

# Engineering Interactive Systems

@SPARKS/wimmics teams

Université Côte d'Azur

**GT-GS GDR-IHM**

*Lyoon, France*

*2 Juillet 2025*

**Prof. Marco Winckler**

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*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

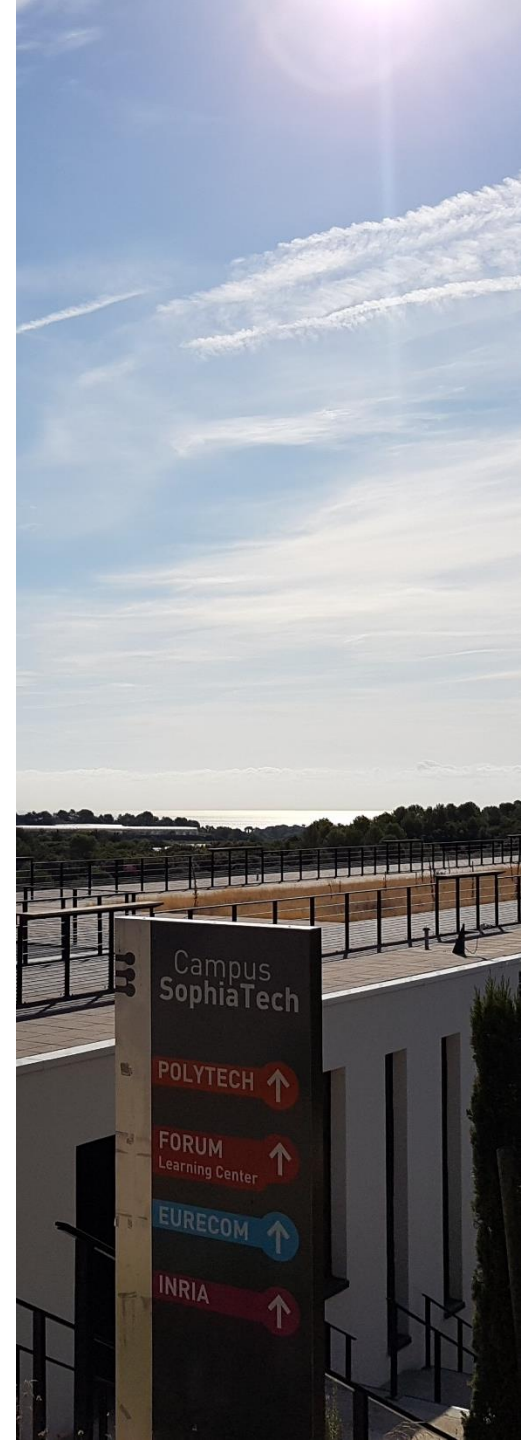


# @Sophia Antipolis Campus

- 1<sup>st</sup> 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





Sophia  
Antipolis

**I3S/INRIA Méditerranée**

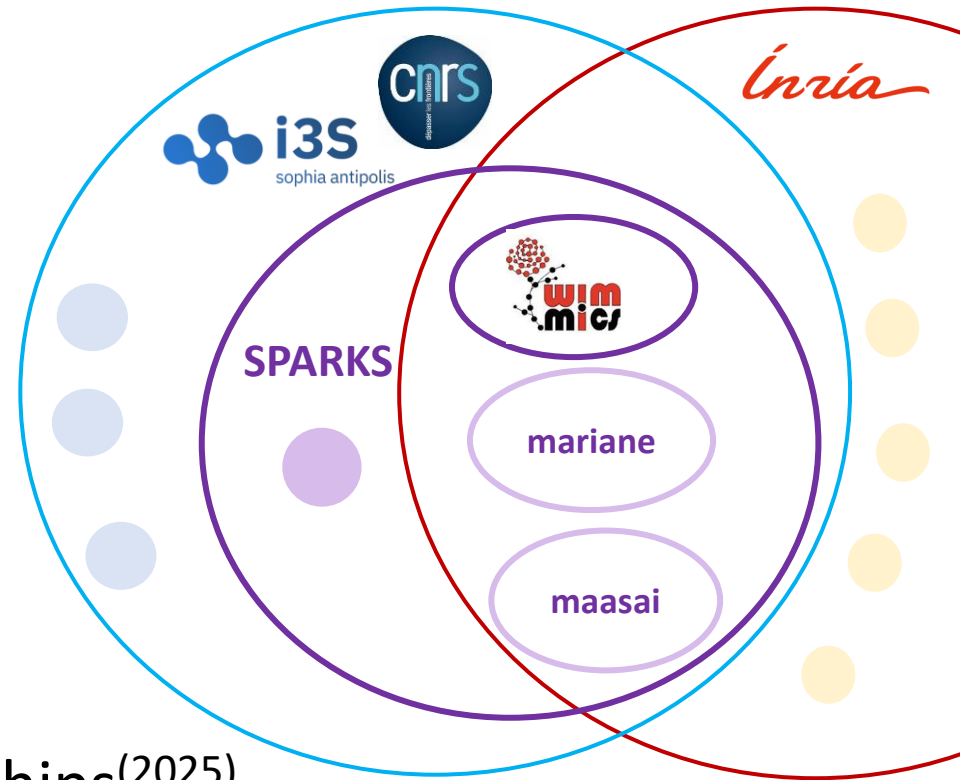
Sophia Tech Campus

Airport Nice Côte d'Azur



# 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<sup>(2025)</sup>
- 3 project-teams (EPC) INRIA: wimmics, mariane, maasai

