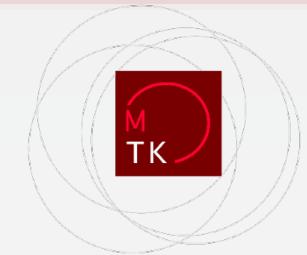




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NYCDH Week + NYU Abu Dhabi WIDH

9 Feb. 2021



Network Analysis

Check Materials at:

<https://github.com/GusRiva/NetworkAnalysisWIDH-NYCDH2021>

Dr. Gustavo Fernández Riva
Universität Heidelberg
SFB 933 – Material Text Cultures

Overview

Introduction: Concepts and Theory

Examples of Network Analysis in the Humanities

Exploration of Movie Networks (moviegalaxies.com)

Formats

Exercises with movies and theater plays (Gephi – Cytoscape – GraphCommons)

INTRODUCTION



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Networks Everywhere



Photo by [Robert Anasch](#) on [Unsplash](#)



Photo by [Denys Nevozhai](#) on [Unsplash](#)



Photo by [Nastya Dulhiier](#) on [Unsplash](#)

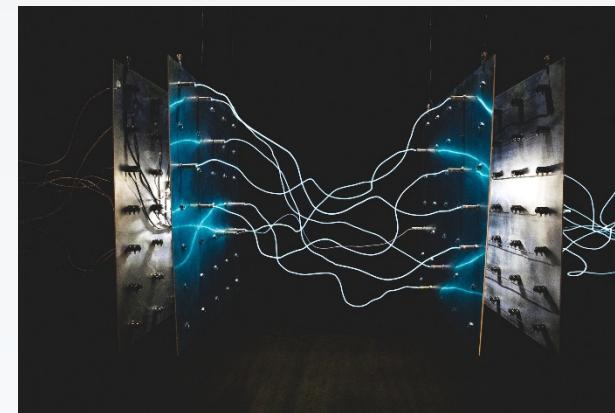
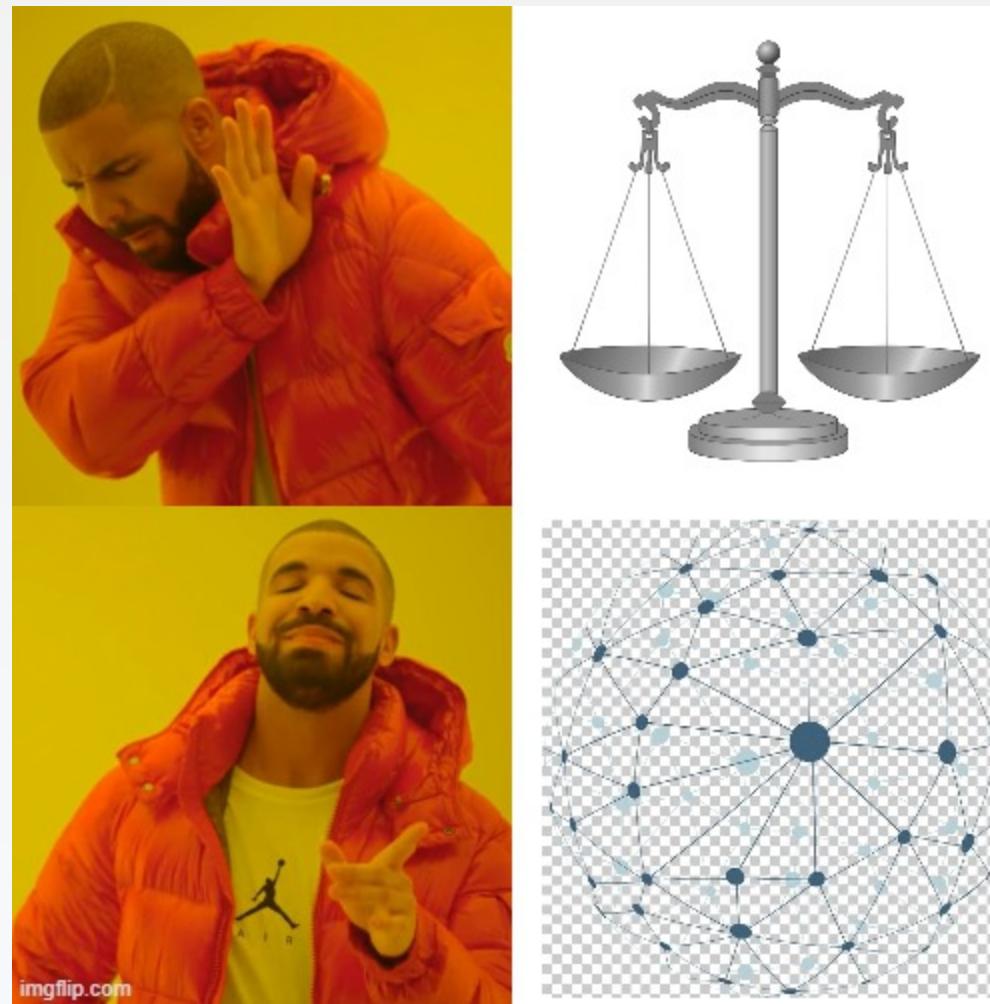


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Zeitgeist



The Revolution of Network Science

In the past, we lacked the tools to map these networks. It was equally difficult to keep track of the huge amount of data behind them. The Internet revolution, offering effective and fast data sharing methods and cheap digital storage, fundamentally changed our ability to collect, assemble, share, and analyze data pertaining to real networks.

Thanks to these technological advances, at the turn of the millenium we witnessed an explosion of map making. [...] The sudden availability of these maps at the end of the 20th century has catalyzed the emergence of network science.

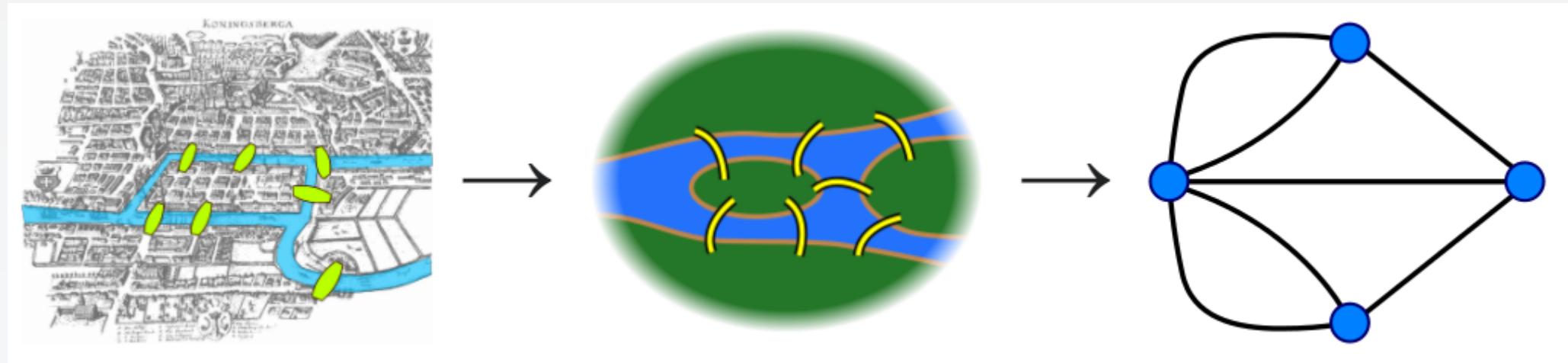
[...]

A key discovery of network science is that *the architecture of networks emerging in various domains of science, nature, and technology are similar to each other, a consequence of being governed by the same organizing principles. Consequently we can use a common set of mathematical tools to explore these systems.*

Albert-László Barabási,
Network Science.

<http://networksciencebook.com/chapter/1#forces-helped>

Eulers Königsberg Bridge Problem - 1736



Source: https://en.wikipedia.org/wiki/Seven_Bridges_of_Königsberg

BASIC CONCEPTS



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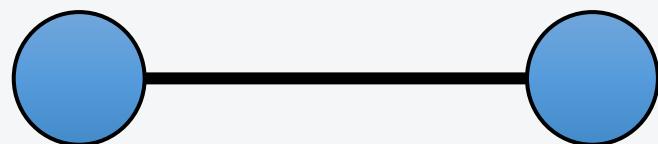
Concepts



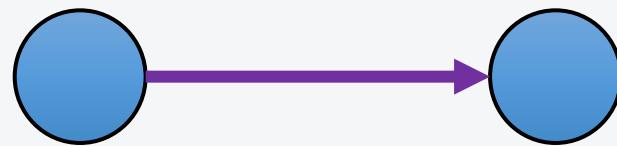
Directed



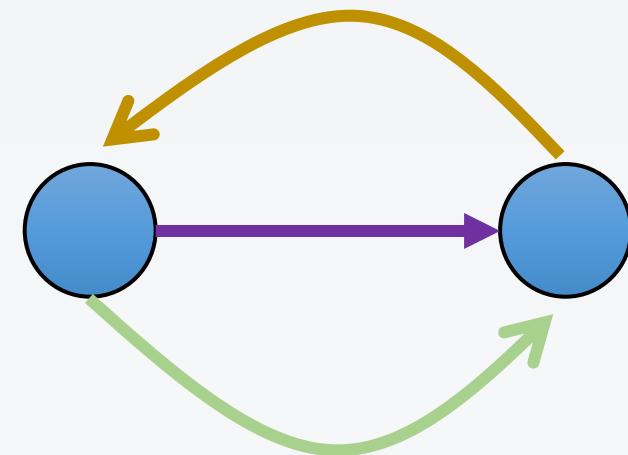
Undirected



Simple

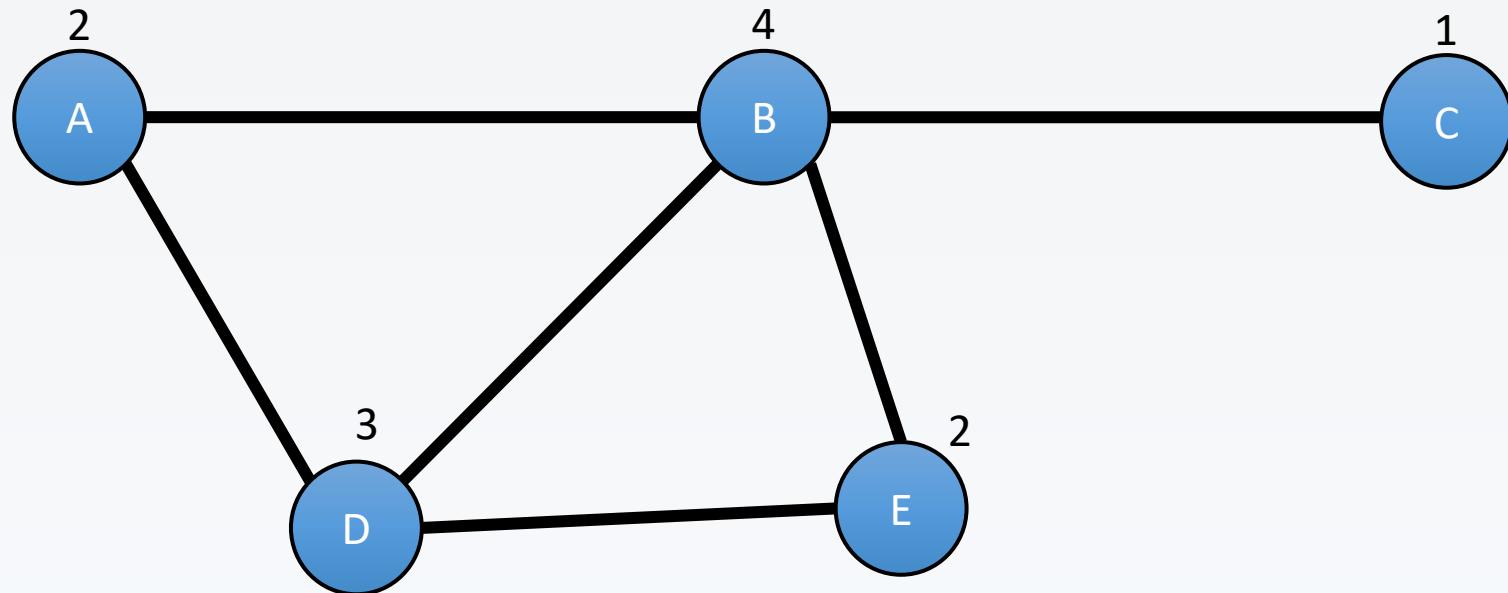


Multigraph



Concepts

Degree of a node is the number of other nodes directly connected to it. In a directed graph we can distinguish the “out-degree”, which only considers outgoing edges and the “in-degree”, which only considers incoming edges.



