Engineering Interactive Systems

@SPARKS/wimmics teams
Université Côte d'Azur

GT-GS GDR-IHM

Lyoon, France

2 Juillet 2025

Prof. Marco Winckler

Université Côte d'Azur, France

Marco.Winckler@univ-cotedazur.fr / marco.Winckler@inria.fr

about me…

- Born in Nonoai, RS, Brazil
- Research domain:
  - Human-Computer Interaction (HCI)
  - Interactive Systems Engineering
  - Information Visualization
  - Immersive Visualization

- Professor at the Université Côte d'Azur, Sophia Antipolis, France
- Head of the research team SPARKS (*Scalable and Pervasive softwARe and Knowledge Systems*)
- Members if the INRIA EPC wimmcis
- Head of the Master track on HCI at Polytech Nice
- External members of ICS team of IRIT

@Sophia Antipolis Campus

- 1st European Science Park Sophia Antipolis
  - initiated in 1969 by Senator Pierre Laffitte, still growing
  - 300 IT companies
  - 45 Health companies
  - 60 research and educational organizations
  - Very international… over 60 nationalities

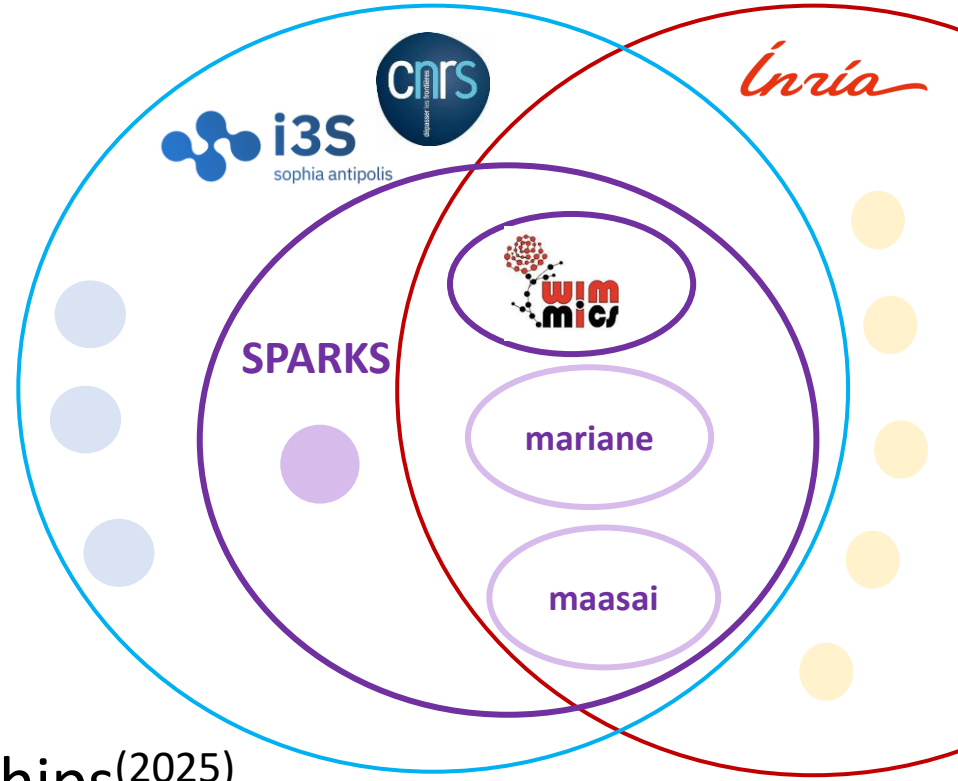
It gathers :

- international standardization institutes: W3C, ETSI
- Large schools: EURECOM Institute Polytech'Nice
- Research institutes: INRIA, CNRS, INRA

Gattières
Saint-Jeannet
Courmes
Drap
La Trinité
A8
D6007
Roquebrun
Monaco-Ville
Èze
Gourdon
Vence
La Gaude
Tourrettes-sur-Loup
A8
Nice
Le Bar-sur-Loup
St Paul
de Vence
OLD NICE
A8
Saint-Jean-Cap-Ferrat
Châteauneuf
Roquefort-les-Pins
St-Laurent-du-Var
Opio
Cagnes-sur-Mer
D2085
Airport Nice Côte d'Azur
Valbonne
A8
Sophia
Antipolis
I3S/INRIA Méditerranée
Sophia Tech Campus
Mougins
A8
Antibes
A8
Le Cannet
D6007
JUAN-LES-PINS
Cannes
Bay of Cannes

SPARKS → pole of I3S CNRS LAB (UMR 7271)

