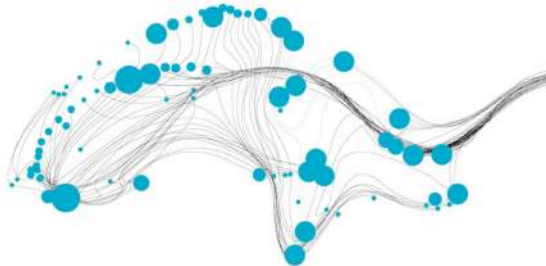


Franck

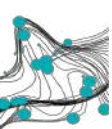
The Network (Science) Wizard

Marc Damie

May 23, 2025 (SCS Cybersec seminar)



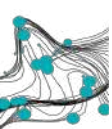
**UNIVERSITY
OF TWENTE.**



DISCLAIMER



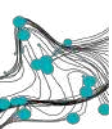
Network science \neq Computer networking



Goal of this presentation



- **Introduce network science** via the work of an atypical researcher.
- **Present a project of mine** related to network science.
- Illustrate the **potential of network science in cybersecurity**.

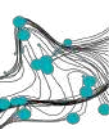


Who the hell is Franck?



- Franck Ghitalla (deceased in 2018)
- Ph.D. of Linguistic in 1995, Associate Prof. at a Uni. of Technology since 1999
- Transitioned to an unknown science around 2000: Network science



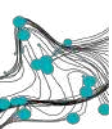


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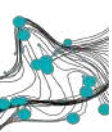
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- Published **no paper in 20 years**
- Received a **massive research funding** from the army!

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Overview

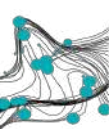


1. A short course on Network Science

2. Franck's "undisciplined" research

3. My tribute: Fedivertex

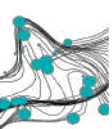
4. Network science for security researchers



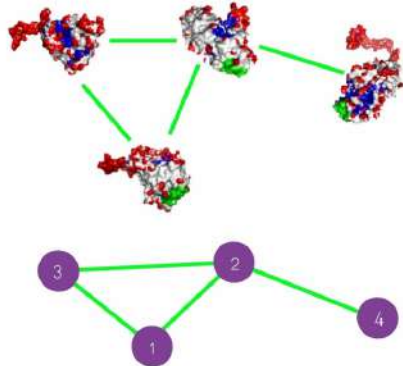
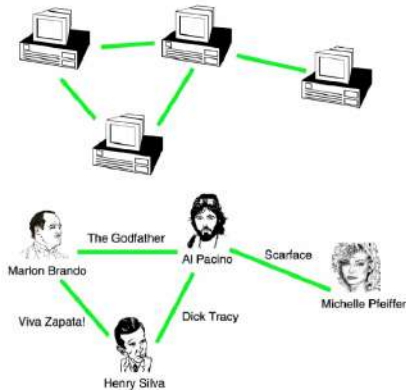
A bit of vocabulary

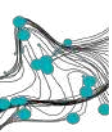


- **Network/Graph Theory** (Mathematics): the study of graphs as a representation of relations between discrete objects.
- **Network Science** (Transdisciplinary): the study of complex networks.
- **Network**: a catalog of a system's components often called nodes or vertices and the direct interactions between them, called links or edges.
- **Applications**: telecommunications, computer networks, biological networks, cognitive and semantic networks, social networks, etc.



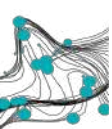
Networks vs. Graphs





Why is a graph so useful?

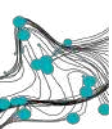




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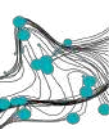
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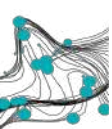


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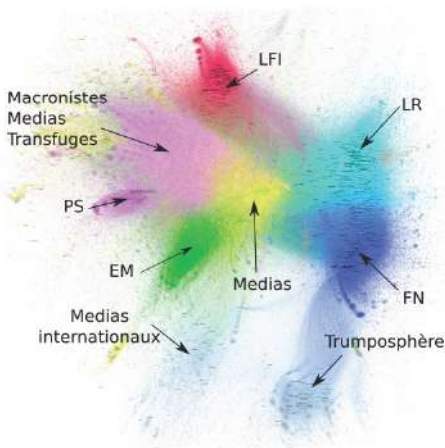


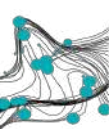
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- Franck Ghitalla: “[Graph] is the compass of digital universes.”