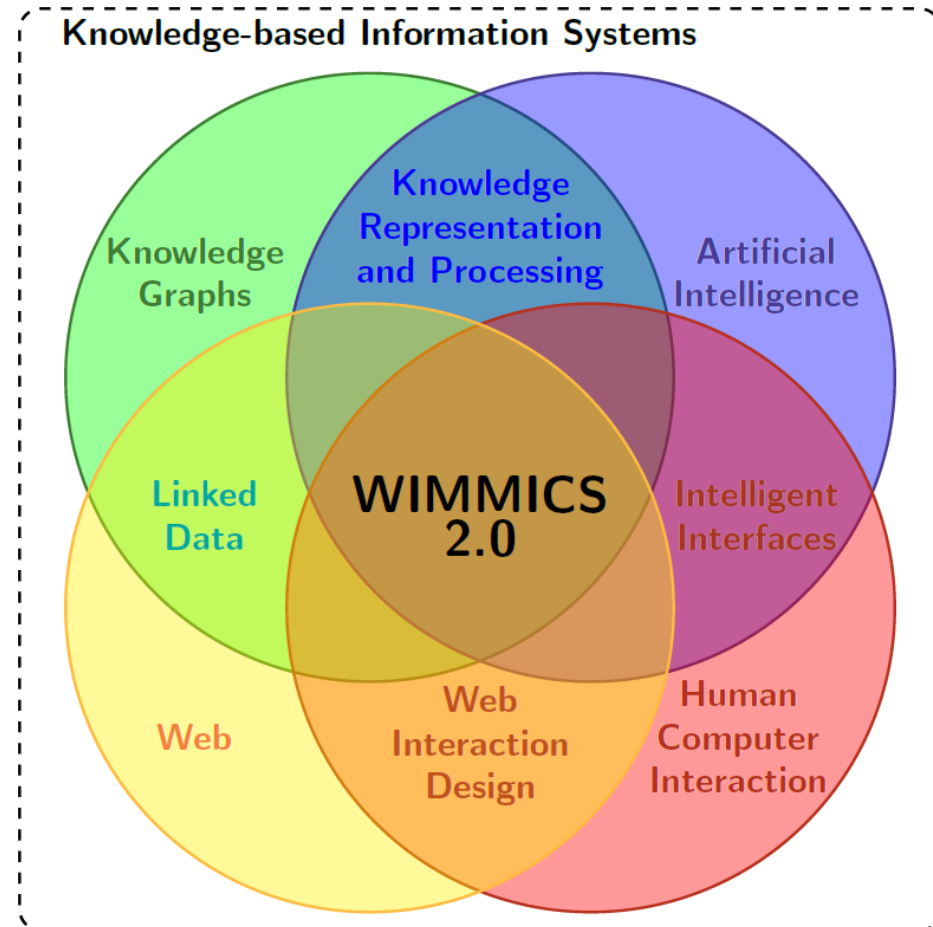




# web-instrumented human-machine interactions, communities and semantics

- 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



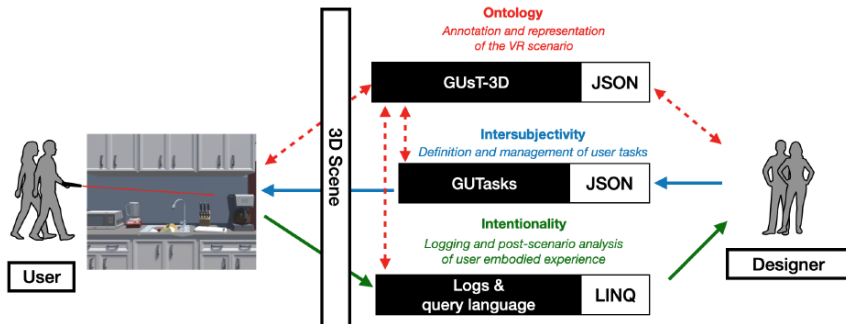
MCF. Florent Robert



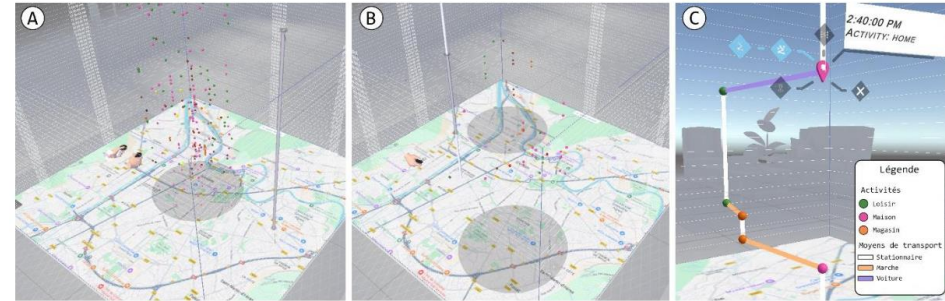
PhD Students: Clément Quéré, Pauline Devictor