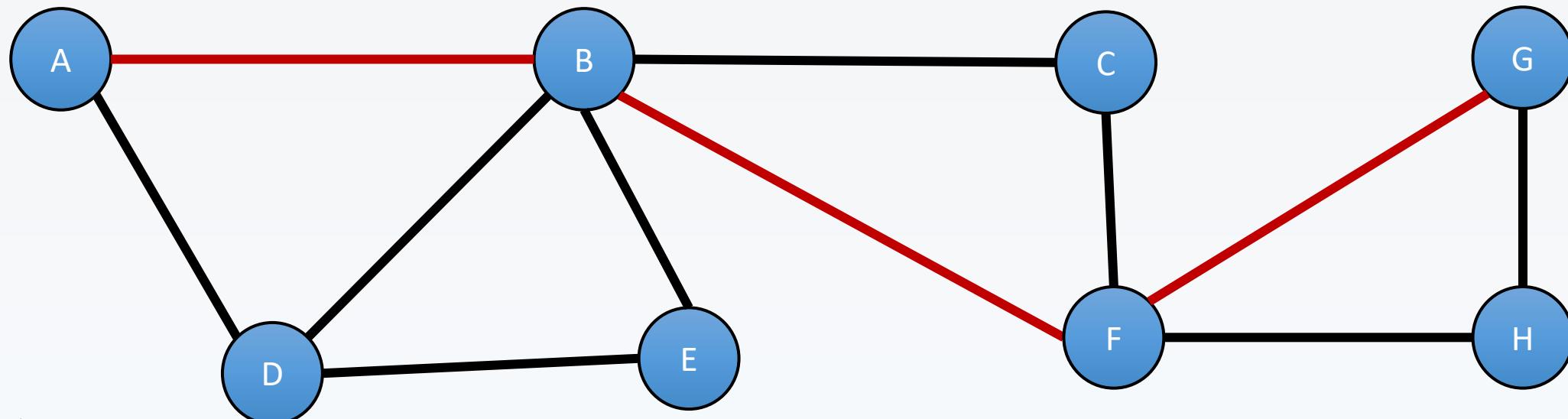
Concepts

Path is a sequence of nodes in which each of them is connected to the following node by an edge.

The **length** of a path is the number of edges it contains.

Geodesical distance between two nodes is equal to the length of the shortest path that connects them.

Diameter of a graph is the longest geodesical distance between any pair of nodes in the graph.



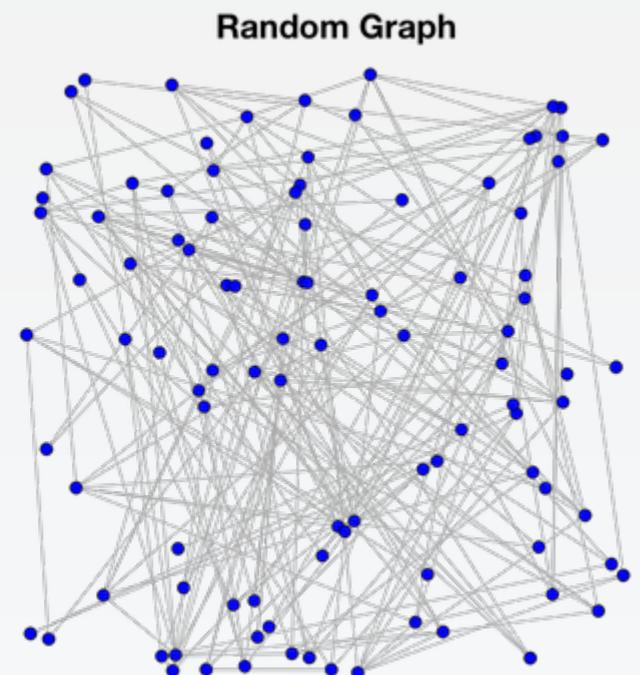
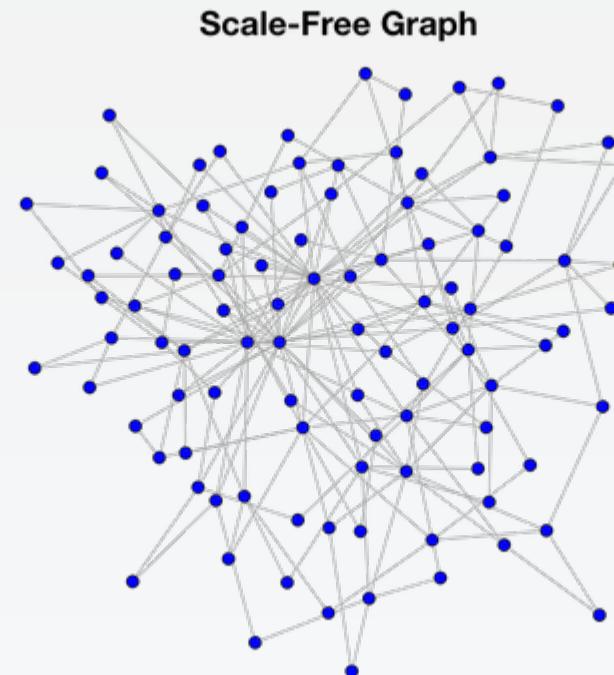
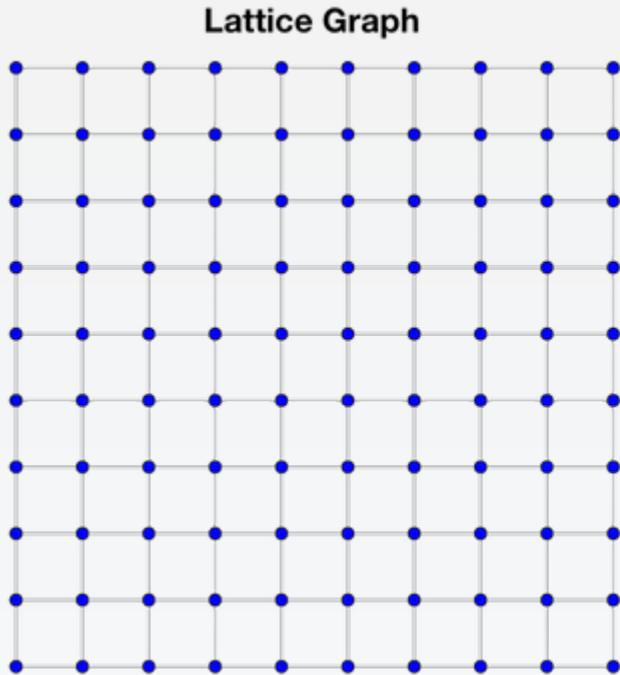
Degree: Higher Degree = Higher Centrality

Closeness Centrality: The more central a node is the lower its total distance to all other nodes.

Betweenness Centrality: Quantifies the number of times a node acts as a bridge along the shortest path between two other nodes.

Eigenvector Centrality: A measure of the influence of a node in a network. It assigns relative scores to all nodes in the network based on the concept that connections to high-scoring nodes contribute more to the score of the node in question than equal connections to low-scoring nodes.

Types of Networks



Uses in Diverse Disciplines and Contexts

Fraud detection and money laudry ([Panama Papers](#))

Tracing and control of infectious desease ([Coronavirus](#))

Biodiversity

Protein interaction in celular biology

Connectivity of information networks

Recommendation systems

Databases

Etc.

