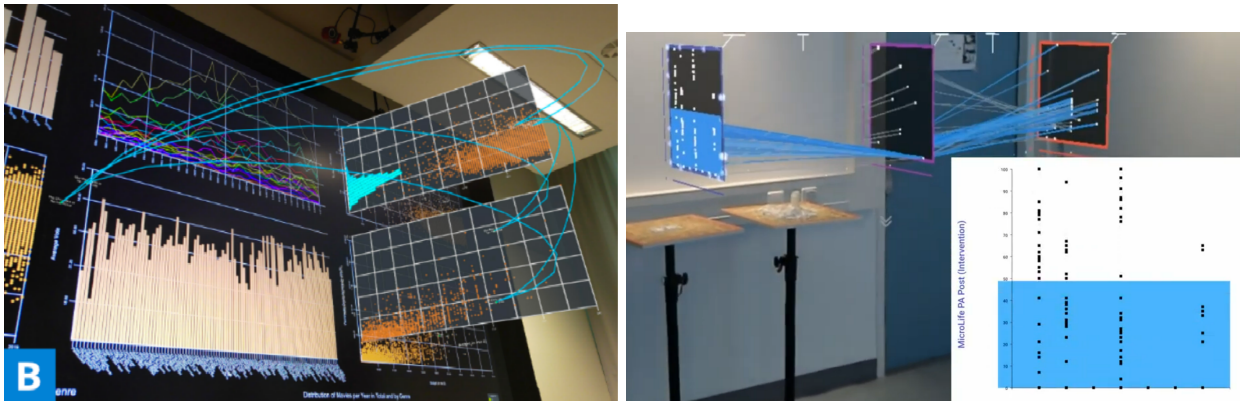

Figure 3: Two augmented reality systems to analyze data. On the left, the work of Reipschlager *et al.* [6] that show a set of techniques for extending visualizations on large displays with AR for better data exploration. On the right, STREAM [3] a technique that allows users to use tablet input to interact with linked visualizations.

Work plan & expected outcome:

The work of the internship will be divided in four main tasks:

1. Review the available visualization libraries for Unity (e.g. IATK [1]) or Web XR [1] and evaluate the feasibility to use them for the project.

2. Implement a first version of Storylines visualizations in an immersive environment as the base of the system.

[1] https://aframe.io/docs/1.6.0/components/webxr.html

3. Design and implement the visualization for expanded relationships in the third dimension, in addition to the connection among the entities within them.

4. Evaluate prototypes of the new designs in a user study.

Relevant skills to have: Experience in computer programming. Knowledge of programming using Unity or other 3D environment is plus. Similarly, having taken courses on visualization, user evaluation and prototyping methods is a plus.

References

[1] Cordeil, M., Cunningham, A., Bach, B., Hurter, C., Thomas, B. H., Marriott, K., and Dwyer, T. Iatk: An immersive analytics toolkit. In *2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)* (2019), IEEE, pp. 200–209.

[2] Fischer, M. T., Frings, A., Keim, D. A., and Seebacher, D. Towards a survey on static and dynamic hypergraph visualizations, 2021.

[3] Hubenschmid, S., Zagermann, J., Butscher, S., and Reiterer, H. Stream: Exploring the combination of spatially-aware tablets with augmented reality head-mounted displays for immersive analytics. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (2021), pp. 1–14.

[4] Hulstein, G., Peña-Araya, V., and Bezerianos, A. Geo-storylines: Integrating maps into storyline visualizations. *IEEE Transactions on Visualization and Computer Graphics 29*, 1 (2023), 994–1004.

[5] Peña-Araya, V., Xue, T., Pietriga, E., Amsaleg, L., and Bezerianos, A. Hyperstorylines: Interactively untangling dynamic hypergraphs. *Information Visualization 0*, 0 (0), 14738716211045007.

[6] Reipschlager, P., Flemisch, T., and Dachselt, R. Personal augmented reality for information visualization on large interactive displays. *IEEE Transactions on Visualization and Computer Graphics 27*, 2 (2021), 1182–1192.