5-Weeks Course on Interactive Visual Network Exploration

Week 4: Exploring Networks with Node-link Diagrams

Feb 2nd, 2022

VIS HUB University of Edinburgh Visual+ Interactive Data

Inria

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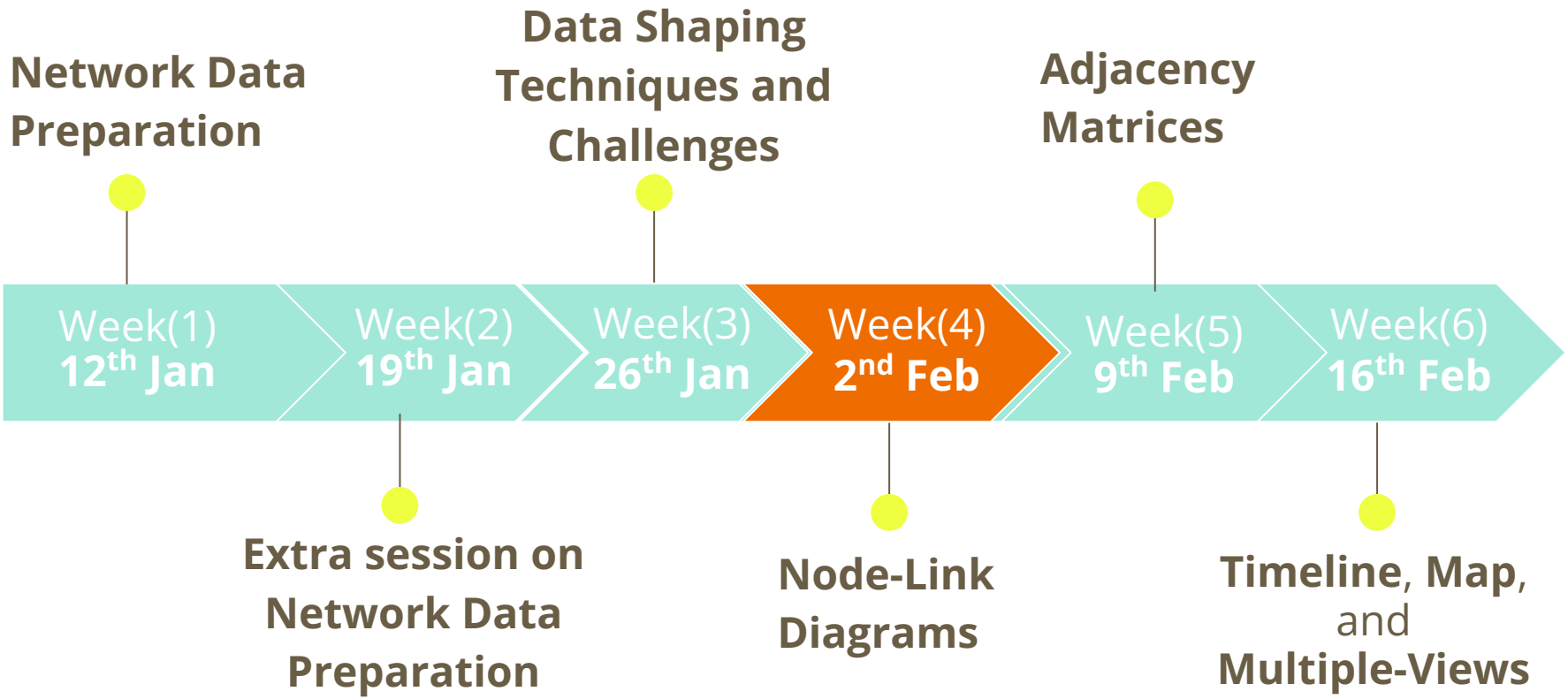

Network Data Preparation
Data Shaping Techniques and Challenges
Adjacency Matrices
Week(1) 12th Jan
Week(2) 19th Jan
Week(3) 26th Jan
Week(4) 2nd Feb
Week(5) 9th Feb
Week(6) 16th Feb
Extra session on Network Data Preparation
Node-Link Diagrams
Timeline, Map, and Multiple-Views