Collaborations with: Michel BUFFA, Hui-Yin WU

# ... examples of on-going projects



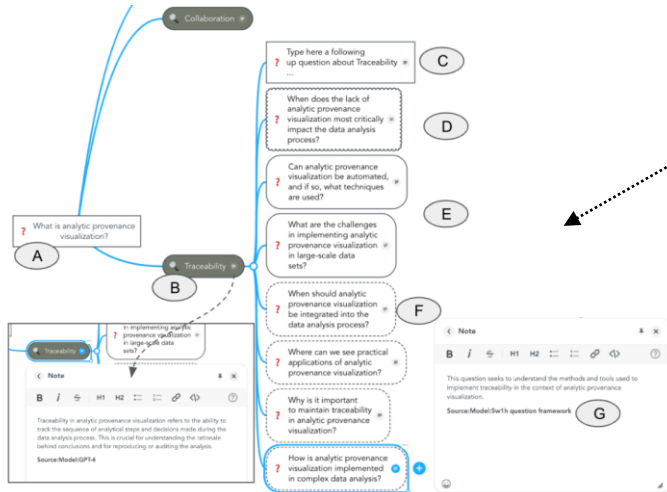
Understanding embodied experience in VR



Engineering Interactions for exploring Spatio-Temporal data in Immersive visualization

on-going projects

Provenance Analysis in Information visualization



Enhancing LLM-Based Information Seeking



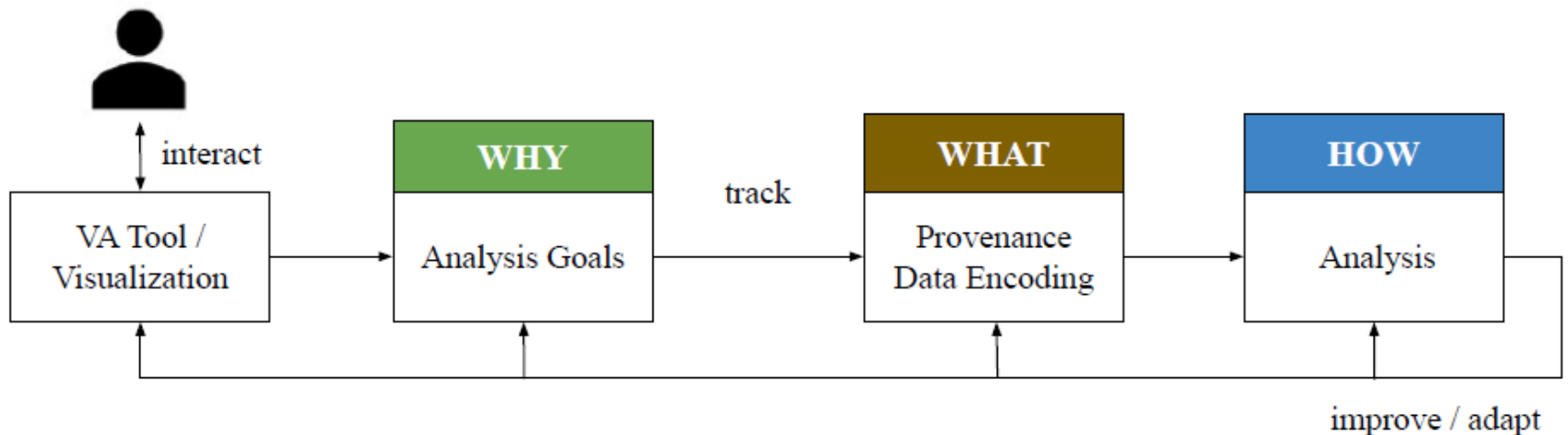


# Outline on analytical provenance

- 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**

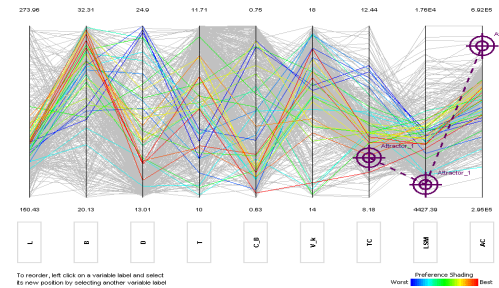
- As much information as possible in a single view of data
- Minimizes the need of exploration as data in on a single display
- Engender cognitive overload and visual clutter issues