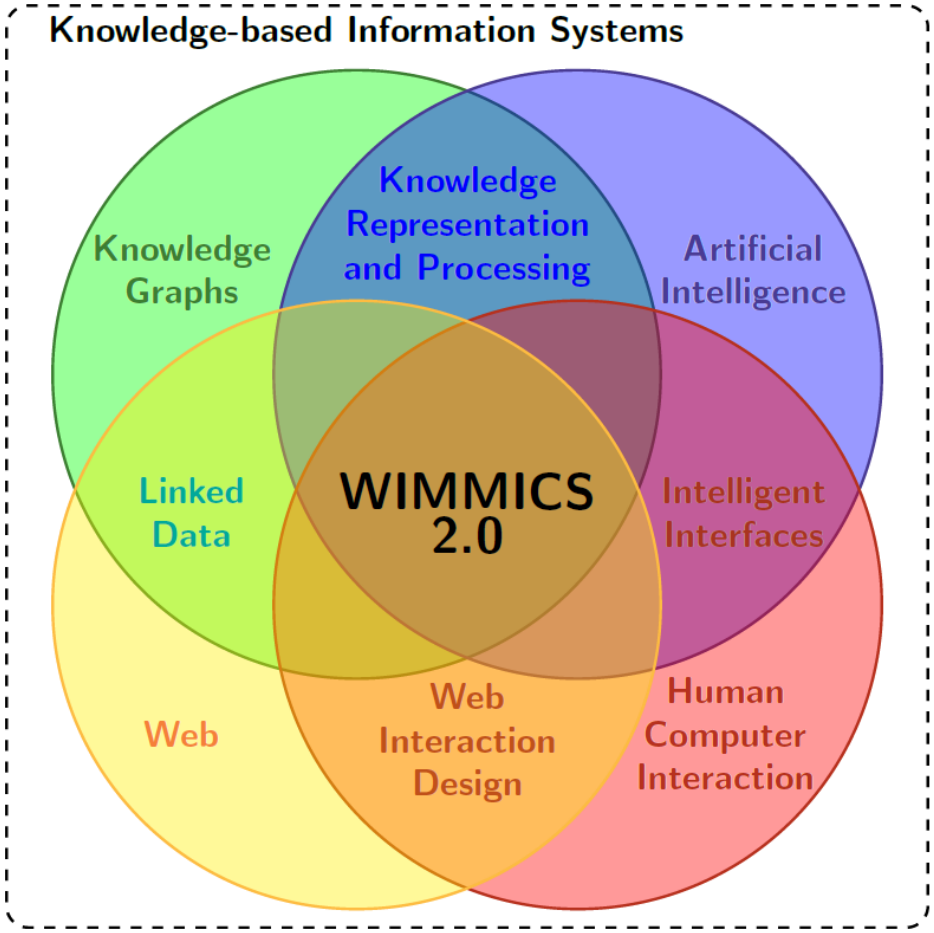
- 44 permanent members
  - 1 DR INRIA, 2 DR CNRS
  - 2 CR CNRS
  - 1 INRIA ISFP
  - 2 IR CNRS, 1 INRIA
  - 14 PU
  - 20 MCF (including 4 HDR)
  - 1 MAST
- + 21 PhD Students
- + 8 PostDoc/CDD 28 internships(2025)
- 3 project-teams (EPC) INRIA: wimmics, mariane, maasai



web-instrumented human-machine interactions, communities and semantics

- EPC INRIA
- After 12 years of wimmics wimmcs 2.0 in 2025
- Director. Pr. Catherine Faron

https://team.inria.fr/wimmics/



HCI team @wimmics

Pr. Marco Winckler

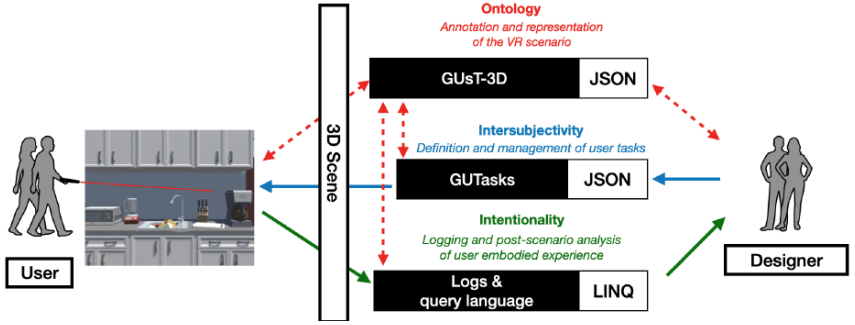
MCF. Aline Menin

MCF. Florent Robert

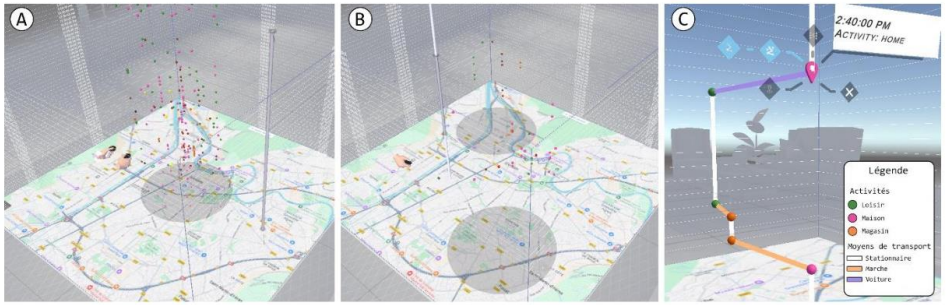
PhD Students: Clément Quéré, Pauline Devictor

Collaborations with: Michel BUFFA, Hui-Yin WU

… examples of on-going projects

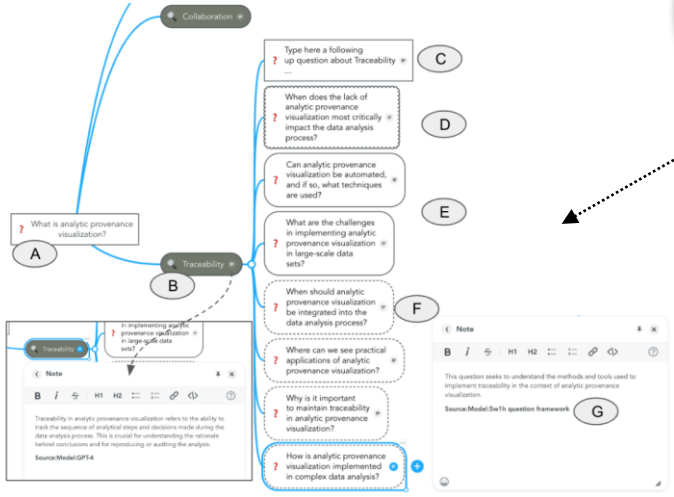


Understanding embodied experience in VR



Engineering Interactions for exploring Spatio-Temporal data in Immersive visualization