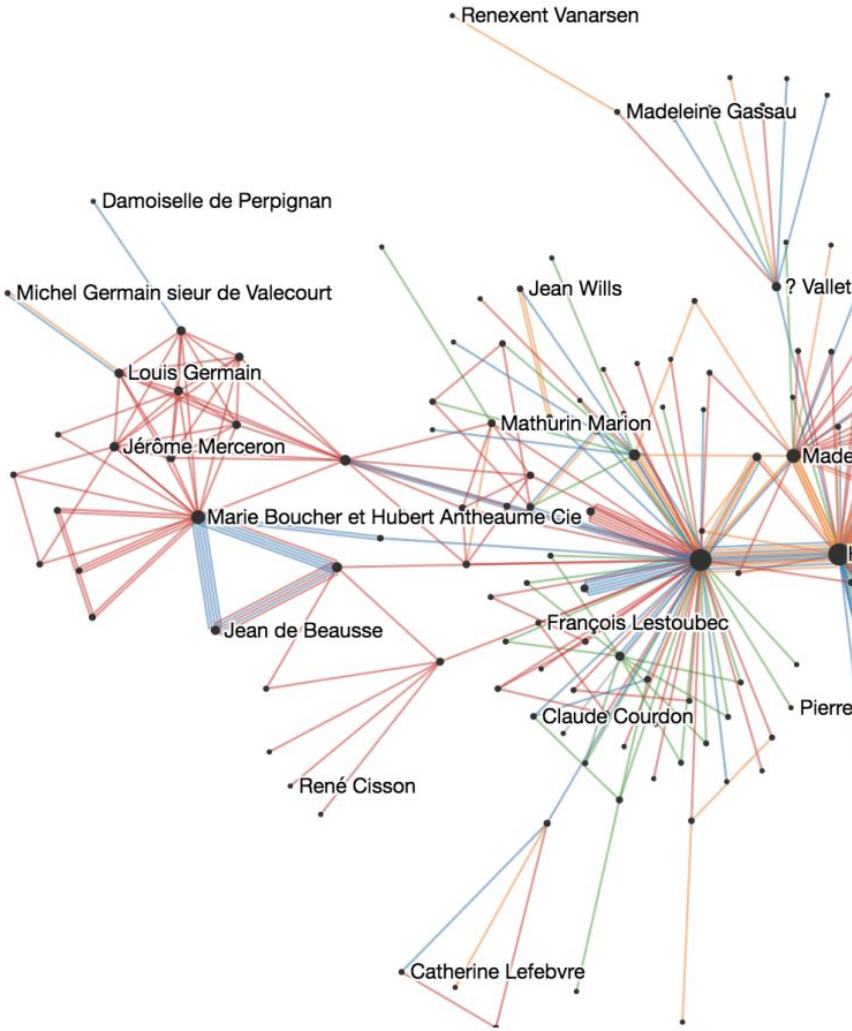
Questions

- Data tables?
- Data upload?

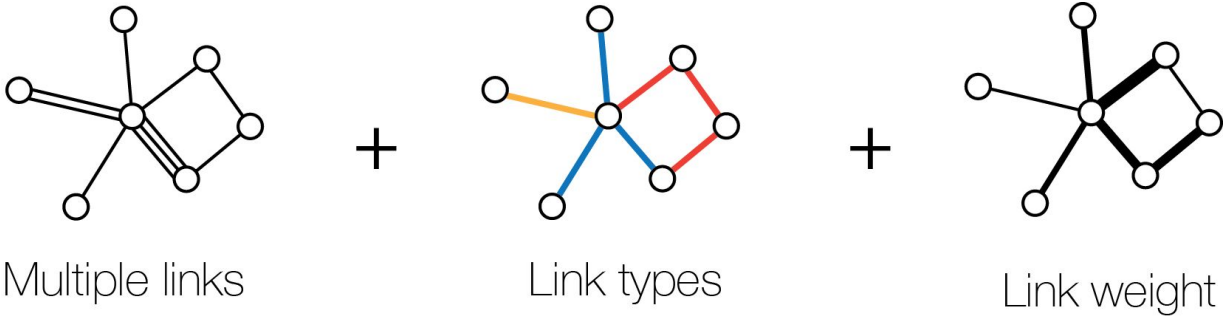
Goals for today

- What is visual network **exploration**
- How to **close-reading** a network diagram (visual patterns)
- Asking **questions** to your data (questions + hypotheses)
- Performing **interactive** exploration (strategies)

What is visual exploration?