- **Coordinate multiple views**

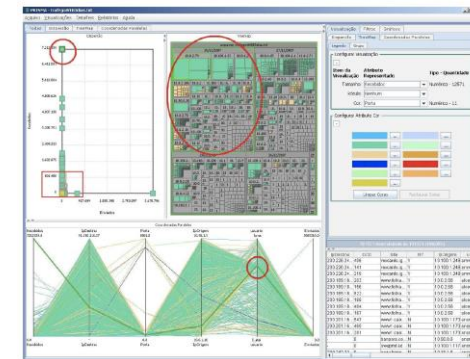
- Each view provides a different perspective on data
- Multiples views increase semantic and articulatory distance (between views)
- Changing one view might change others views losing information provenance

- **Chained views**

- Multiple visualization techniques are articulated in single view
- A single graph can describe the entire exploratory path



Parallel Coordinates



PRISMA

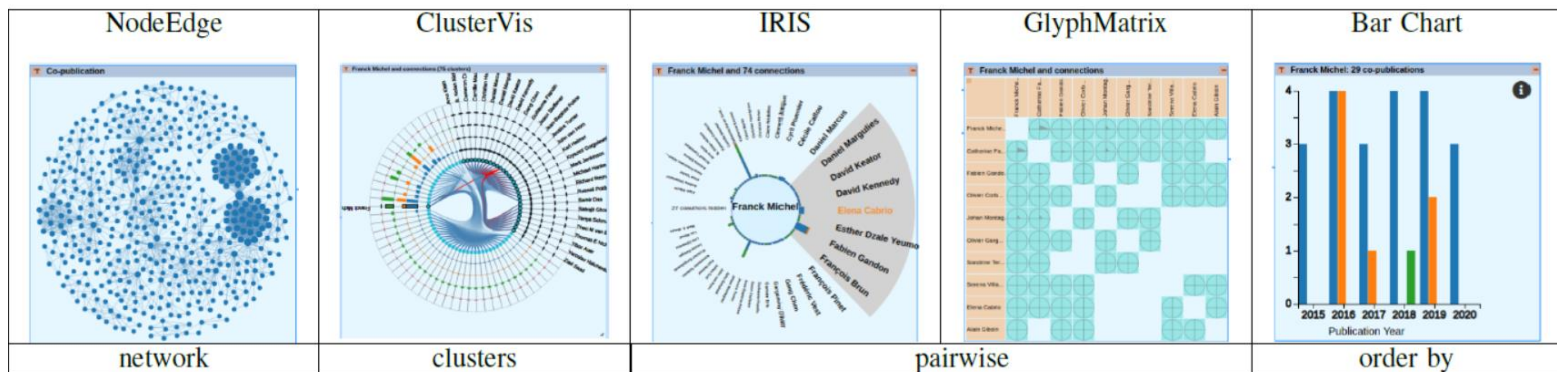


GraphTrail

# 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

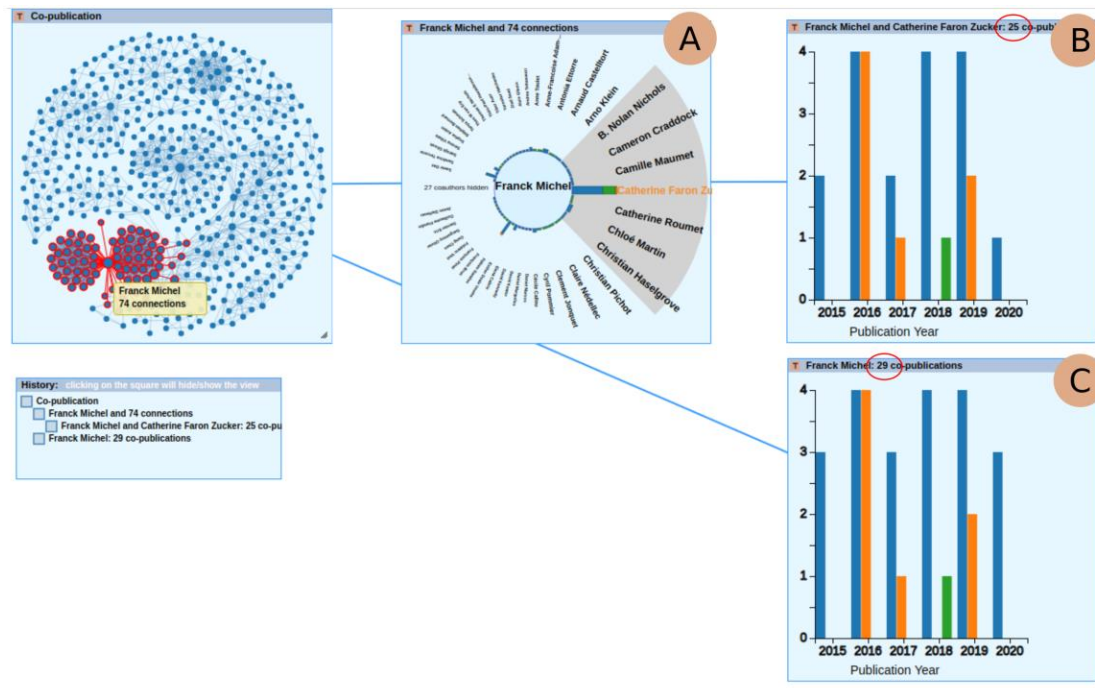


Aline Menin, Minh Nhat Do, Carla Maria Dal Sasso Freitas, Olivier Corby, Catherine Faron, Alain Giboin, Marco Winckler: Using Chained Views and Follow-Up Queries to Assist the Visual Exploration of the Web of Big Linked Data. *Int. J. Hum. Comput. Interact.* 40(2): 224-240 (2024)



# 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>

The screenshot shows a web browser window displaying the HAL website. The address bar shows the URL <https://hal.archives-ouvertes.fr>. The page is for a document with the title "An End-User Pipeline for Scraping and Visualizing Semi-Structured Data over the Web" by Gabriela Bossetti, Firmenich Sergio, Marco Winckler, Gustavo Rossi, Fandos, Ulises, and