on-going projects



Enhancing LLM-Based Information Seeking

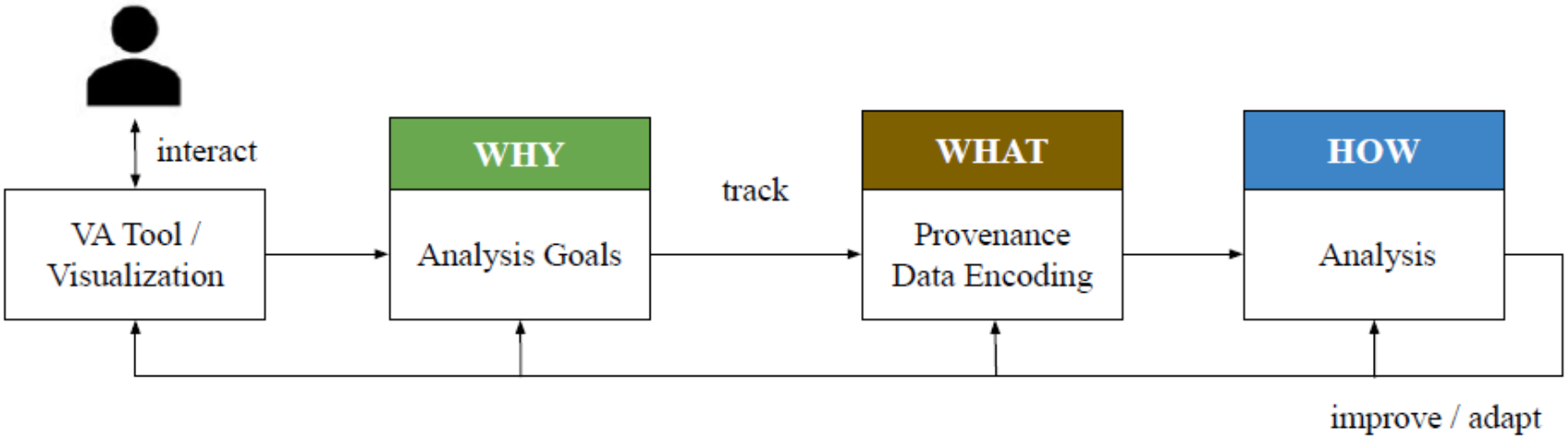
Provenance Analysis in Information visualization

Outline on analytical provenace

- Gaps of Interactive Systems for covering Analytical Provenance in terms of:
  - Data source traceability
  - Sequence of user interaction
  - Sensemaking
- Examples of how provenance analysis can be implemented in information visualization techniques
  - MGExplorer/LDViz : http://dataviz.i3s.unice.fr/ldviz/
  - ARVIZ : http://dataviz.i3s.unice.fr/arviz/
  - CROBORA : http://dataviz.i3s.unice.fr/crobora

Data Provenance

- Provenance: “The place of origin or earliest known history of something”
- Provenance might be understood as the history of the data and reasoning involved and the context within which sensemaking was performed.
- It might be applied data, computation, user interaction, and reasoning



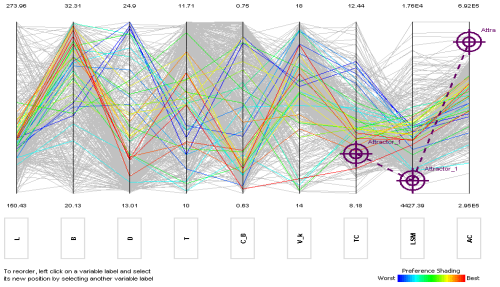
K. Xu, S. Attfield, T. Jankun-Kelly, A. Wheat, P. H. Nguyen, and N. Selvaraj, “Analytic provenance for sensemaking: A research agenda,” IEEE Computer Graphics and Applications, vol. 35, no. 3, pp. 56–64, 2015.

Analytical Provenance and Information Visualization

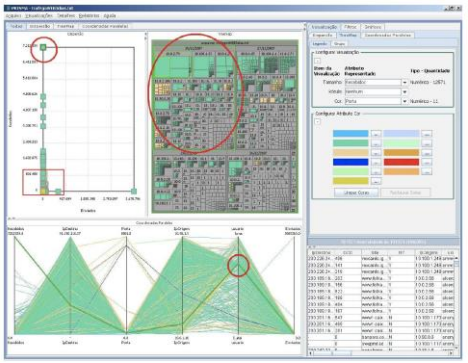
- **Visual analytics** supports human reasoning in decision-making processes by visually representing patterns and casual relationships between data…
- The discovery of patterns and relationships between data requires **exploration of datasets**…
- **Analytical provenance** focus on understand users' reasoning processes though interaction with the system
- Underling research questions:
  - Which users tasks can be supported by visualization techniques?
  - Which visualization technique to use when many of them provide complementary views on data ?
  - How to retrace an exploratory path to explain (to others) findings of interest in a dataset ?
  - How compare findings found following alternative exploratory paths?

Visualization strategies

- **Single view**
  - As much information as possible in a single view of data
  - Minimizes the need of exploration as data in on a single display
  - Engender cognitive overload and visual clutter issues
- **Coordinate multiple views**
  - Each view provides a different perspective on data
  - Multiples views increase semantic and articulatory distance (between views)
  - Changing one view might change others views losing information provenance
- **Chained views**
  - Multiple visualization techniques are articulated in single view
  - A single graph can describe the entire exploratory path



Parallel Coordinates



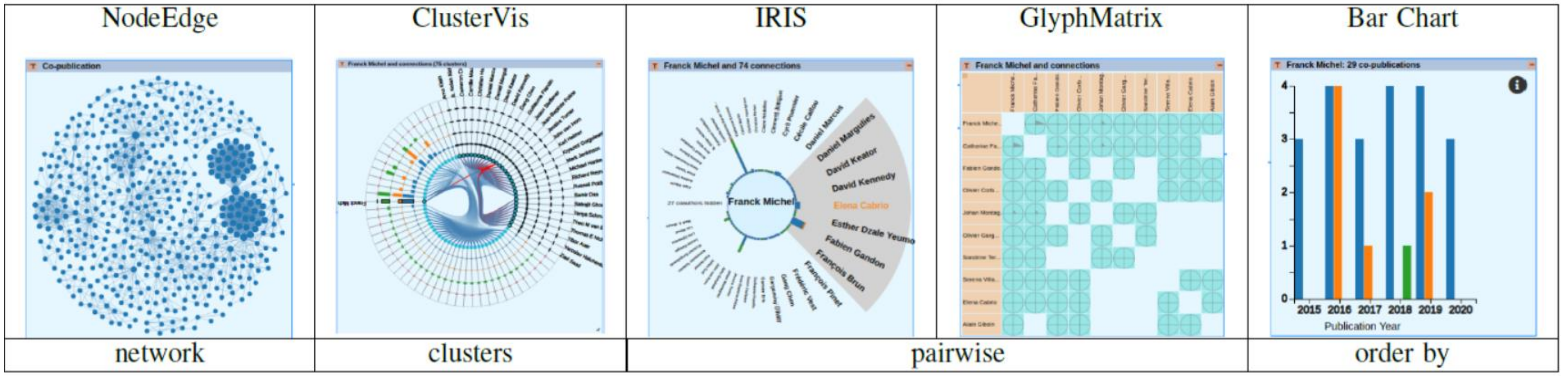
PRISMA

GraphTrail

Analytical provenance with the Visualization techniques in MGExplorer

Data can be visually represented in many ways.