Topology + Attributes



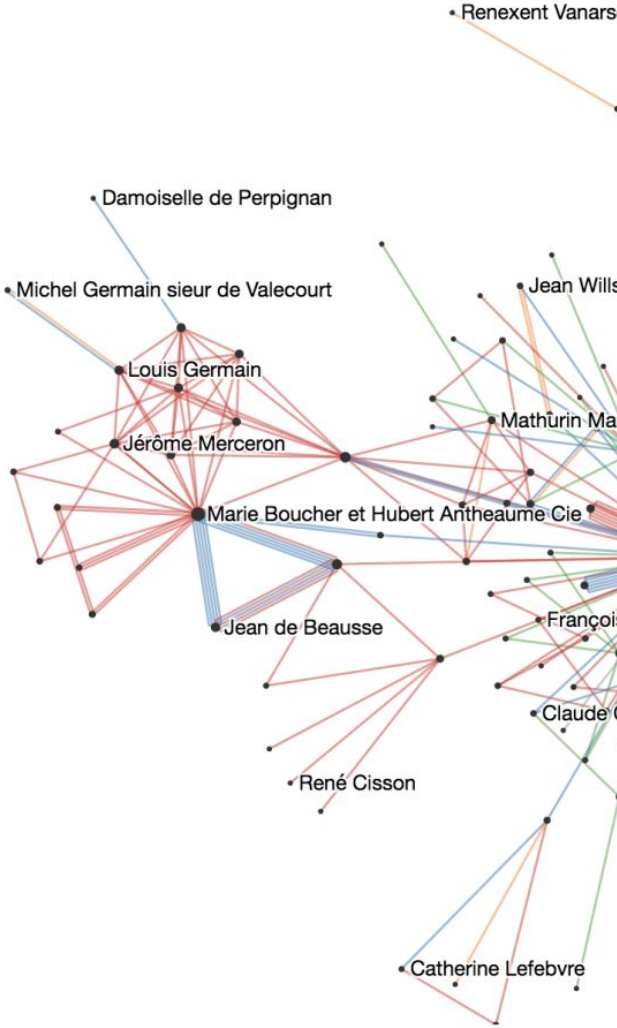
Exploratory Data Analysis (EDA)

	Univariate *Looks at one variable (data column) at a time*	**Multivariate** *Looks at two or more variables at a time to explore relationships*
Non- Graphical (quantitative and objective)	• Sample vs population distribution • Outlier detection	show the relationship between two or more variables in the form of statistics
Graphical (more qualitative and subjective)	• Sample's distributional characteristics (e.g. histogram)	Summarizes the data in a diagrammatic or pictorial way (e.g. Network topology, temporal changes)

It is almost always a good idea to perform univariate EDA on each of the components of a multivariate EDA before performing the multivariate EDA.