Elod Egyed-Zsigmond. The document is identified by HAL ID: hal-02179226, version 1. The page includes an abstract, a list of authors with their affiliations (UNLP, I3S, DRIM, LIRIS), and a list of keywords. On the right side, there are sections for "IDENTIFIANTS", "COLLECTIONS", "CITATION", "EXPORTER", "PARTAGER", and "MÉTRIQUES". The "MÉTRIQUES" section shows 37 consultations and 6 downloads. The bottom of the page has a search bar and navigation links.

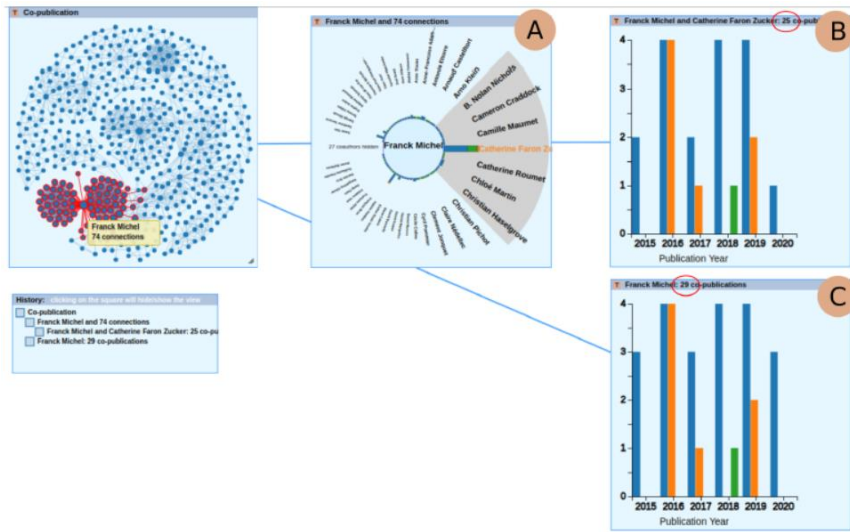
HAL web site where data were extracted

# Data from the case study

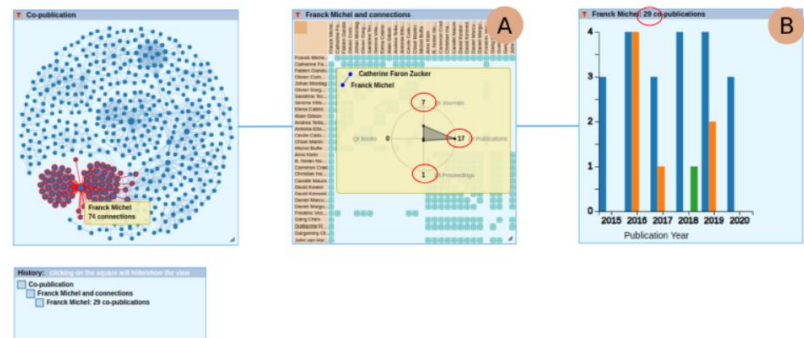
- Publications co-authored by at least one member of the I3S lab
- Publications from 2015-2020
  - 497 nodes (authors)
  - 2 080 edges (co-publications)
- Exploratory task in the two scenarios explored in the case study:
  - *Determine the impact of recurrent co-authorship to the total number of publications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

**LDViz**

Query name: **Wikipedia term logic - I3S - UCA - CNRS**

Initial Query

SPARQL Endpoint \* **https://data.archives-ouvertes.fr/sparql**

Query \* **Query 7. Scenario 2: Collaboration r**

Period From **2015** To **2020**

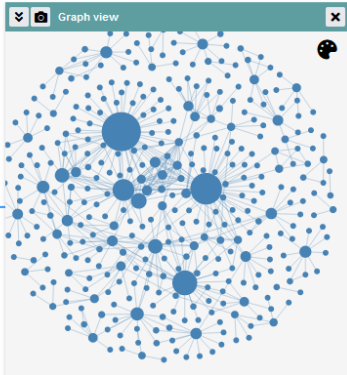
Institution **Laboratoire d'Informatique, Signaux**