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Example 2: Social Media Analysis (by Ratinaud et al.)





Overview

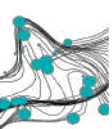


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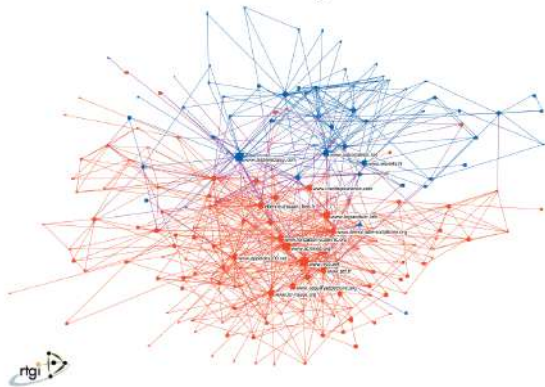
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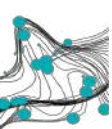


Example 1: 2005 European referendum

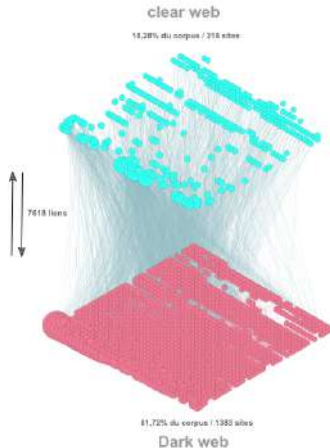
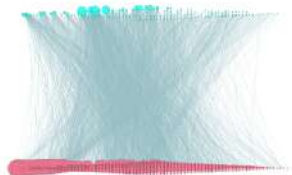


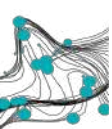
Website debating about the referendum



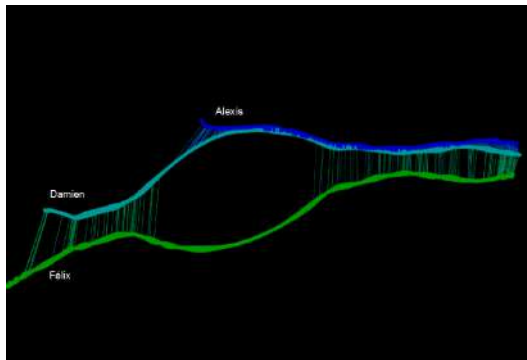
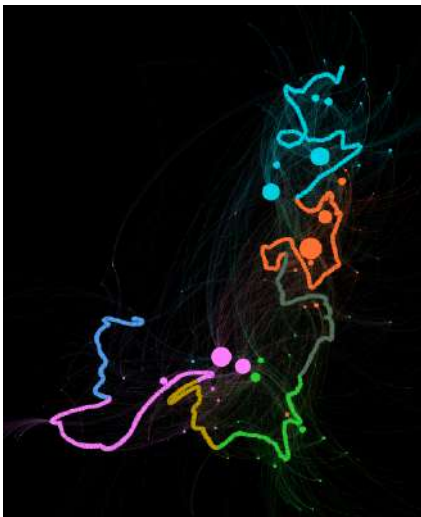


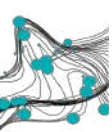
Example 2: Dark Web graph





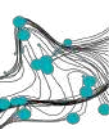
Example 3: Temporal Data Skeletons





Work process: never stop scrapping!

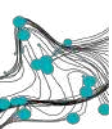




An unfinished work...



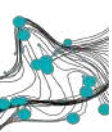
- **2015 Paris attacks**, a turning point...
- ... started applying his research to counterterrorism
- End-2018: an unexpected end.



His uncredited achievements



- His research project was successfully conducted



His uncredited achievements



- His research project was successfully conducted
- **Gephi**, a popular graph visualization software

[Gephi: an open source software for exploring and manipulating networks](#)

14205

2009

M Bastian, S Heymann, M Jacomy

Proceedings of the International AAAI conference on web and social media 3 ...