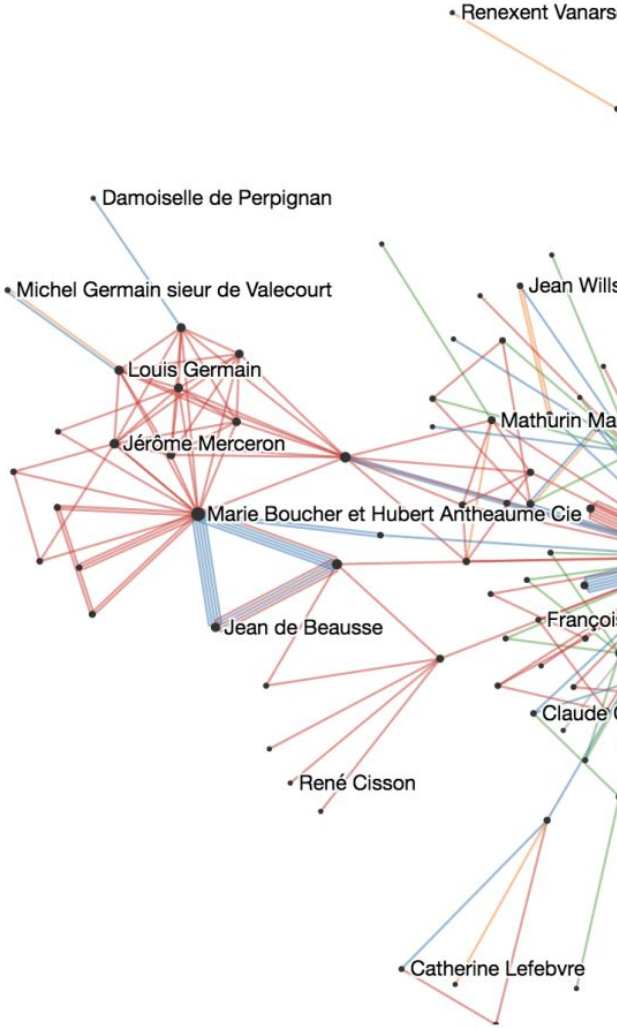
Visual Exploration:

1. Describing **visual patterns**



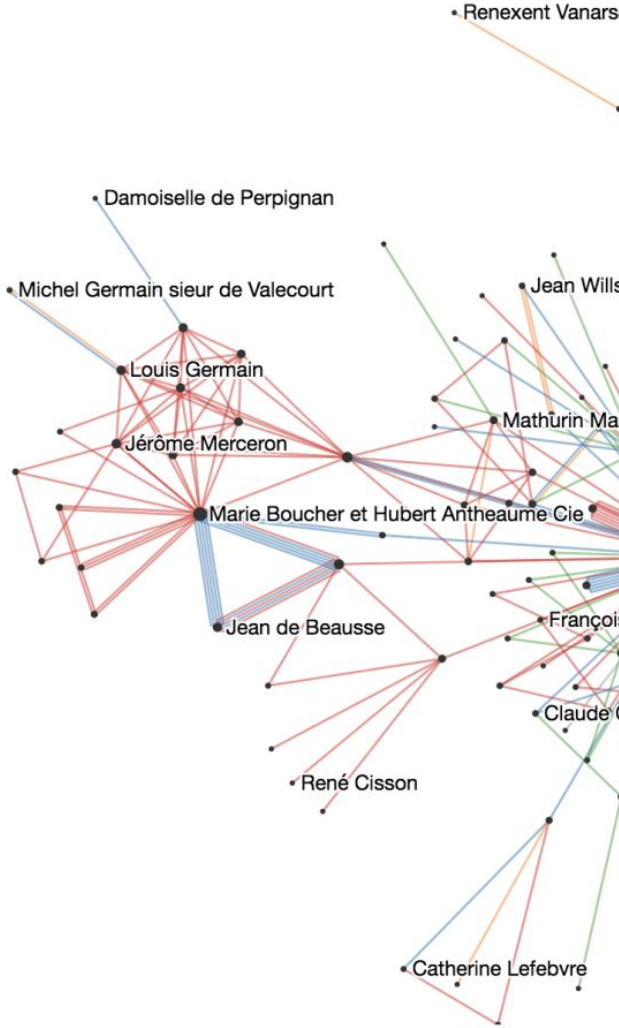
Visual Exploration:

1. Describing **visual patterns**
2. Asking **questions**



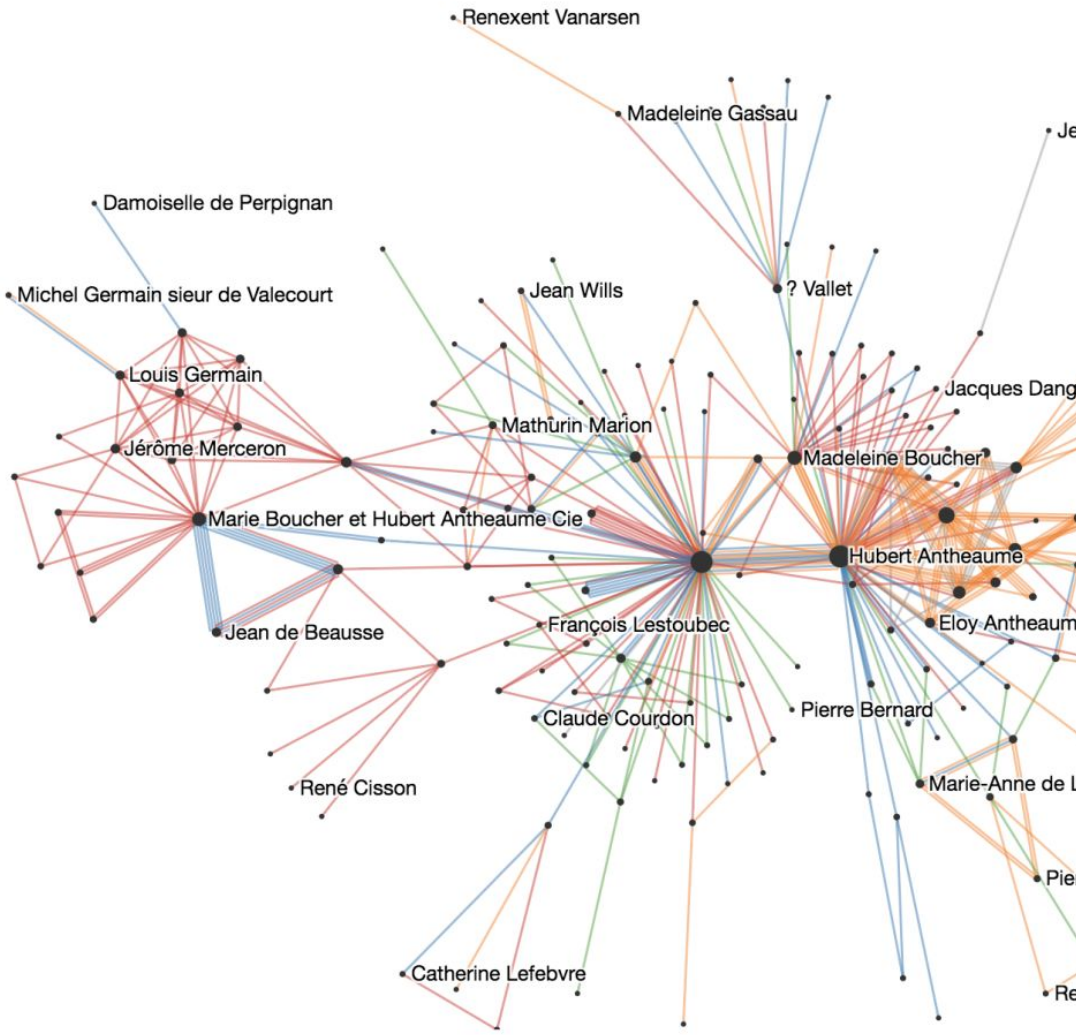
Visual Exploration:

1. Describing **visual patterns**
2. Asking **questions**
3. Generating **hypotheses**



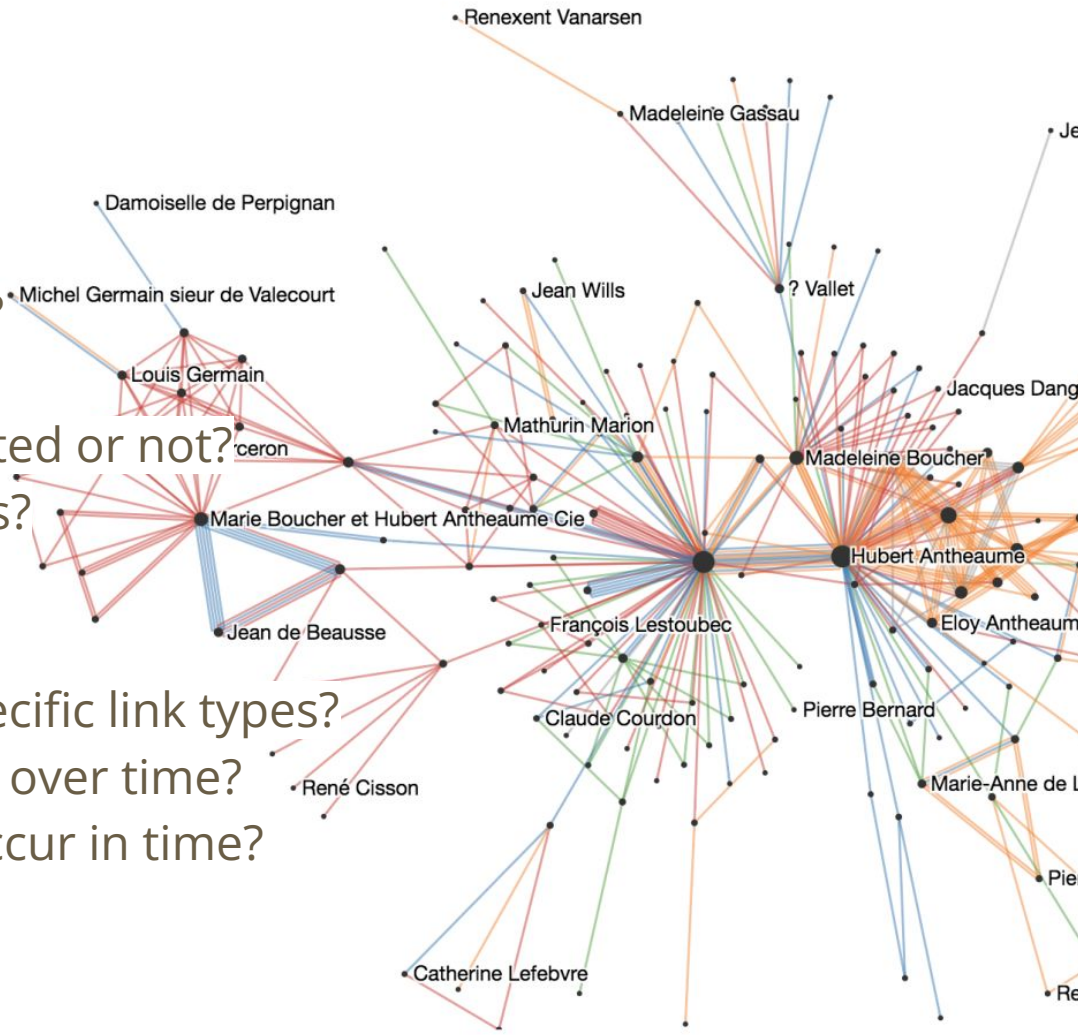
1. Visual Patterns

- Highly connected nodes
- Clusters
- Bridges (connect clusters)
- Neighbors
- Paths
- Motifs
- Multiple links
- Attributes
- > *Questions?*



2. Questions

- What are *other* central nodes?
- What are the isolated nodes?
- Are the central nodes connected or not?
- Does the network has clusters?
- How are these clusters?
- Are clusters connected?
- What is the distribution of specific link types?
- How does the network evolve over time?
- When do specific link types occur in time?
- How do communities form?
- ....