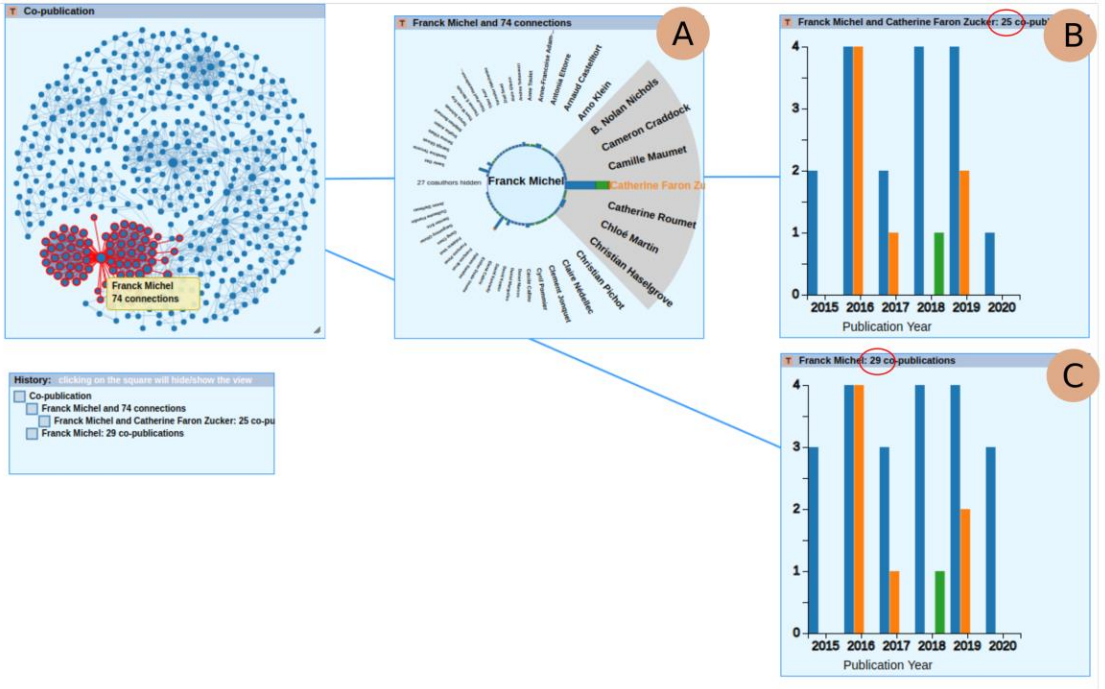
Users can choose among five visualization techniques according to the data structure



Aline Menin, Minh Nhat Do, Carla Maria Dal Sasso Freitas, Olivier Corby, Catherine Faron, Alain Giboin, Marco Winckler: Using Chained Views and Follow-Up Queries to Assist the Visual Exploration of the Web of Big Linked Data. Int. J. Hum. Comput. Interact. 40(2): 224-240 (2024)

Exploration process and chained views

- Exploration process = to find meaningful information
- Chained views = How to retrace the exploratory paths

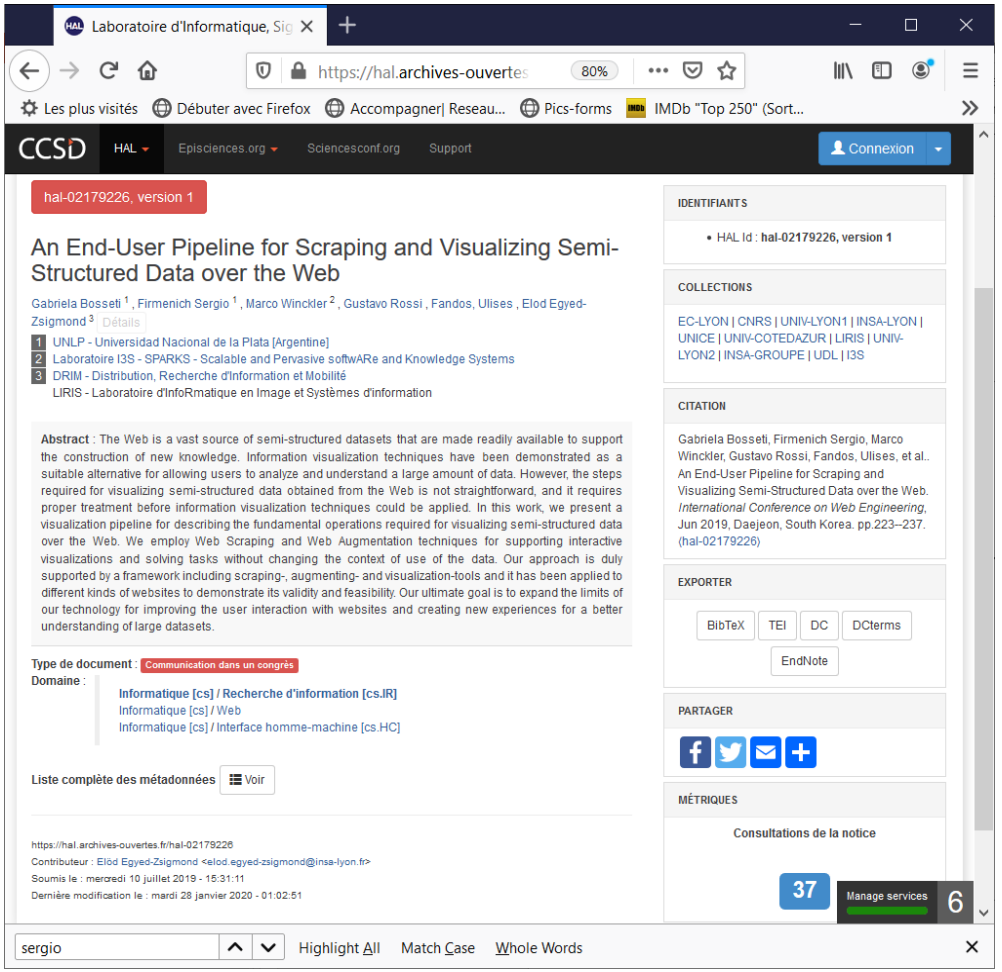


Example of chained views with MGExplorer

Case study

- Case study
  - HAL Open data
  - Co-publications of I3S
  - Types of publications
  - Collaboration between authors
- Target users
  - (French mainly) researchers
  - Director of scientific agencies and departments