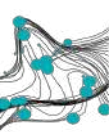
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3685

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M Jacomy, T Venturini, S Heymann, M Bastian

PloS one 9 (6), e98679



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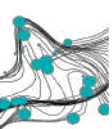
3685

2014

M Jacomy, T Venturini, S Heymann, M Bastian

PloS one 9 (6), e98679

- Contaminated many students with the “network-science virus.”



Overview

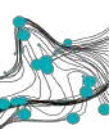


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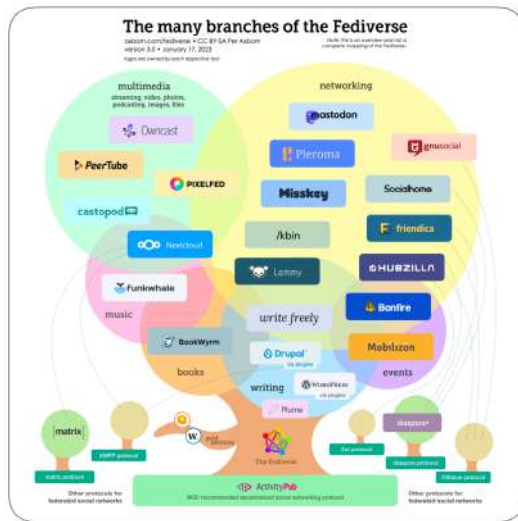
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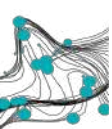
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The Fediverse

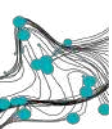




Starting point: Federated Learning for the Fediverse



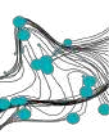
- With Edwige Cyffers (a French colleague of mine), we wanted to apply our work on Federated Learning to the Fediverse.
- **Goal:** Federated Recommender System for Peertube.
- **Problem:** existing works are not tested on graphs realistically simulating Federated Learning deployments.
- **Need new graphs.**



Fedivertex: Scope



- **New graph dataset** modeling interactions between Fediverse servers.
- Weekly crawl to **capture the temporal evolution**.
- **7 Fediverse social media** covered: Bookwurm, Friendica, Lemmy, Mastodon, Misskey, Peertube, Pleroma
- 13 unique graphs, 14 weekly snapshots \Rightarrow **182 graphs**.

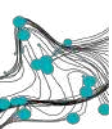


Fedivertex: Developing a crawler



Before deploying a crawl:

- 1 year of discussion with the legal department...
- Special declaration to the SOC.



Fedivertex: Developing a crawler

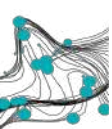


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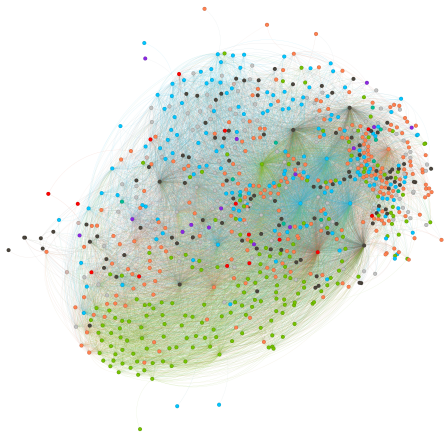
- 1 year of discussion with the legal department...
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Ethical concerns regarding a crawler:

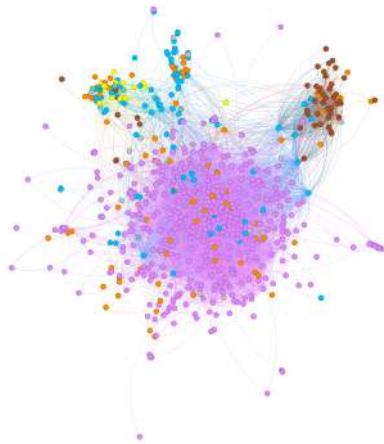
- **Privacy:** only query public APIs, only publish aggregated data.
- **Acceptability:** respect `robots.txt`, “slow” crawl, do not lie in the user agent.



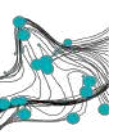
Fedivertex: Example graphs



Peertube



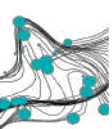
Misskey



Fedivertex: from a dataset to a paper



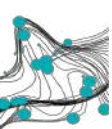
- What is a dataset paper?