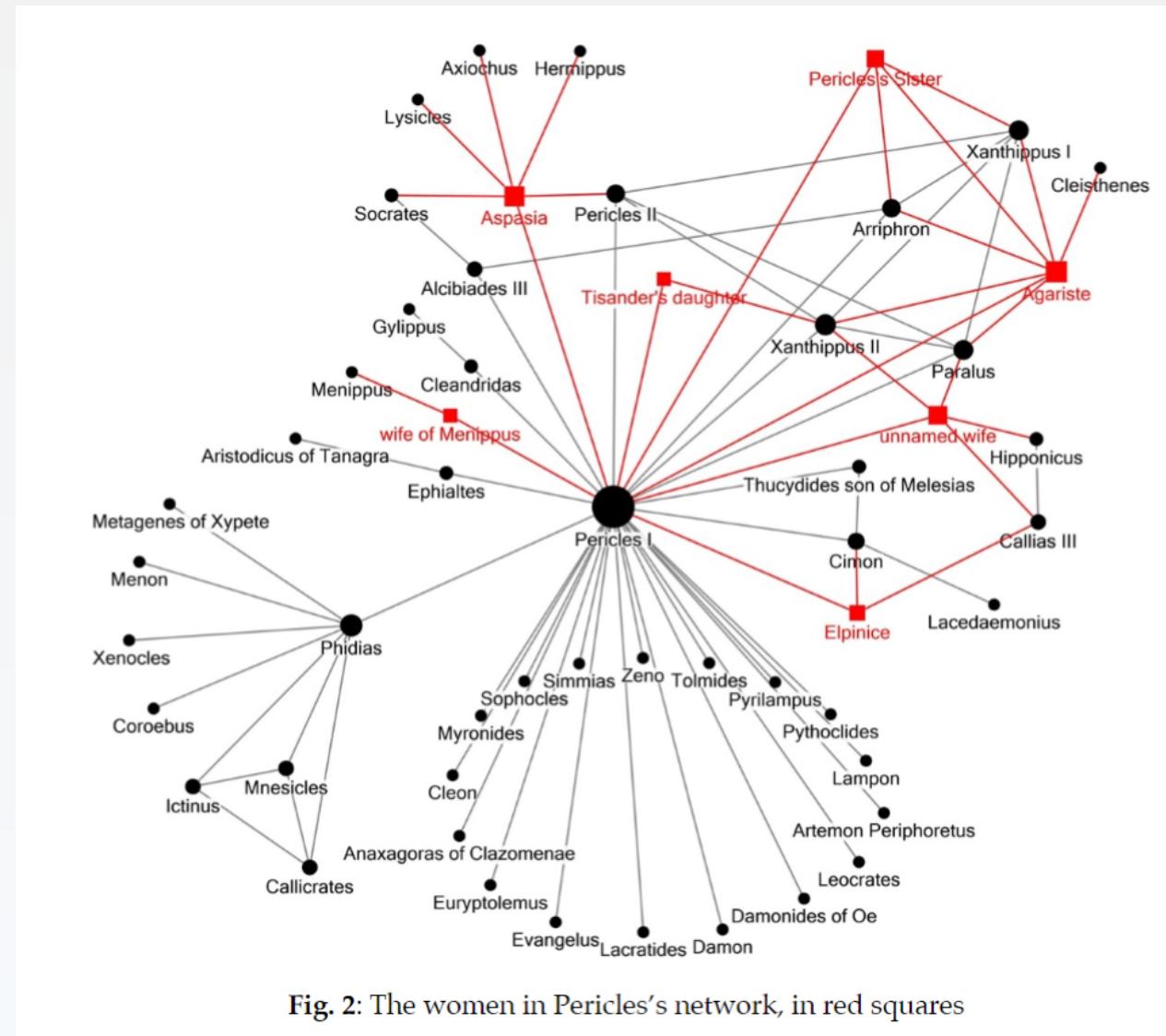


NETWORK ANALYSIS IN THE HUMANITIES

SOME EXAMPLES



Social Networks



Cline, D. (2020). Athens as a Small World. *Journal of Historical Network Research*, 4, 36-56.
<https://doi.org/10.25517/jhnrv4i0.84>

Social Networks

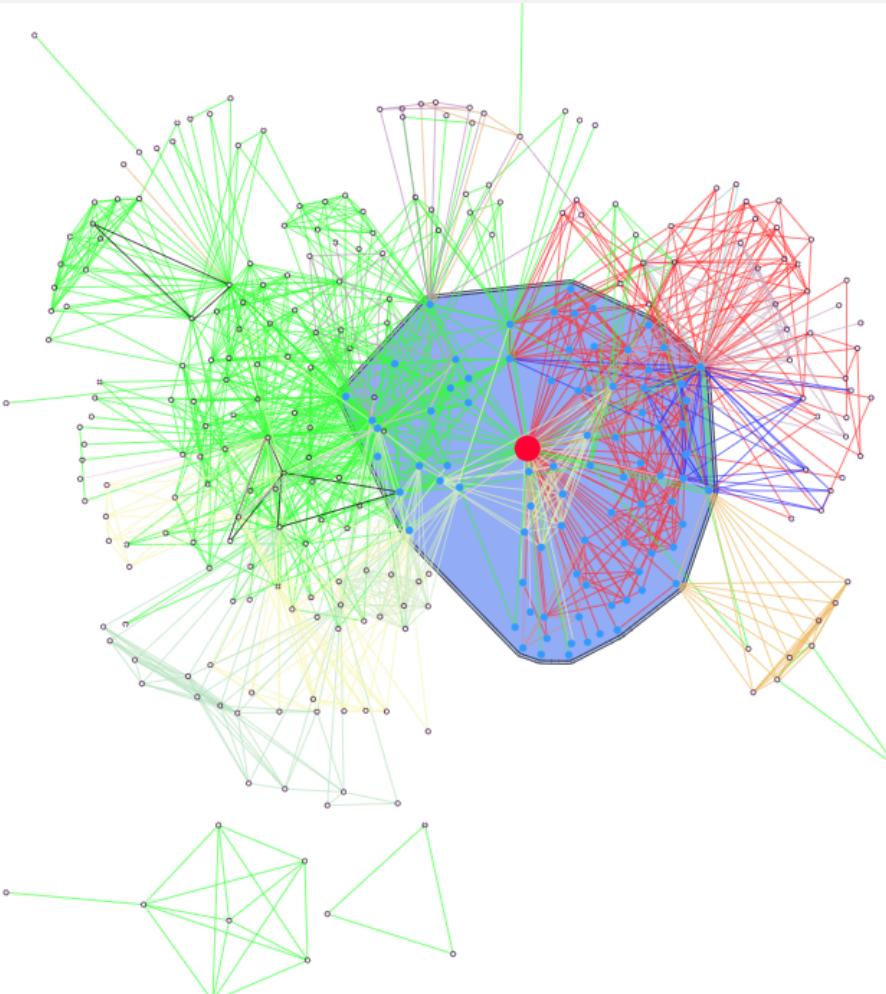
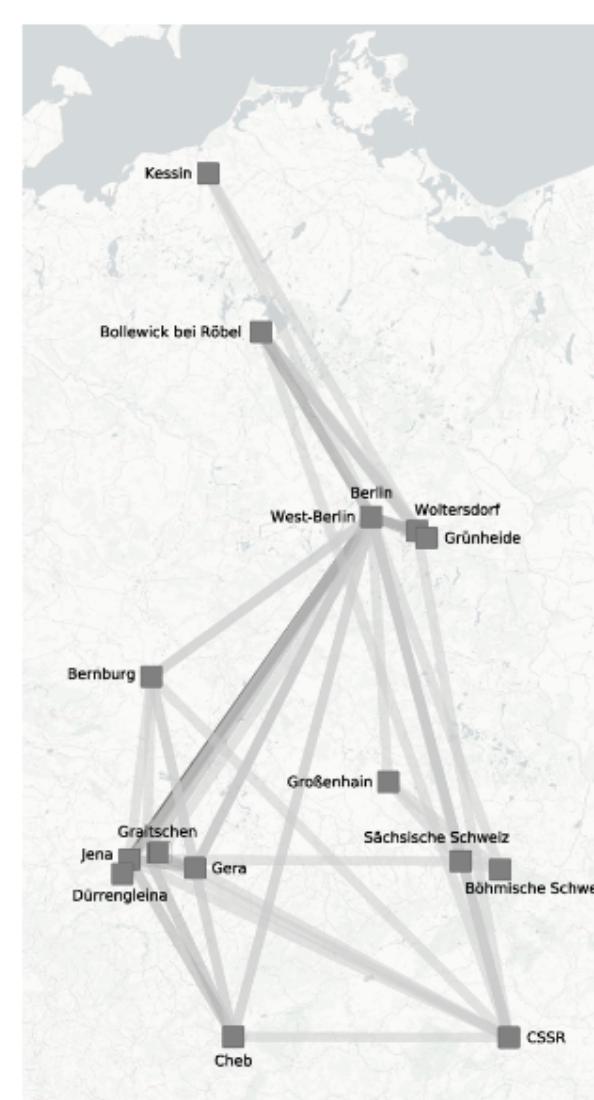
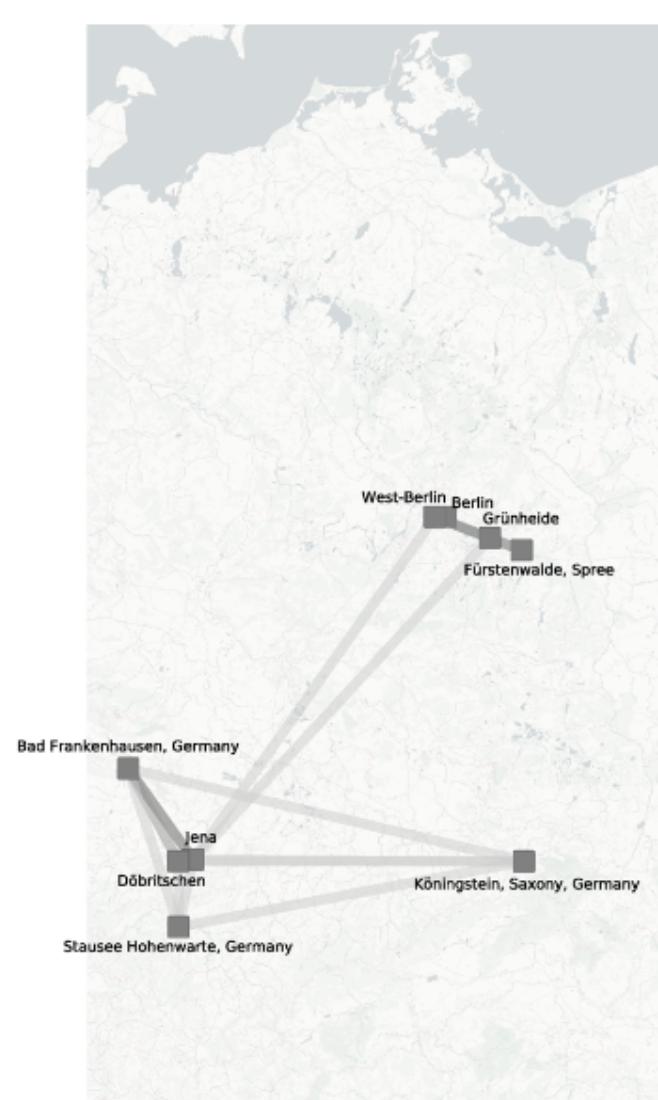


Figure 3: Roland Jahn's social network within the whole network structure between 1975-1990. Red node: Roland Jahn. Blue nodes: Jahn's direct neighbours. Layout: stress minimisation. Red edges = JENA, Green edges = BERLIN AREA, other colours = diverse geographical connections.

Elo, K. (2018). Geospatial Social Networks of East German Opposition (1975-1989/90). *Journal of Historical Network Research*, 2(1), 143-165.