**Clear cache** **Run**

**History**

- ☒ Initial Query
- ☐ Graph view
- ☐ Egocentric view (Marco Winckler)
- ☐ annotation-1
- ☐ Listing view (Marco Winckler)

**Graph view**



**Listing view (Marco Winckler)**

- (2017) A Behavior-Based Ontology for Supporting Marco Winckler, Jean-Luc Hak, Thiago Rocha Silva
- (2017) A Comparative Study of Milestones for Feature Marco Winckler, Jean-Luc Hak, Thiago Rocha Silva
- (2017) A FORMAL ONTOLOGY FOR DESCRIBING INTE Marco Winckler, Jean-Luc Hak, Thiago Rocha Silva
- (2020) A Generic Multimodels-Based Approach for t Marco Winckler, Céline Martinie, Philippe Palanque, Dr S
- (2019) A New Adaptation Lever in 360° Video Stream Ramon Aparicio-Pardo, Lucile Sassatelli, Marco Winck
- (2017) A Scenario-Based Approach for Checking Co Marco Winckler, Thiago Rocha Silva
- (2019) A Testbed Tool for Comparing Usability and S Karima Boudaoud, Marco Winckler, Philippe Palanque,
- (2019) An End-User Pipeline for Scraping and Visual Marco Winckler, Elod Egyed-Zsigmond, Gustavo Rossi
- (2020) Covid-on-the-Web: Knowledge Graph and Ser Elena Cabrio, Raphaël Gazzotti, Marco Winckler, Tobias
- (2020) Entrain, exploring new territorial user interfa

**dataHAL**

https://data.archives-ouvertes.fr/document/hal-02138473v1

Testing of Interactive Systems

Ontological Modeling

http://www.openarchives.org/terms/aggregates

Nowadays many software development frameworks implement Behavior-Driven Development (BDD) as a mean of automating the test of interactive systems under construction. Automated testing helps to simulate user's action on the User Interface and therefore check if the system behaves properly and in accordance to Scenarios that describe functional requirements. However, most of tools supporting BDD requires that tests should be written using low-level events and components that only exist when the system is already implemented. As a consequence of such low-level of abstraction, BDD tests can hardly be reused with diverse artifacts and with versions of the system. To address this problem, this paper proposes to raise the abstraction level by the means of a behavior-based ontology that is aimed at supporting test automation. The paper presents an ontology and an on-ontology-based approach for automating the test of functional requirements of interactive systems. With the help of a case study for the flight tickets e-commerce domain, we demonstrate how tests written using our ontology can be used to assess functional requirements using different artifacts, from low-fidelity to full-fledged UI Prototypes.

https://hal.science/hal-02138473

Thiago Rocha Silva, Jean-Luc Hak, Marco Winckler. A Behavior-Based Ontology for Supporting Automated Assessment of Interactive Systems. 11th International Conference on Semantic Computing IEEE ICSC 2017, 2017, San Diego, United States. &#x27E8;hal-02138473v1&#x27E9;