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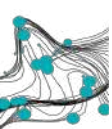
- What is a dataset paper?
- What are the requirements?
 - ⇒ Dataset presentation, Novelty vs. existing datasets, Applications



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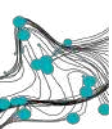
- What is a dataset paper?
 - ⇒ Dataset presentation, Novelty vs. existing datasets, Applications
- Where can I submit it?
 - ⇒ NeurIPS, KDD, SIGMOD/PODS



What's next for Fedivertex?



- Get the paper accepted
- Keep updating the dataset with new graphs
- Reproducing decentralized ML papers on this dataset \approx SoK?
- **Social science research:** does the Fediverse support “better” interactions than mainstream social media?
- **Security research:** how to efficiently stop spam waves in the Fediverse?

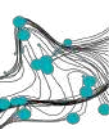


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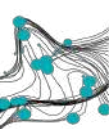


Towards network science in security research

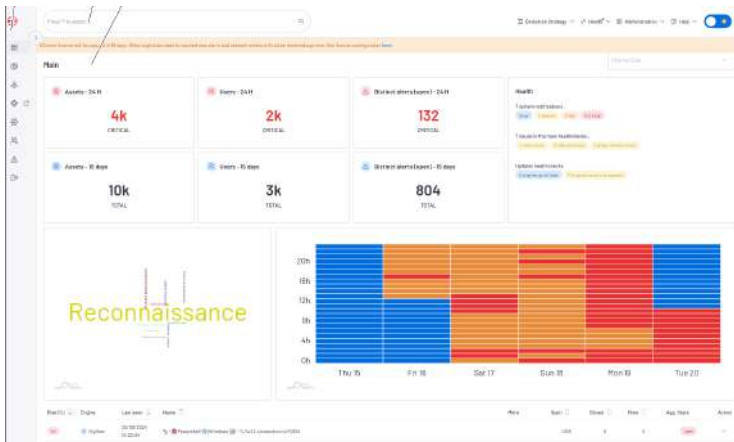


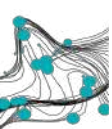
Cybersecurity could benefit from network science insights in different ways:

- Networks naturally emerge in cybersecurity problems.
- Clarify the large load of data (instead of feeding it to an LLM).
- Methods applied to terrorist networks could be transferred to hackers'.



Example problem: information load in NDR products

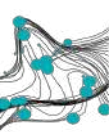




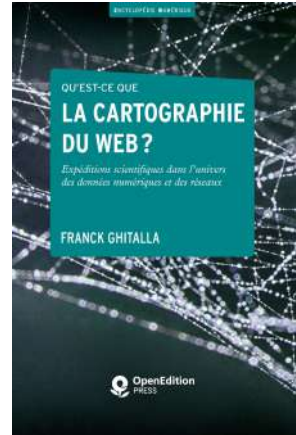
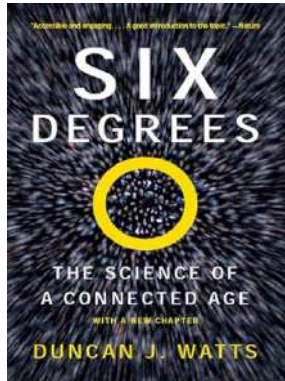
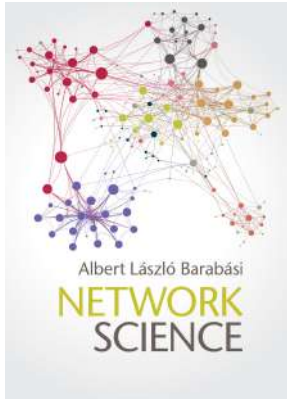
Example: Graph-based visualization for SOC logs?

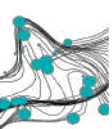


- **Problem:** SOC operators deals with a large amount of logs.
- **Solution:** introduce graphs to synthesize information in their dashboards.
- **Novelty:** ~~automating SOC tasks using AI~~ \Rightarrow simplify SOC tasks using graphs
- **Warning:** Go beyond trivial graphs of communications between IPs.



Wanna learn about Network Science?

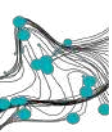




Wanna work with Network Science?



- Come talk to me :-)
- (Or even better) Talk to Doina Bucur (DMB)



Questions?