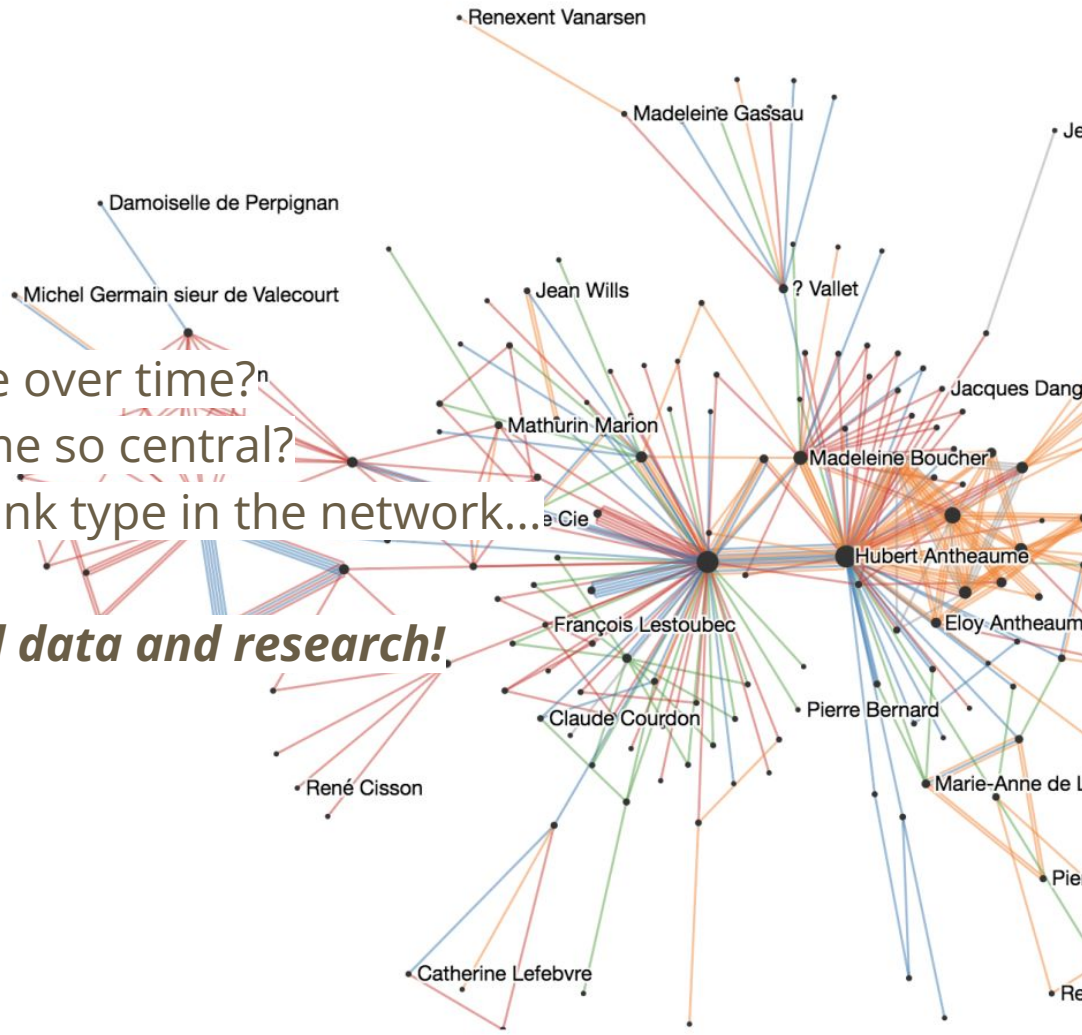


Additional Questions

- **Do we have a flows across your network?**
  - E.g. innovation can be interpreted as flow of patents or startups through relations and identifying large nodes for example with high number of relations
  - E.g. Care can be interpreted as flow of services or referrals through network relations
  - E.g. money laundering involves looking at financial flows among people and companies and identifying areas that don't make sense, either because they have more inflows than outflows or because they appear central in a network when they shouldn't be. (source: Visualizing Graph Data)

3. Hypotheses

- What makes up clusters?
- Why do specific things change over time?
- Why did specific nodes become so central?
- What is the role of a specific link type in the network...
- ...
- ***These may require additional data and research!***



Strategies

- **Overview**: Gain an overview of the entire network.
- **Zoom** : Zoom in on items of interest
- **Filter**: filter out uninteresting items (e.g., links)
- **Details-on-demand**: Select an item or group and get details when needed (e.g., neighbors)
- **History**: explore temporal evolution
- **Compare:** e.g., clusters, nodes, ...
- ...

Demo

- Data upload
- Timeslider
- Link filtering
- Visual parameters
- Bookmarks
- Mini questions

Hands on

- Free exploration
- We are around to help
- If you have questions, share your screen and we help

Exercise : What did you find?

- **What are you expecting?**
  - Dense or sparse?
  - Nodes with high degree?
  - Certain topology

- **What are you NOT expecting?**
  - E.g. certain clusters
  - E.g. certain association

General Questions?