https://hal.archives-ouvertes.fr



HAL web site where data were extracted

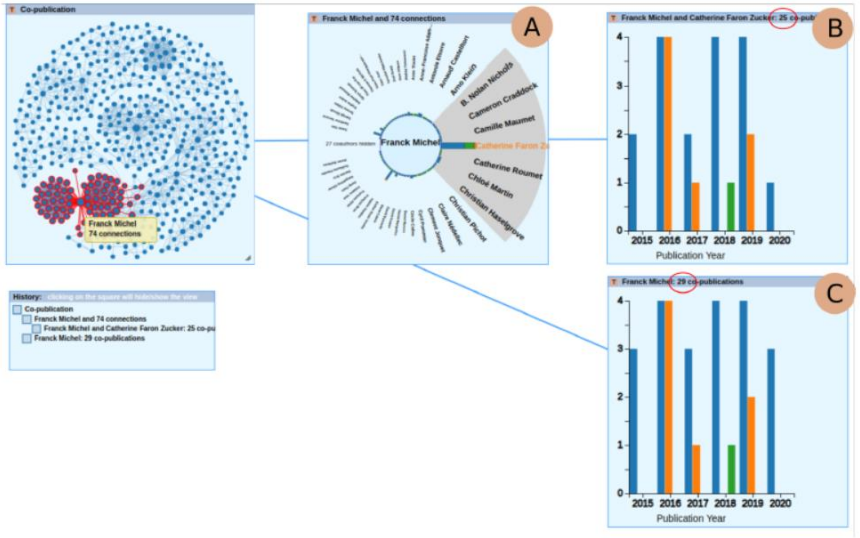
Data from the case study

- Publications co-authored by at least one member of the I3S lab
- Publications from 2015-2020
  - 497 nodes (authors)
  - 2 080 edges (co-publications)
- Exploratory task in the two scenarios explored in the case study:
  - *Determine the impact of recurrent co-authorship to the total number of publications of a particular author*

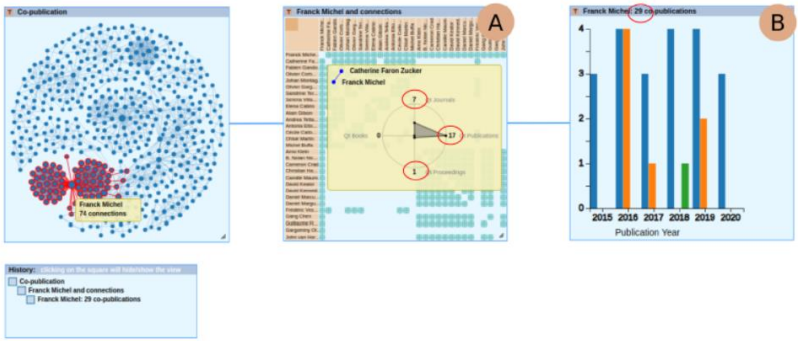
    - from a given author A
    - we determine the highest number of co-authors of author A
    - we identify the most recurrent co-author (author B), the one with most co-publications with A
    - we compare the number of co-publications between A and B