Retrieved from
<http://jhnr.uni.lu/index.php/jhnr/article/view/45>

Social Networks

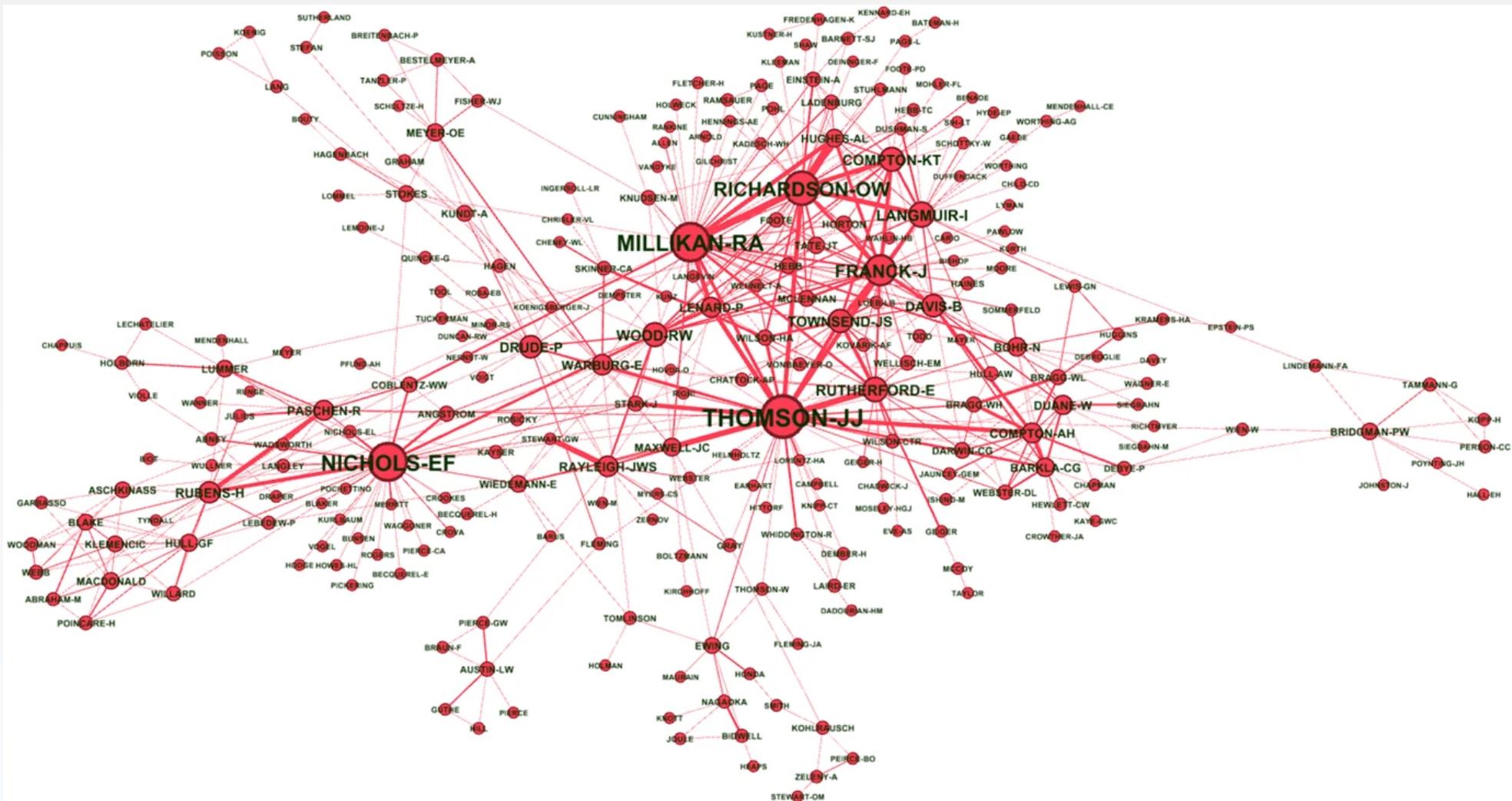


Elo, K. (2018). Geospatial Social Networks of East German Opposition (1975-1989/90). *Journal of Historical Network Research*, 2(1), 143-165.

Retrieved from
<https://jhnr.uni.lu/index.php/jhnr/article/view/45>



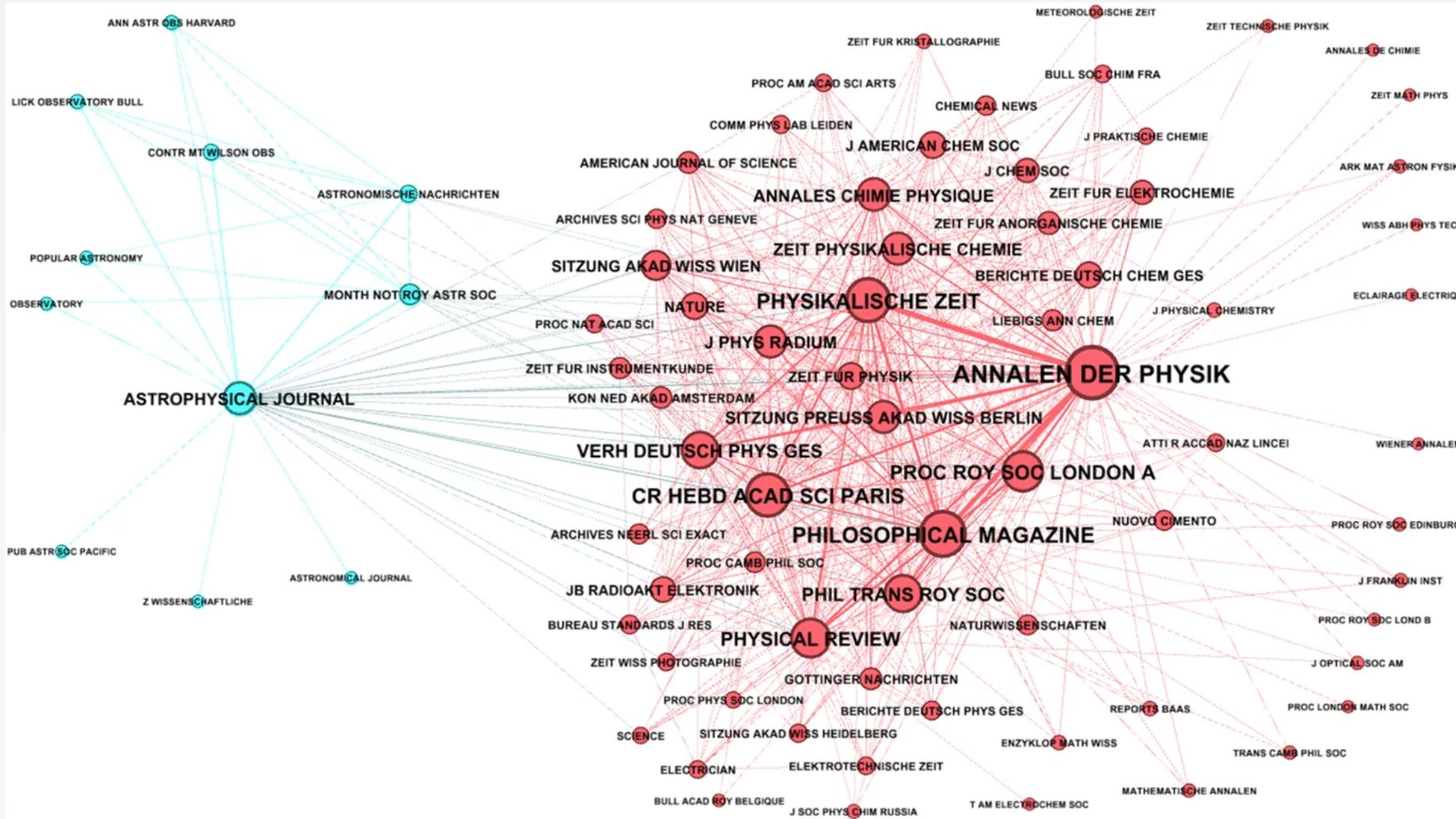
Co-Citation Networks



Khelfaoui, M., Gingras,
Y. "Physical Review:
From the Periphery to
the Center of Physics".
Phys. Perspect 21, 23–
42 (2019).
<https://doi.org/10.1007/s00016-019-00235-y>



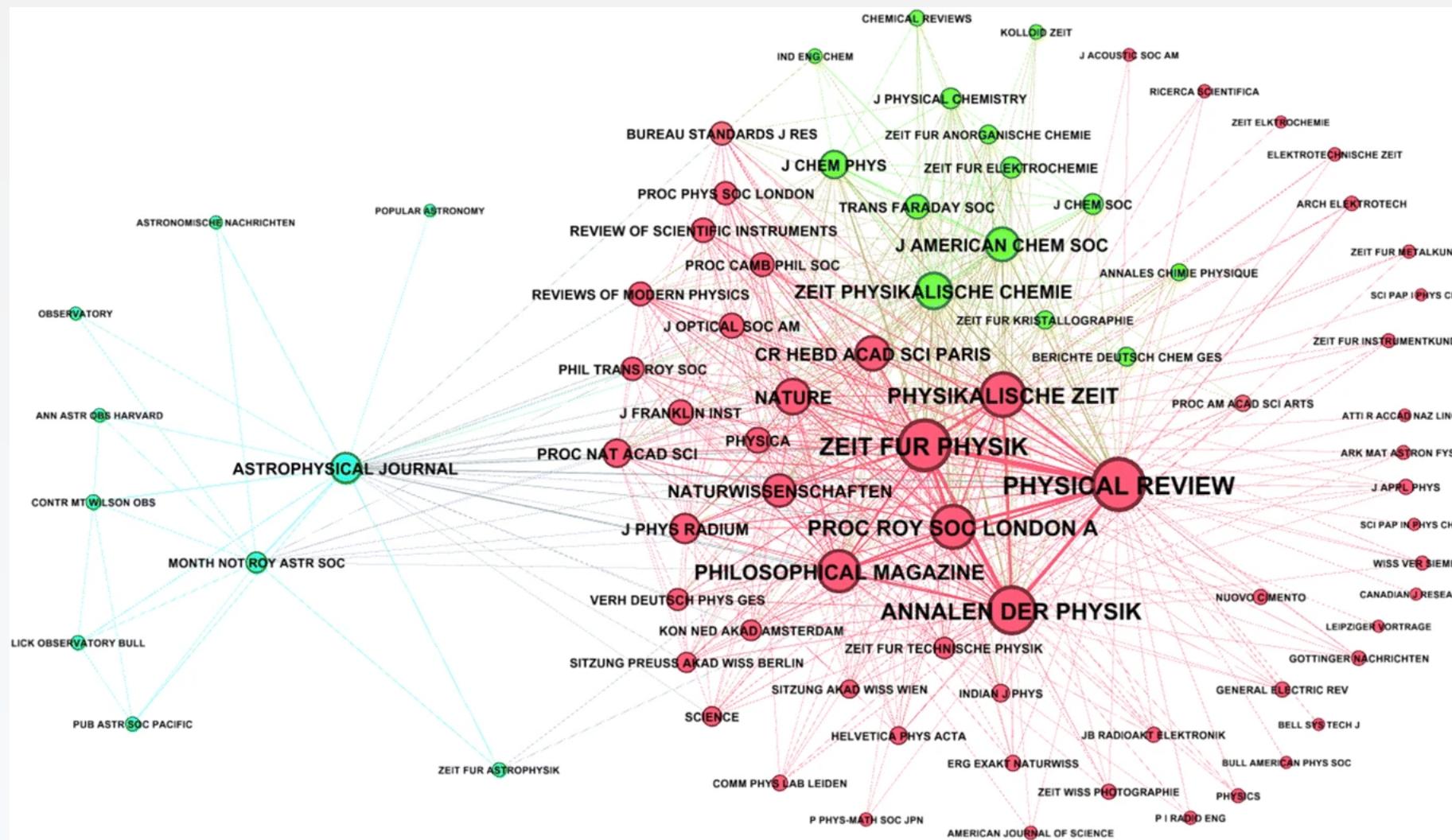
Co-Citation Networks



Khelfaoui, M., Gingras, Y.
“Physical Review: From the Periphery to the Center of Physics”. *Phys. Perspect* 21, 23–42 (2019).
<https://doi.org/10.1007/s0016-019-00235-y>