https://hal.archives-ouvertes.fr/hal-01712526

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v6938878618

v6938878619

v6938878617

https://data.archives-ouvertes.fr/documents/hal-02138473v2

2017

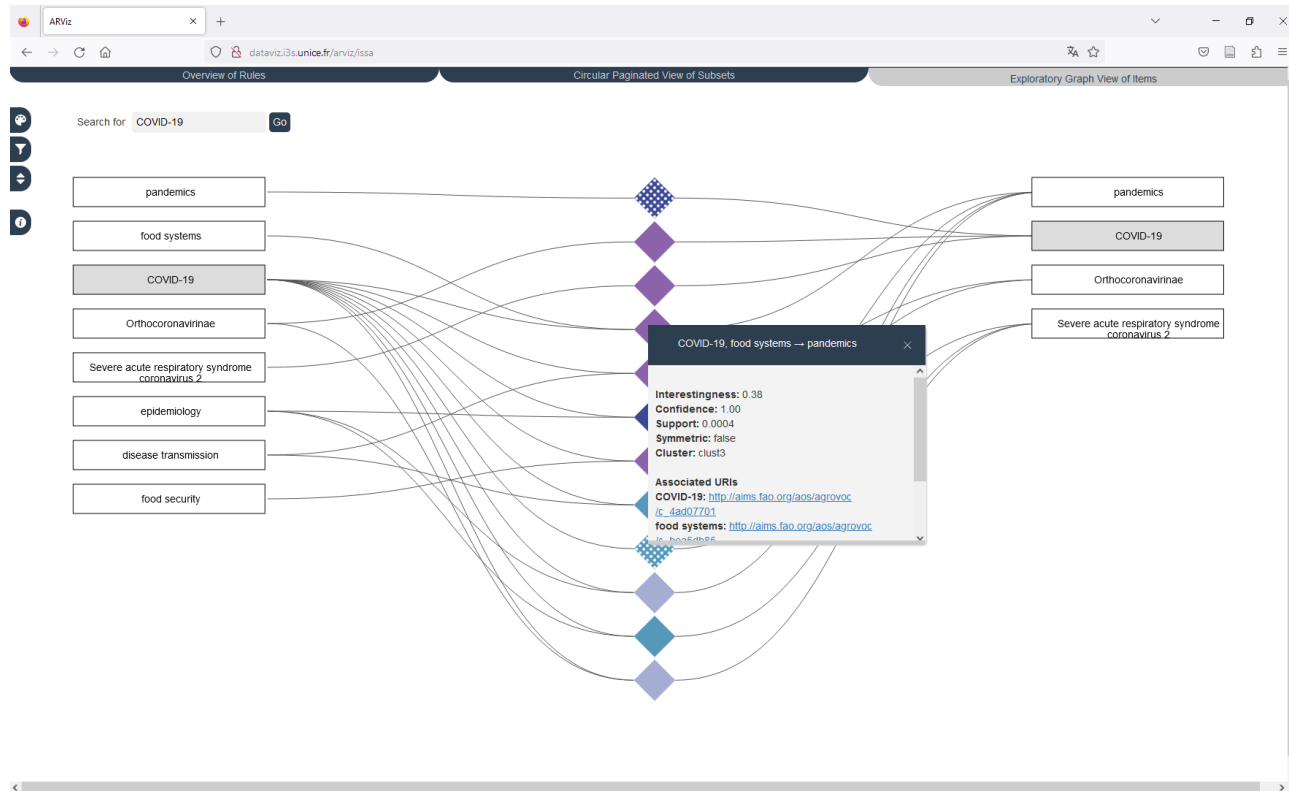
https://hal.science

https://data.archives-ouvertes.fr/documents/hal-02138473

hal-02138473



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

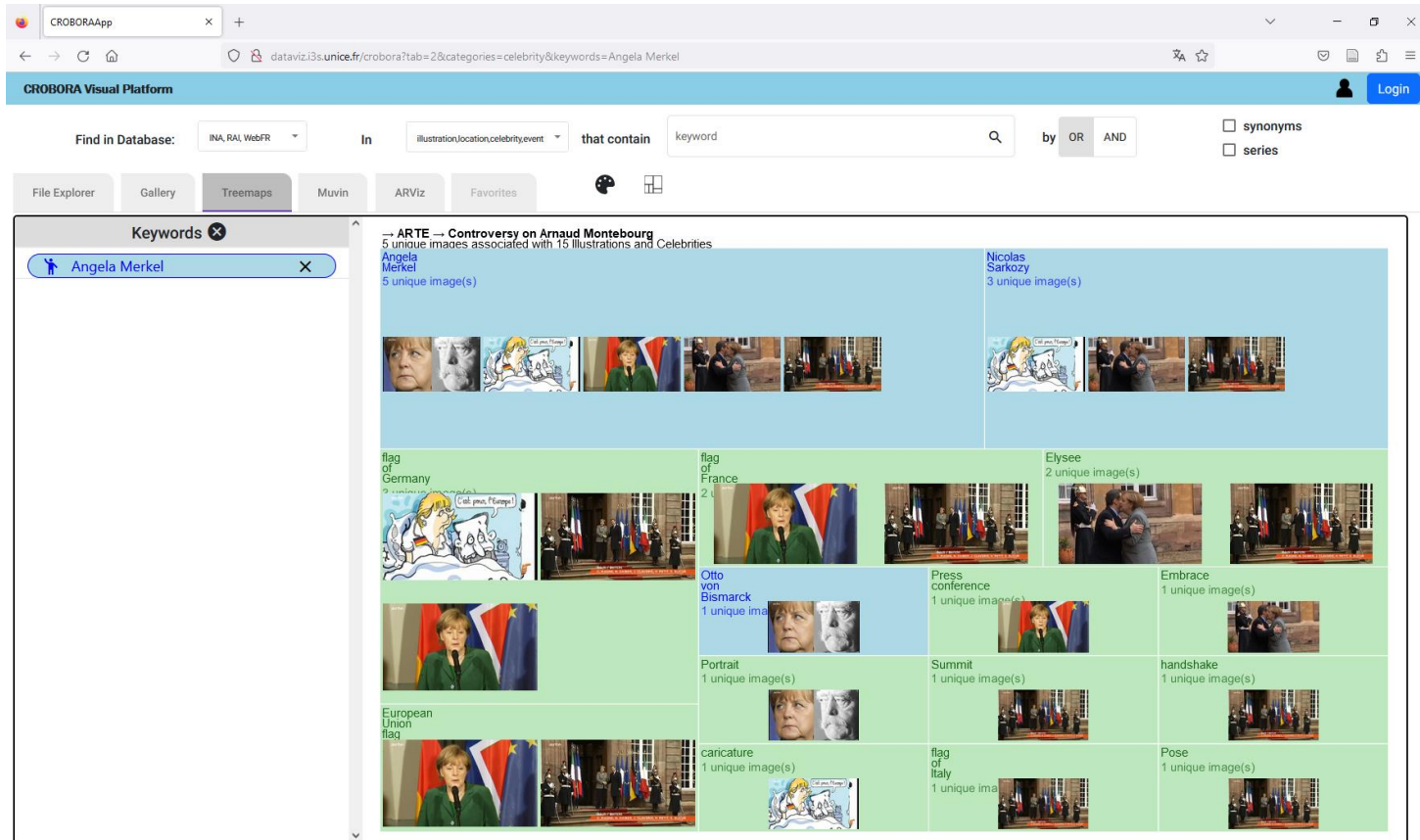


<https://www.youtube.com/watch?v=JbjTlWuQCMc&t=2s>

<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

LDViz

dataviz.i3s.unice.fr/ldviz/

## Linked Data Explorer

Query name:  
Wimmics team Inria I3S UCA CNRS

Initial Query

SPARQL Endpoint \* <https://data.archives-ouvertes.fr/sparql>

Query \* Query 7. Scenario 2: Collaboration r

Period From 2015 To 2020

Institution Laboratoire d'Informatique, Signaux

Clear cache Run

History

- Initial Query
- Graph view
- Egocentric view (Marco Winckler)
- annotation-1

Save

Graph view

Egocentric view (Marco Winckler)

annotation-1

Connect to View

Select an option

Views \*

- ☐ Graph view
- ☒ Egocentric view (Marco ...

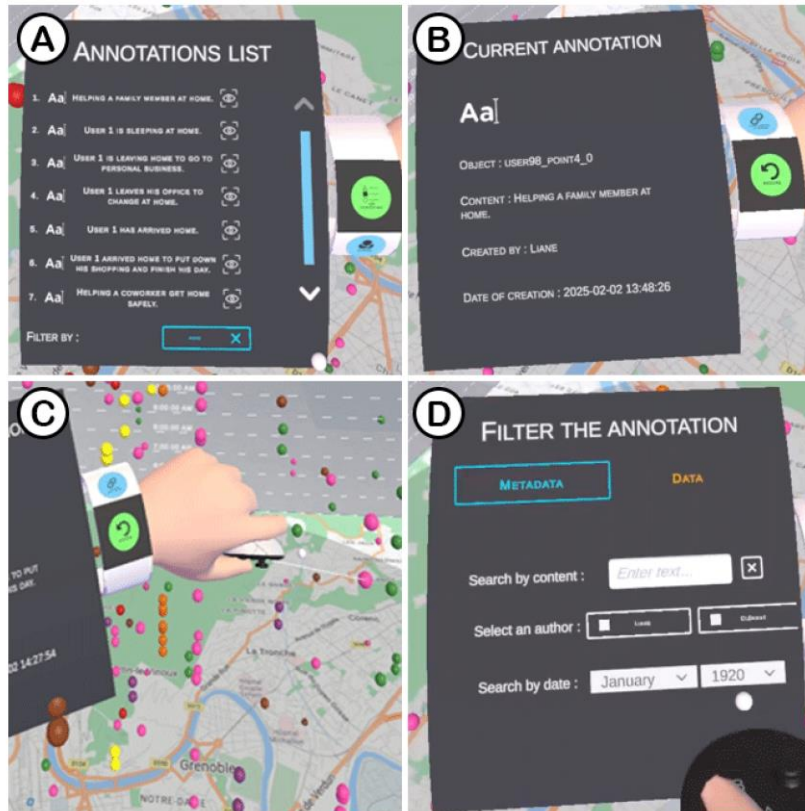
Note \* missing publications with Aline Menin

Save Cancel Reset Export

Interactive annotations of graphs

The screenshot displays the LDViz web application interface. On the left, the 'Initial Query' panel shows the SPARQL endpoint, query name, period, and institution. Below it is a 'History' panel listing the current views. The main area features two graph views: a 'Graph view' showing a dense network of blue nodes and edges, and an 'Egocentric view (Marco Winckler)' showing a radial graph centered on Marco Winckler. A red circle highlights an 'annotation-1' window that is open over the egocentric view. This window allows the user to connect the annotation to a specific view (here, 'Egocentric view (Marco Winckler)') and add a note. The note entered is 'missing publications with Aline Menin'. The window includes 'Save', 'Cancel', 'Reset', and 'Export' buttons.

# 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 goal 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 they might need to complete their tasks with interactive systems





**Au plaisir de vous retrouver  
sur la Côte d'Azur**

**Merci de votre attention!**

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marco.Winckler@inria.fr*