Provenance as interaction: navigation paths

Scenario 1

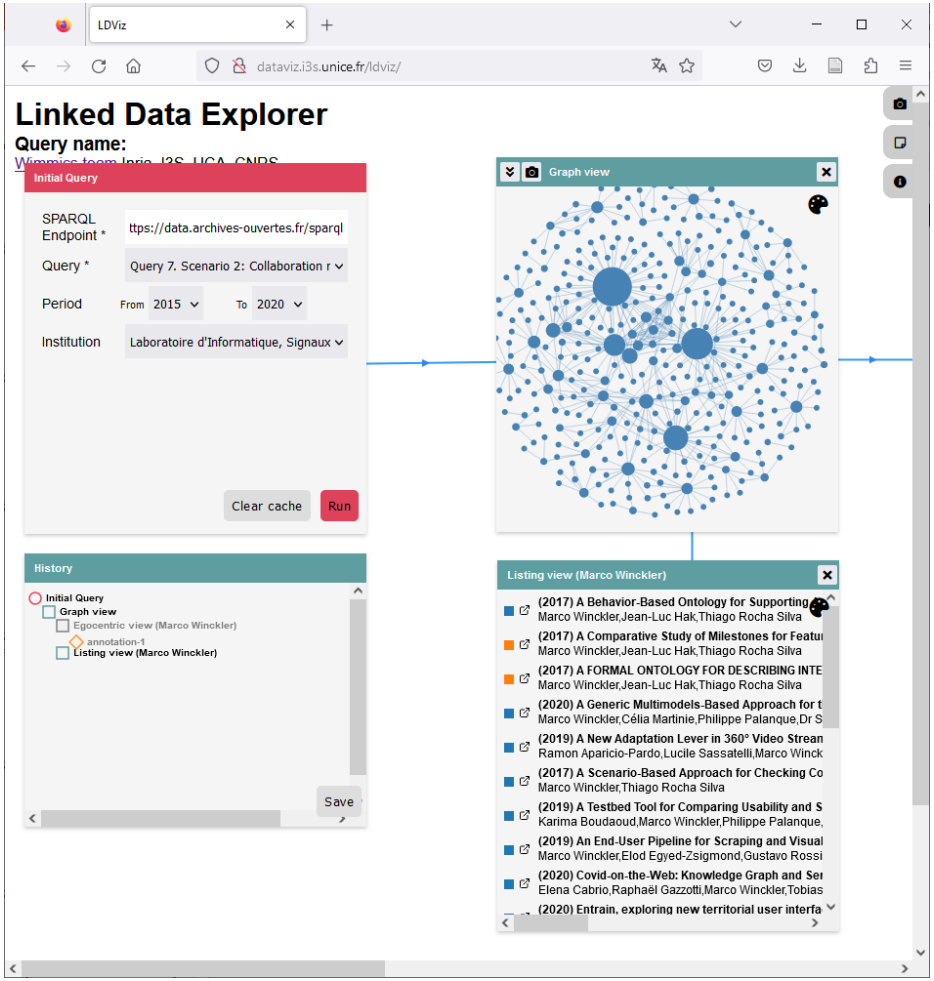


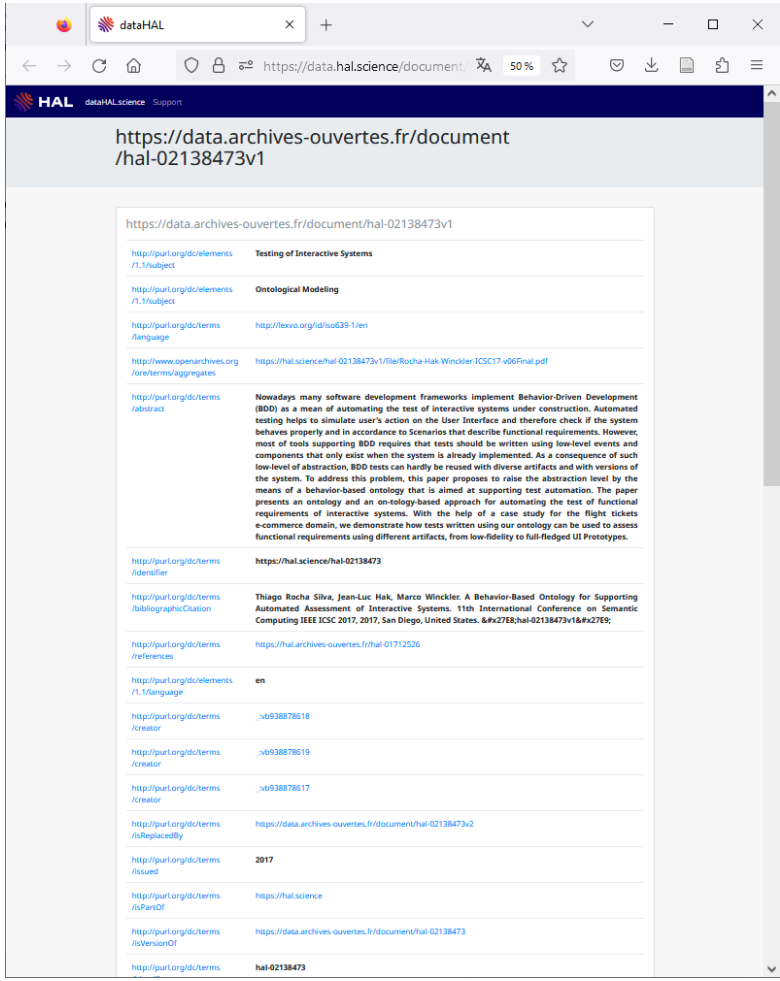
Scenario 2



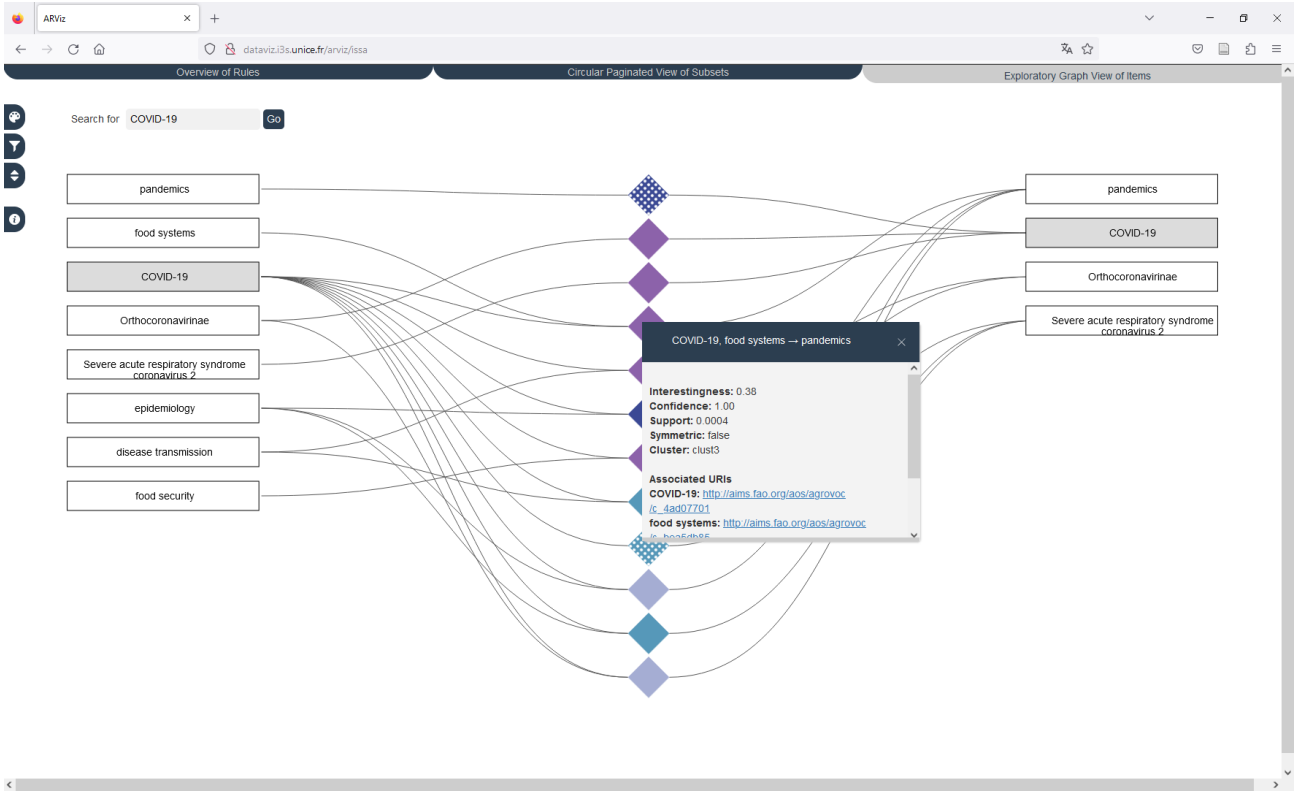
https://www.youtube.com/watch?v=CA1AfQlagOE&t=57s