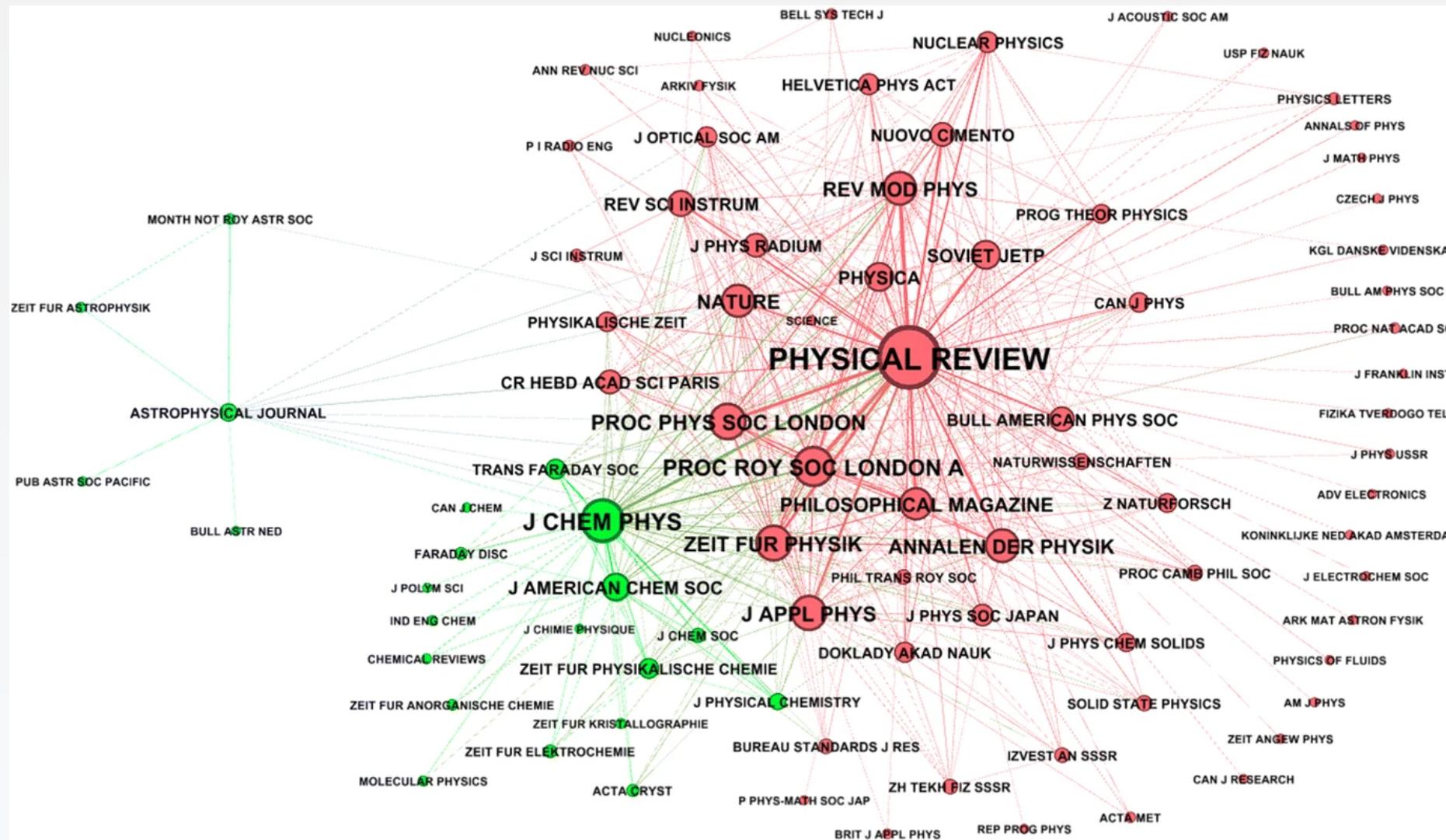
Co-Citation Networks



Khelfaoui, M., Gingras, Y.
“Physical Review: From the
Periphery to the Center of
Physics”. *Phys. Perspect* 21,
23–42 (2019).
<https://doi.org/10.1007/s0016-019-00235-y>



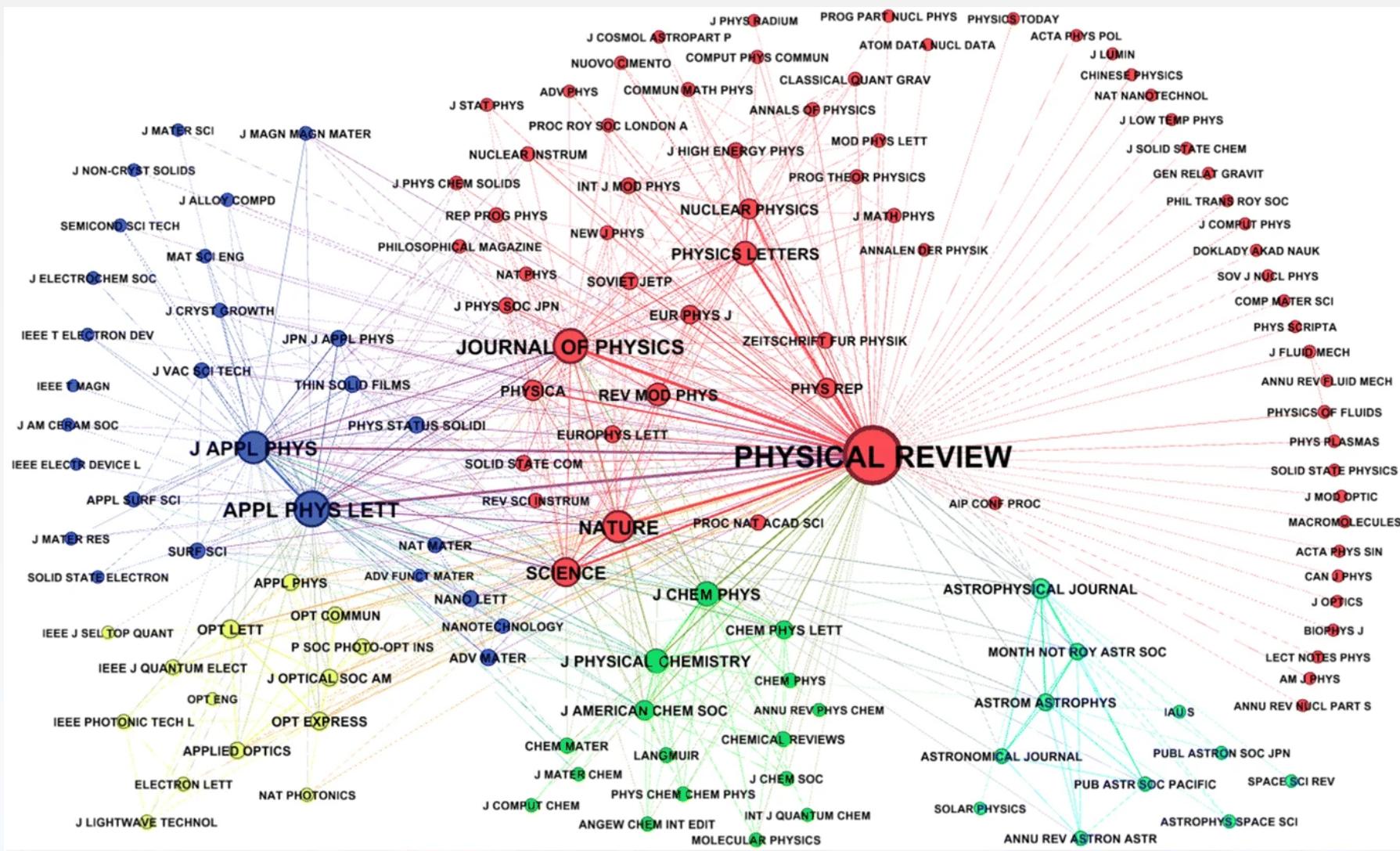
Co-Citation Networks



Khelfaoui, M., Gingras, Y.
“Physical Review: From the
Periphery to the Center of
Physics”. *Phys. Perspect.* 21, 23–
42 (2019).
<https://doi.org/10.1007/s00016-019-00235-y>



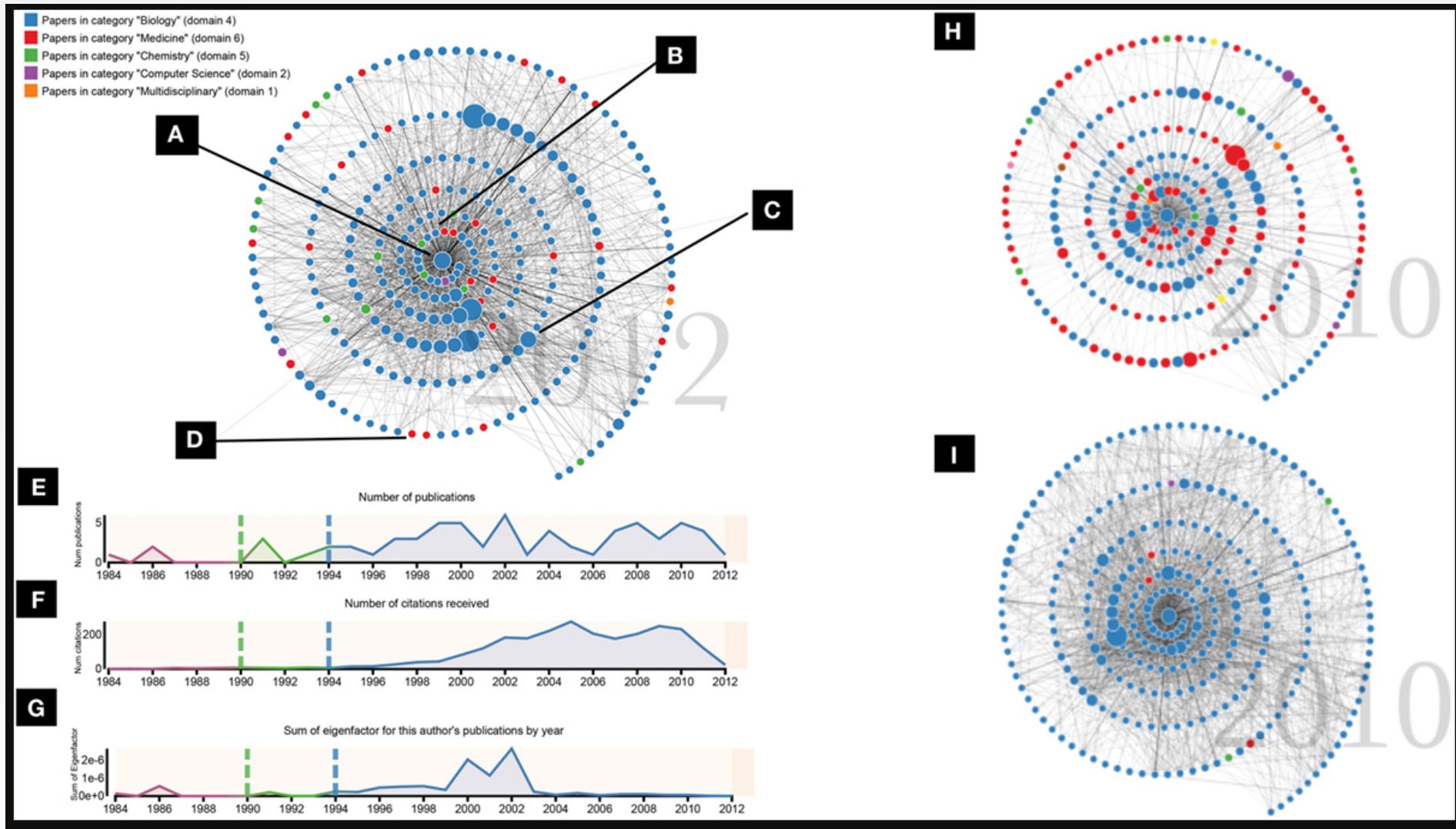
Co-Citation Networks



Khelfaoui, M., Gingras, Y. "Physical Review: From the Periphery to the Center of Physics". *Phys. Perspect* 21, 23–42 (2019). <https://doi.org/10.1007/s00016-019-00235-y>