Homework

- Apply discussed techniques of SNA on your own dataset. Try to create 3-5 Vistorian bookmarks showing a Eureka Moment! where you've found an answer or something interesting. The following week we will discuss how did your find your exploration using node links such as:
    - What wasn't applicable? What was hard to find/figure?
    - Do you find that some properties are missing from Vistorian to help your exploration process ?
    - What was useful through your exploration
- You may also try it on each of the data models you've created try to explore and answer some of the questions. Which of the data models was more discoverable.

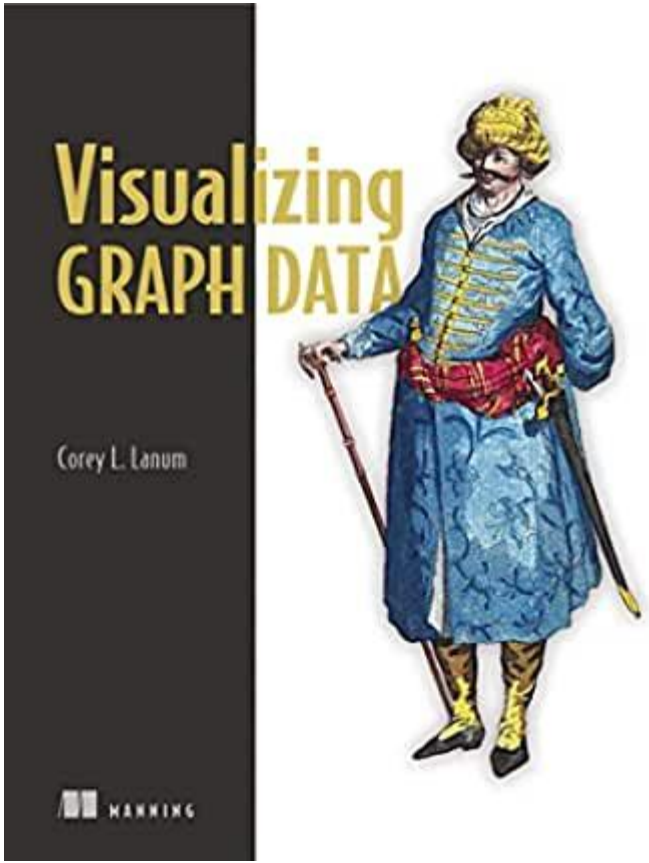
References

- Social network analysis - Introduction to structural thinking: Dr Bernie Hogan https://www.youtube.com/watch?v=2ZHuj8uBinM&t=5188s
- A Tour through the Visualization Zoo https://forms.office.com/r/YKiWbzP9EZ

Useful Guides

Examples on :

- Intelligence and law enforcement graphs
- Financial and online review fraud graphs
- Cyber security
- Sales and marketing graphs



Assistive Techniques in Exploring your Network

- **Helping Techniques :**
  - Filter nodes by using centrality score called Betweenness to hide the less influential bides and focus only on the more central nodes. This includes:
    - Degree Centrality
      - Inbound Centrality
      - Outbond Centrality
    - Betweenness Centrality
    - Path Finder
  - Filter by node type
  - Filter by link type
  - Aggregate nodes

Readings

- Beck, Fabian, et al. "A taxonomy and survey of dynamic graph visualization." *Computer Graphics Forum*. Vol. 36. No. 1. 2017: http://dynamicgraphs.fbeck.com/
- Herman, Ivan, Guy Melançon, and M. Scott Marshall. "Graph visualization and navigation in information visualization: A survey." *IEEE Transactions on visualization and computer graphics* 6.1 (2000): 24-43.
- Von Landesberger, Tatiana, et al. "Visual analysis of large graphs: state-of-the-art and future research challenges." *Computer graphics forum*. Vol. 30. No. 6. Oxford, UK: Blackwell Publishing Ltd, 2011.
- Hadlak, Steffen, Heidrun Schumann, and Hans-Jörg Schulz. "A Survey of Multi-faceted Graph Visualization." *EuroVis (STARs)*. 2015.
- Schöttler, Sarah, Tobias Kauer, and Benjamin Bach. "Geographic Network Visualization Techniques: A Work-In-Progress Taxonomy." *Computer Graphics* 20 (2014): 2043-2052.: https://geographic-networks.github.io