Provenance of data source, as part of the visualization





Provenance of data source, as part of the visualization (ex. ARVIZ)

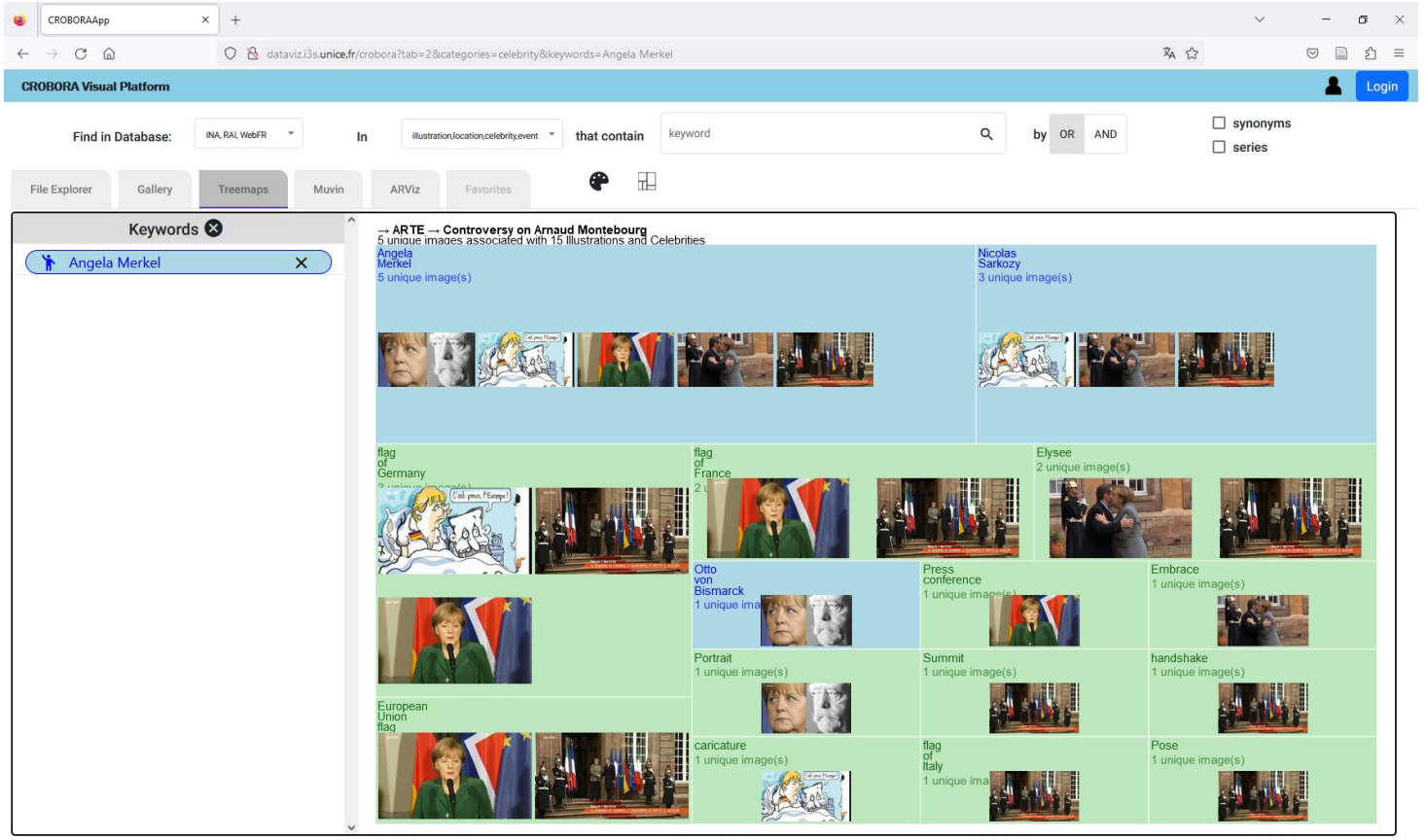


https://www.youtube.com/watch?v=JbjTlwuQCMc&t=2s

http://dataviz.i3s.unice.fr/arviz/issa

Aline Menin, Lucie Cadorel, Andrea Tettamanzi, Alain Giboin, Fabien Gandon, Marco Winckler: ARViz: Interactive Visualization of Association Rules for RDF Data Exploration. IV 2021: 13-20