Co-Citation Networks



Portenoy Jason,
Hullman Jessica, West
Jevin D., “Leveraging
Citation Networks to
Visualize Scholarly
Influence Over Time”,
*Frontiers in Research
Metrics and Analytics*
2, 2017



Co-Citation Networks

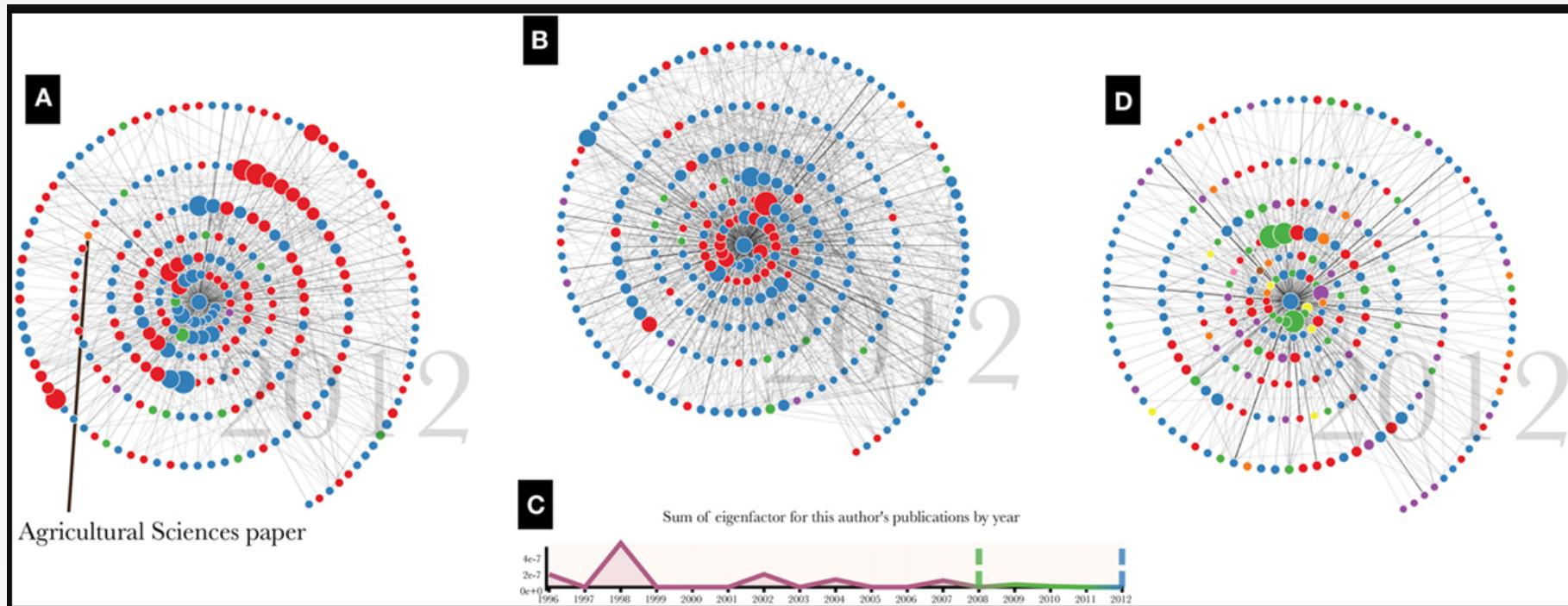


FIGURE 3

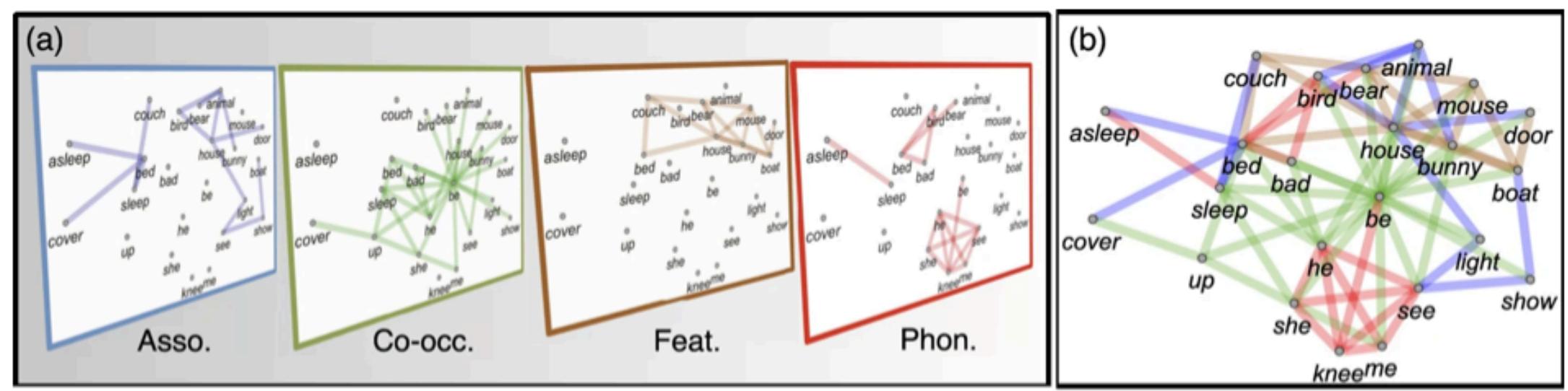
Figure 3. Four stories that emerged from demonstrations with the scholars. **(A)** A scholar who had influence in a field she had not expected. **(B)** A career shift reflected in changing color bands in the graph. **(C)** An early-career peak in influence that prompted a scholar to reflect on the freedoms afforded by different research positions. **(D)** A scholar with influences in very diverse areas.



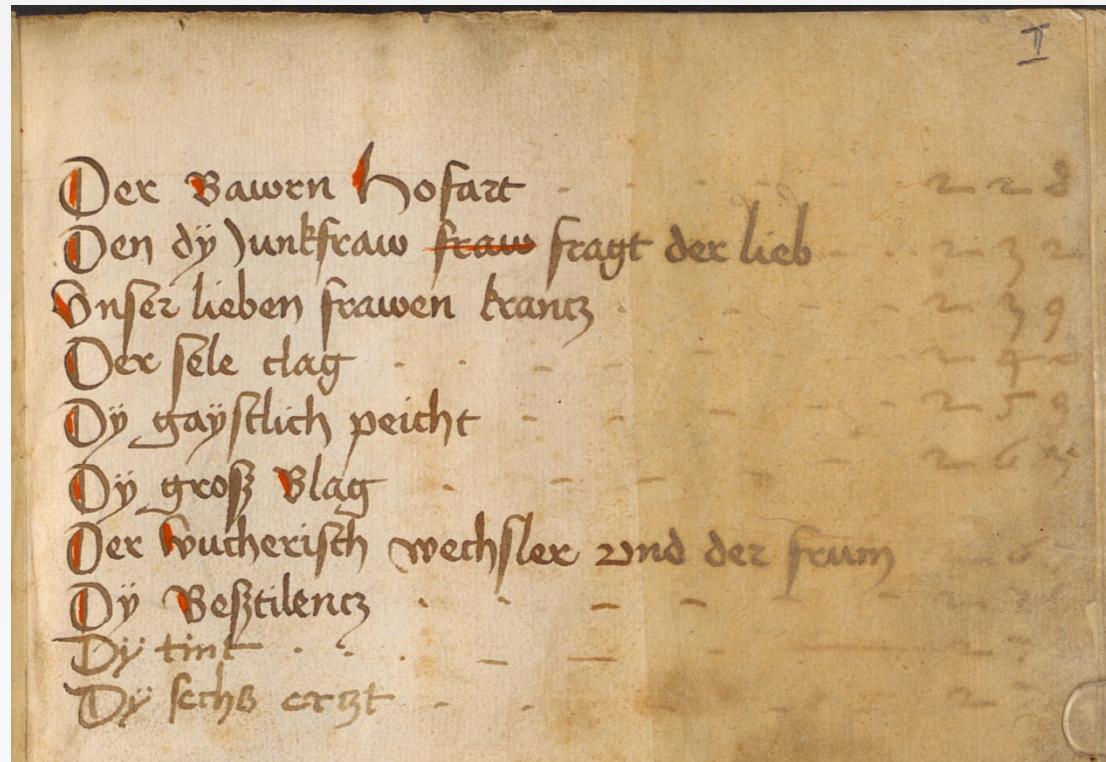
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Portenoy Jason,
Hullman Jessica, West
Jevin D., “Leveraging
Citation Networks to
Visualize Scholarly
Influence Over Time”,
*Frontiers in Research
Metrics and Analytics*
2, 2017

Lexical Networks



Stella, M., Beckage, N. & Brede, M. Multiplex lexical networks reveal patterns in early word acquisition in children. *Sci Rep* 7, 46730 (2017).
<https://doi.org/10.1038/srep46730>



Index. Munich, BSB, Cgm. 714, f. 2r (15th c.)

