Augmented-Reality Storylines Visualizations
Master 2 Internship

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Internship period: starting in March/April 2024, 5 or 6 months duration.
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Location: ILDA, Université Paris-Saclay, building 660.

In our past contact with data journalists we've seen that they are interested in analyzing the relationships among politicians, whether they visit particular locations or if they are linked to certain organizations (e.g. political parties, enterprises, etc). These relationships help them understand recent news events, like why a politician won an election or why they quit their political party.

Visualizing these datasets is an emerging research field [3]. Our HyperStorylines [6] 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, a design that includes geospatial context.

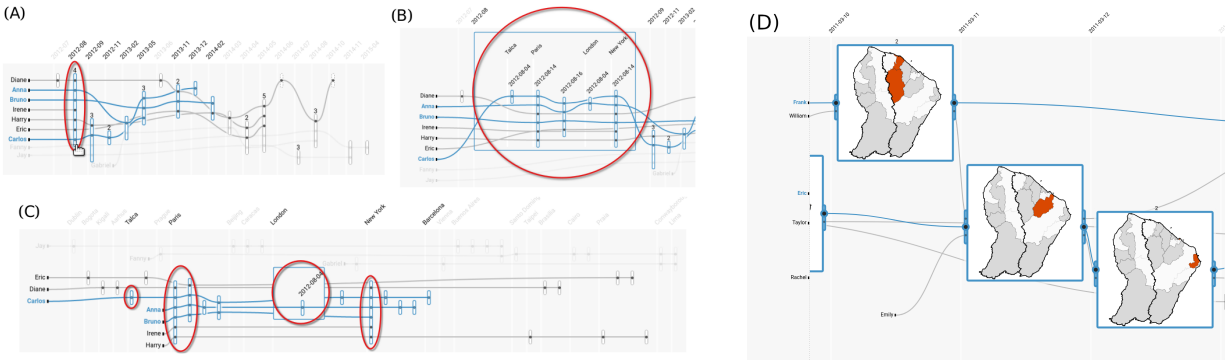

Figure 1: (A-C) HyperStorylines visualization with three views of a dataset. (A) Shows a view of people (represented by lines) that evolve along the horizontal axis, that here represents time (aggregated by months). Small vertical bars are relationships, positioned in the intersection of both axes of 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.

It is very common that these relationships include geographical locations that show, for example, where an event happened or what locations are important in the development of an event. To consider this component, we extended our initial design in a set of visualizations called Geo-Storylines [5]. The resulting designs can be seen in Figure 2.

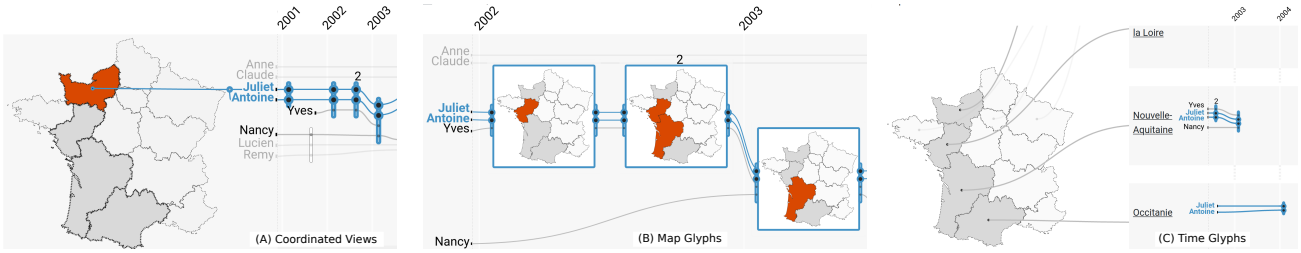

Figure 2: Three Geo-Storyline designs showing the geo-temporal evolution of the relationships between people. The two selected people in blue moved together from north to south. (A) **Coordinated Views** include a map on the left and a unique Storyline timeline on the right. While scrolling, links appear between the relationship nearest to the map and the associated locations. (B) In **Map Glyphs** each relationship is represented by a map with the associated locations drawn in orange. (C) **Time Glyphs** are composed by a map on the left and a scrollable list of Storyline glyphs on the right. Each Storyline glyph contains all the relationships associated with one location. Gray lines between a location on the map and a storyline glyph indicate the correspondence between the two.

Internship goal:

The volume of real-world datasets makes the resulting views complex and hard to analyze. In order to make the analysis of them easier, the goal of this project is to take advantage of the 3D space and data manipulation provided by Augmented Reality (often referred to as Immersive Analytics in the visualization community [1]). Therefore, the goal of this internship is to design and implement a new version of HyperStorylines in AR that allow users to explore these datasets in an immersive environment. This new representation of Hypergraphs should also allow the integration of contextual views of the information, like geographic maps in a similar way Geo-Storylines [5] does. As inspiration, Figure 3 shows two immersive analytic systems that show different ways to link data across views.

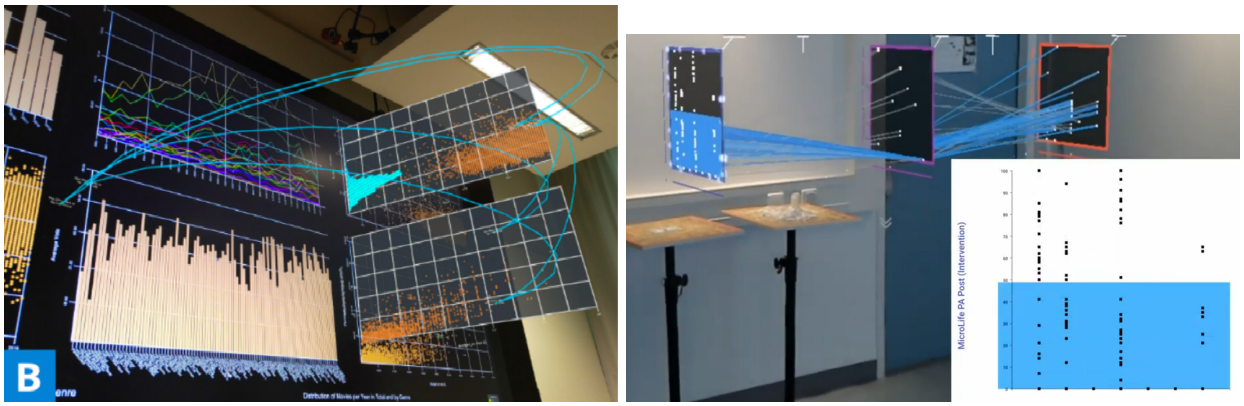

Figure 3: Two augmented reality systems to analyze data. On the left, the work of Reipschlager *et al.* [7] that show a set of techniques for extending visualizations on large displays with AR for better data exploration. On the right, STREAM [4] a technique that allows users to use tablet input to interact with linked visualizations.

Work plan:

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

1. Review the available visualization libraries for Unity (e.g. IATK [2]) and evaluate the feasibility to use them for the project.
2. Implement a first version of Storylines visualizations in Augmented Reality as the base of the system.
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.

Requirements for Applicants: Knowledge of programming using Unity is a big plus, having taken user evaluation and prototyping methods.

References

[1] Chandler, T., Cordeil, M., Czauderna, T., Dwyer, T., Glowacki, J., Goncu, C., Klapperstueck, M., Klein, K., Marriott, K., Schreiber, F., and Wilson, E. Immersive analytics. In *2015 Big Data Visual Analytics (BDVA)* (2015), pp. 1–8.

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

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[5] 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.

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

[7] 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.