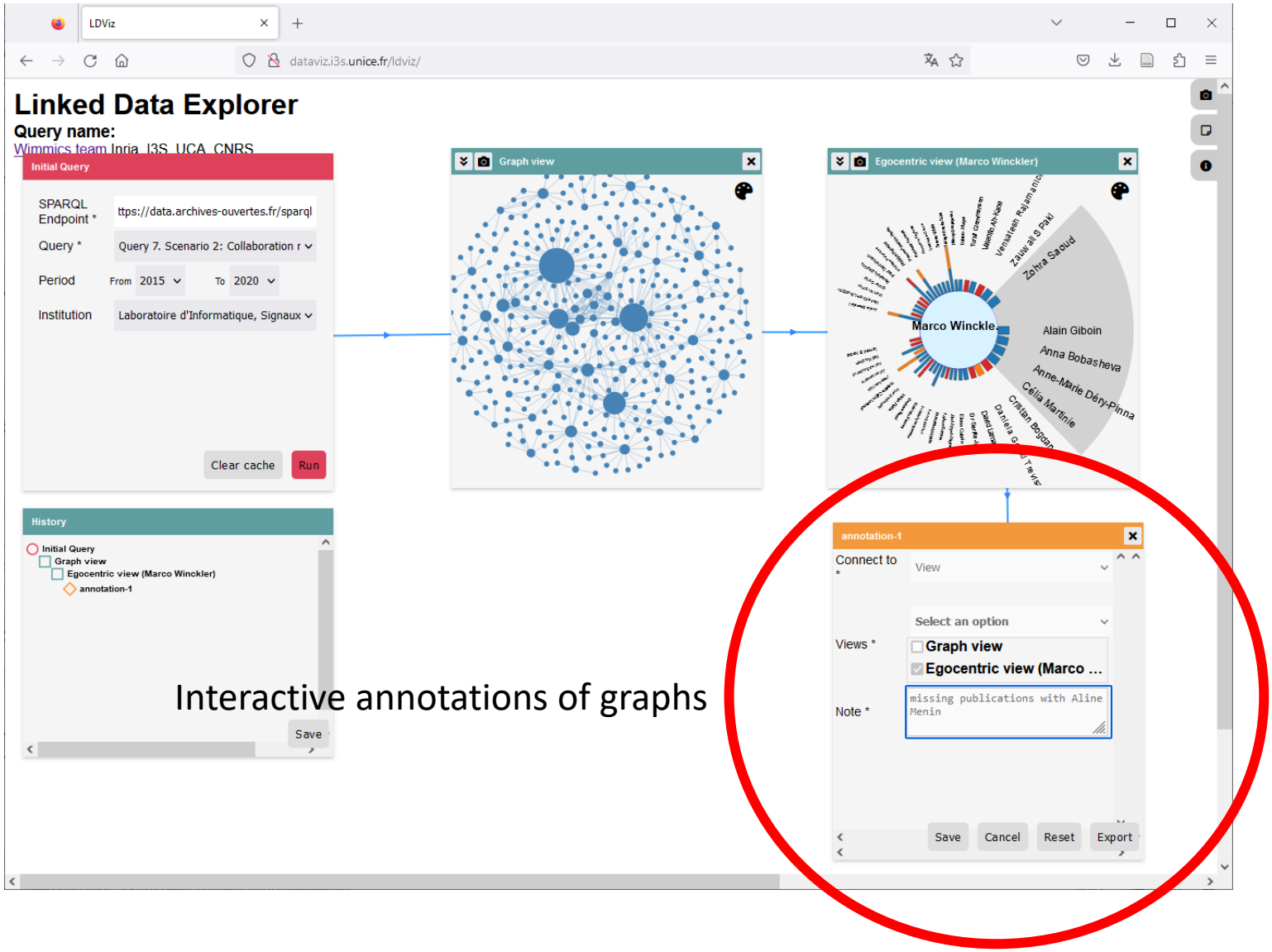
Provenance of user interaction (ex. CROBORA)



https://crobora.huma-num.fr/crobora

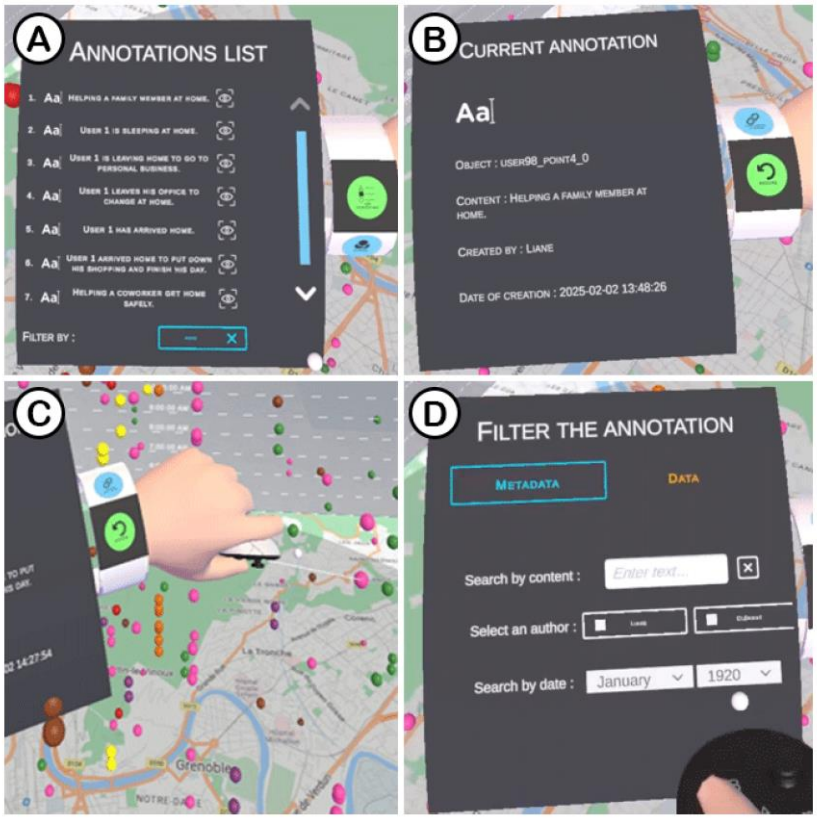
Shiming Shen, Matteo Treleani, Dario Compagno, Marco Winckler. From Stock Shots to Ghost Data: Tracking Audiovisual Archives about the European Union. VIEW Journal of European Television History and Culture, 12(23): 4 – 23 https://viewjournal.eu/articles/10.18146/view.292

Provenance as sensemaking: through annotations



Interactive annotations of graphs

Provenance of user interaction in immersive visualization (WristNotes)



Clément Quéré, Aline Menin, Eliezer Bernart, Carla Freitas, Luciana Nedel, Marco Winckler: WristNotes: Detachable Menu for Annotations in Immersive Environments. (to appear) In Proc. of IFIP INTERACT 2025.

Final remarks

- Analytical provenance might cover:
  - The data source and algorithms for treating data
  - The user interaction, to find the data
  - The sensemaking of data
- So far, few visualization tools integrate analytical provenance

- Our ultimate goals is to help users to better accomplish their tasks:
  - Investigate the use and potential uses of information
  - Provide **methods** and **tools** for
    - exploring information sources in particular **Knowledge Graphs**
    - **engineering annotations** for sense-making of data
    - understanding the **impact in terms of UX** of the uses of information (including embodied experience)
    - **designing and integrating affordances** for informing and guiding users towards the information the might need to complete their tasks with interactive systems

Au plaisir de vous retrouver sur la Côte d'Azur

Merci de votre attention!

Marco.Winckler@univ-cotedazur.fr /
marco.Winckler@inria.fr