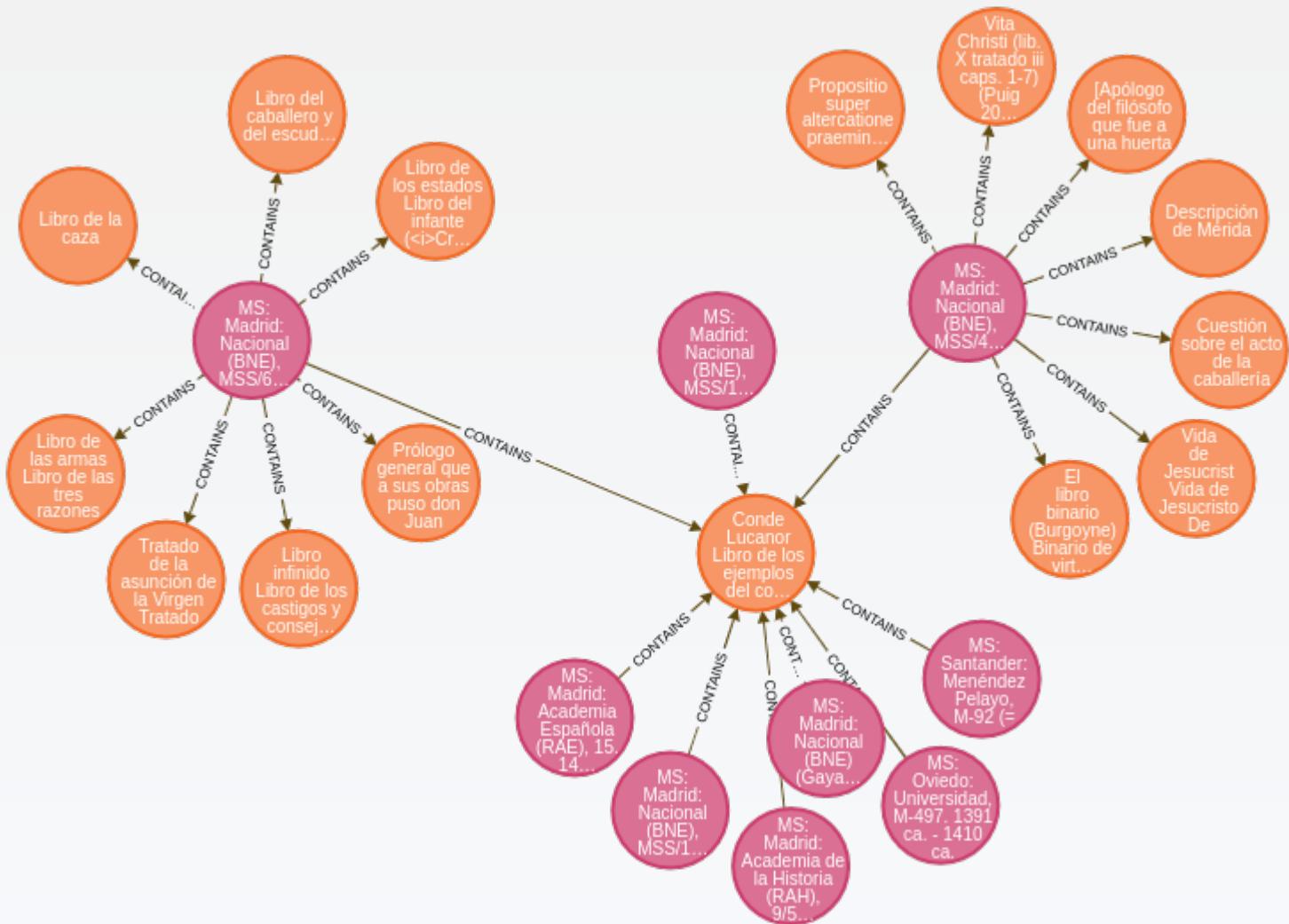
O ecce deuum requere la sue pite
 A inre cherlaigni quimaut entrante
 T ant cum nus sumes el siecle cui pou reclam
 Q uiltolget den tot iox quilhet
 E sez comandenes n diuist illi garder
 K ela sue amiste en puissum adhater
 J coeli otreit li parmandables deus
 Q uihomex femme cel etere e mer am
Vela passionis Ihu.
 Oe auint al quinrime an q
 tyberie cesar auert este empur
 de rome. eal disnefime an qui
 herodes le fir herode auert este
 rei degalilee. e en lutisme
 kalende daueril. ku est el uirt + neofi
 me ior de marz + al qirt an del cunte
 rutin. e leun. cu lan qirt furent eues
 ques ioseph etayphas. el quint an
 aproef la passiun nre seignur. Hichode

Title for a new text. London, British Library, MS Harley 2253, f. 33v (c. 1300)

Shared Manuscript Transmission

Full presentation at: <https://doi.org/10.5281/zenodo.4184046>

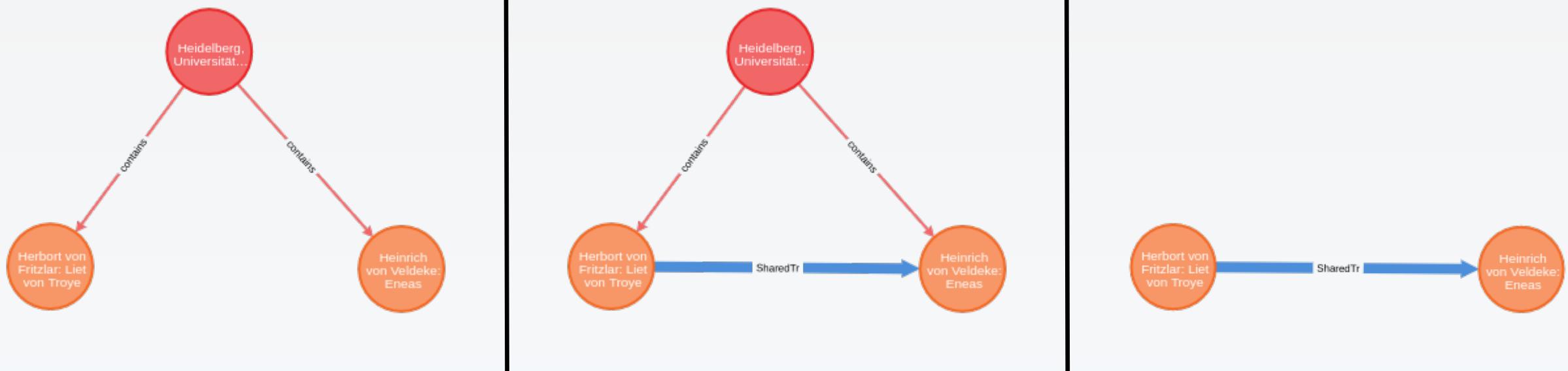
Image generated with Neo4J



Two-Mode and One-Mode Networks

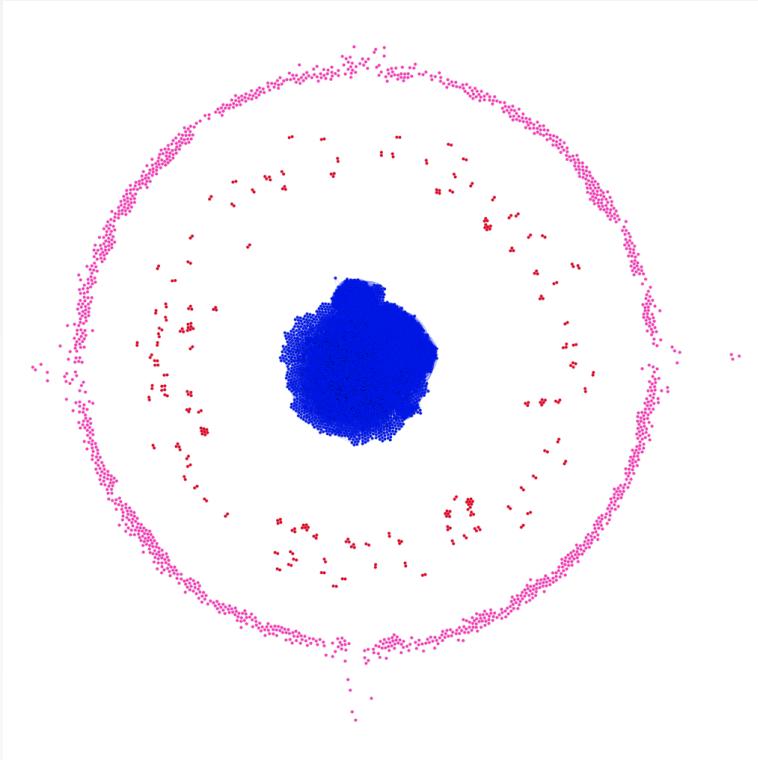
Full presentation at: <https://doi.org/10.5281/zenodo.4184046>

Images generated with Neo4J

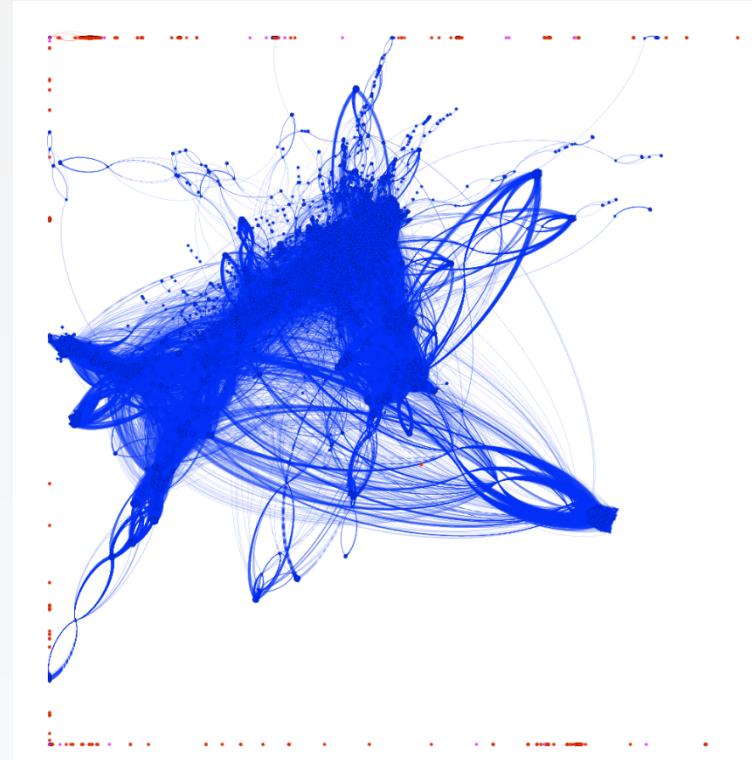


Images generated with Gephi

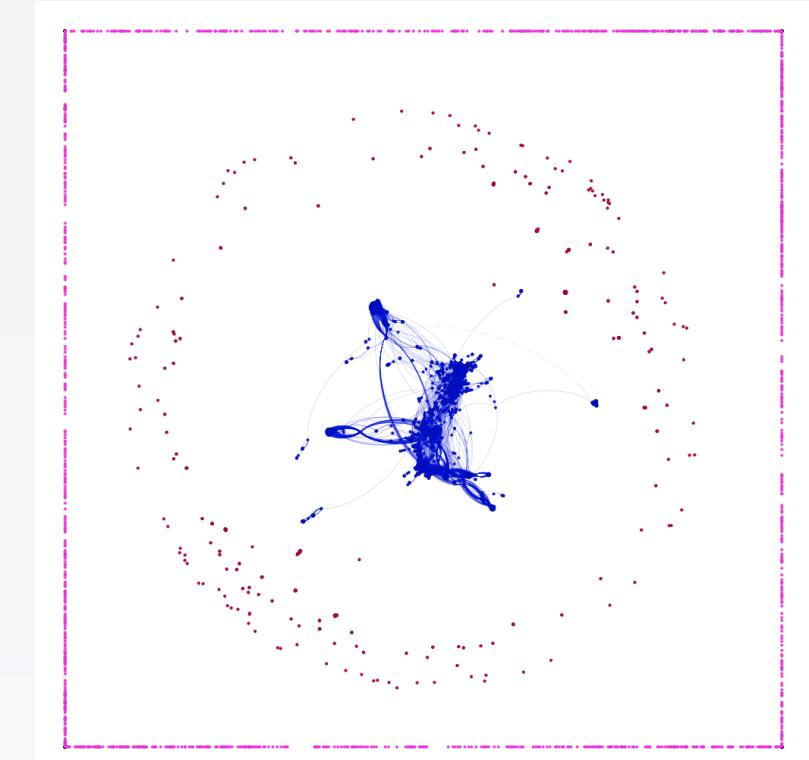
Handschriftencensus



Jonas



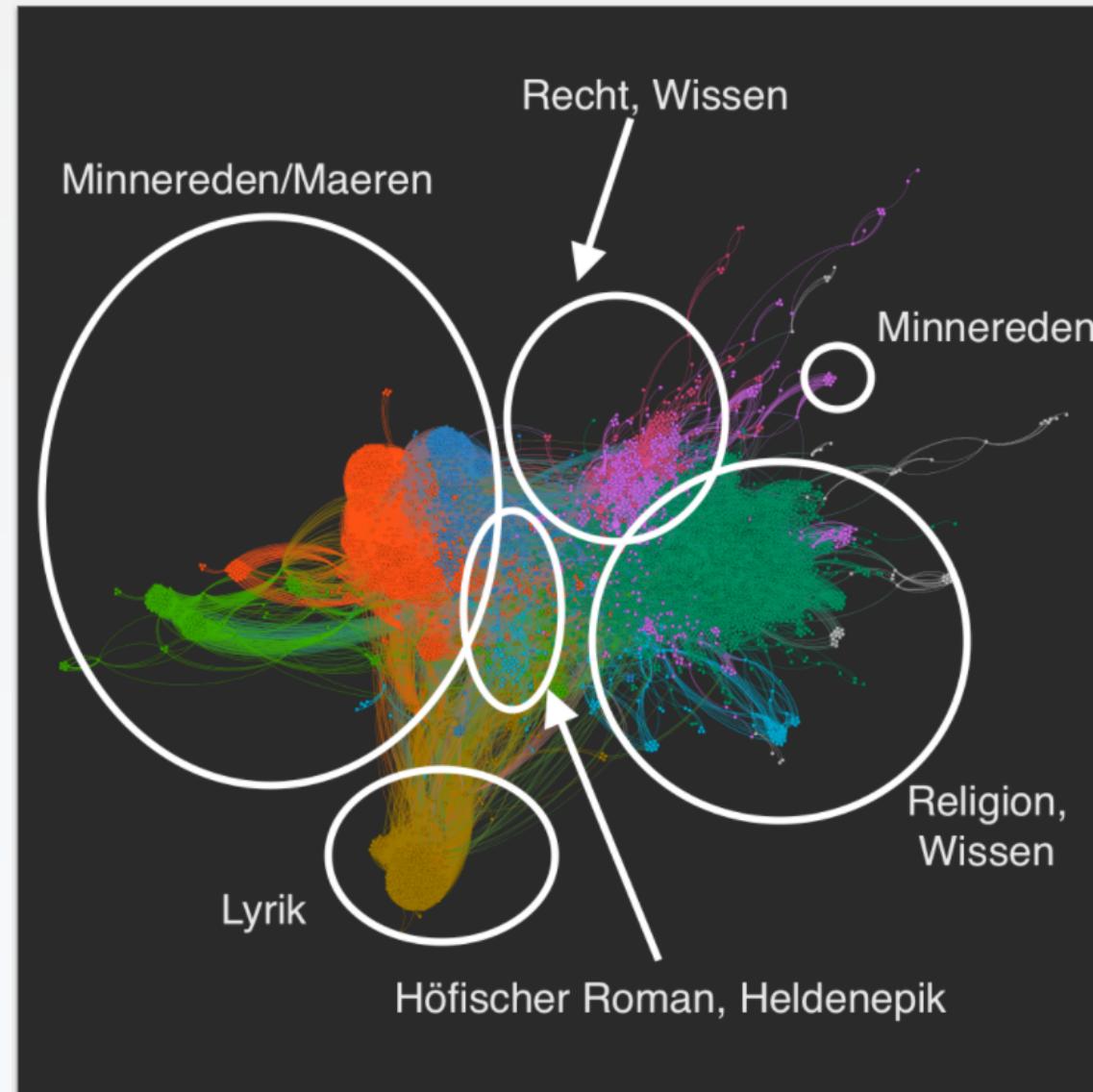
Philobiblon



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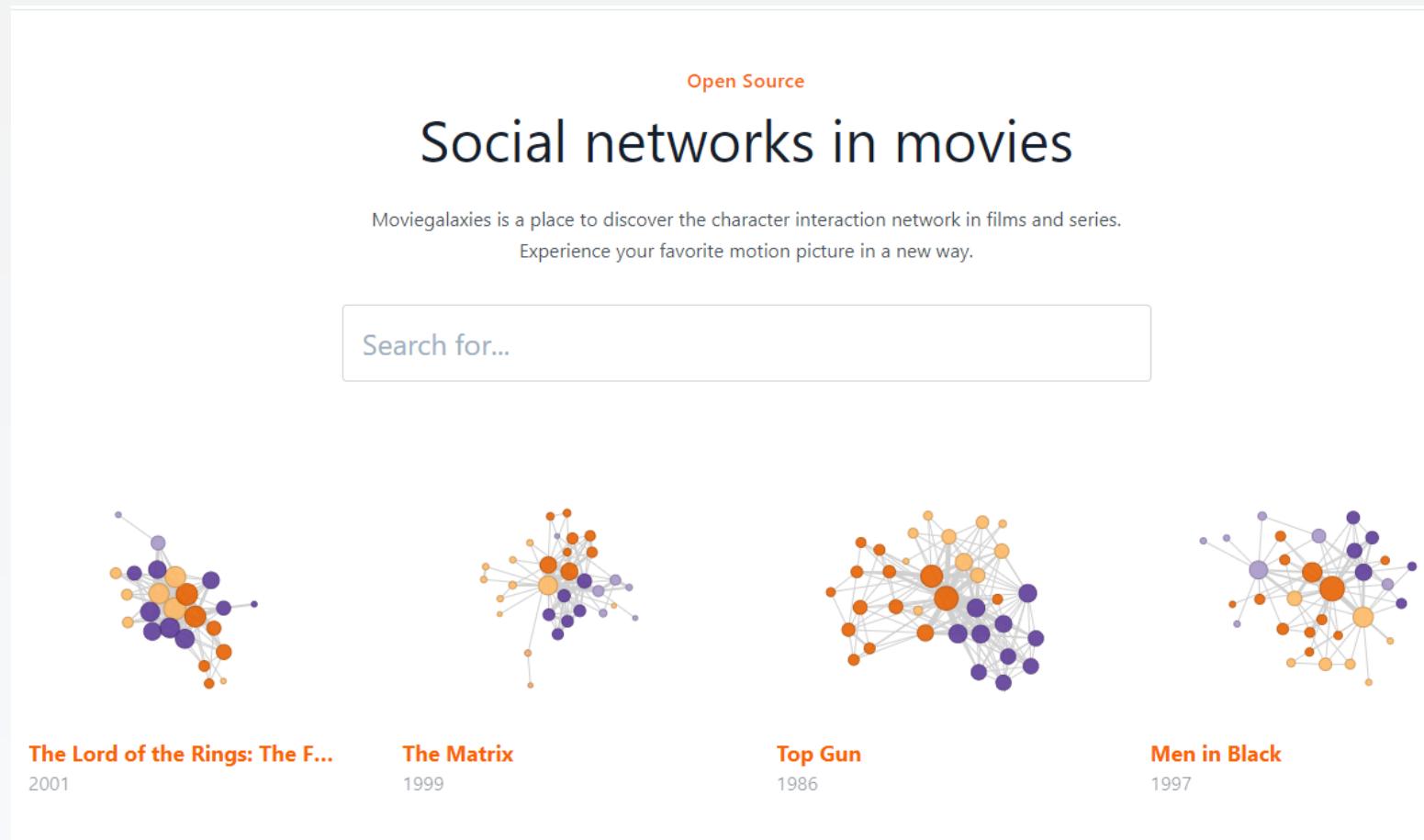
Shared Manuscript Transmission

Fernandez Riva, G. (2019).
Network Analysis of Medieval
Manuscript Transmission. *Journal
of Historical Network
Research*, 3(1), 30-49.
<https://doi.org/10.25517/jhnrv3i1.61>



Explore Networks (Intuition)

Website: <https://moviegalaxies.com/>



Dataset: <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/T4HBA3>

FORMATS



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Formats - CSV

This is a table that can be edited with spreadsheet editing software (Calc, Excel, etc.)

Depending on the program to use there might be slight differences, but it is common to have a table of edges and a table of nodes that need to be read jointly.

Source	Target	Type	Weight
1	2	undirected	1
1	3	undirected	3
2	3	undirected	2

Node	Label	Group	Att.
1	One	Blue	A
2	Two	Blue	B
3	Three	Green	B

Source,Target,Type,Weight

1,2,undirected,1
1,3,undirected,3
2,3,undirected,2

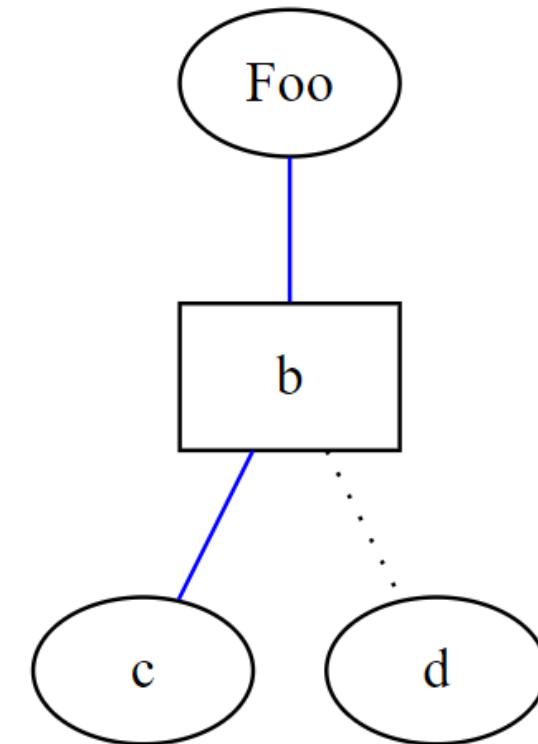
Node,Label,Group,Att.

1,One,Blue,A
2,Two,Blue,B
3,Three,Green,B

Formats - GraphViz

This is very simple way of creating a text description that maps to a graph originally designed for GraphViz a Javascript library for graphs.. There is an online editor: <https://edotor.net/>

```
1  graph graphname {  
2  
3      size="1,1";  
4  //nodes  
5      a [label="Foo"];  
6      b [shape=box];  
7  //edges  
8      a -- b -- c [color=blue];  
9      b -- d [style=dotted];  
10  
11 }  
12
```



Formats - GraphML

This is an XML format to store the graph.

Useful as exchange format between applications. Gephi developed a similar format called GEFX

```
1 <?xml version='1.0' encoding='utf-8'?>
2 <graphml xmlns="http://graphml.graphdrawing.org/xmlns"
3   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
4   xsi:schemaLocation="http://graphml.graphdrawing.org/xmlns http://graphml.graphdrawing.org/xmlns/1.0/graphml.xsd">
5   <key id="d2" for="node" attr.name="date" attr.type="string"/>
6   <key id="d1" for="node" attr.name="label" attr.type="string"/>
7   <key id="d0" for="node" attr.name="author" attr.type="string"/>
8   <key id="d3" for="edge" attr.name="weight" attr.type="float"/>
9   <graph edgedefault="undirected">
10    <node id="w1">
11      <data key="d0">Anonyme</data>
12      <data key="d1">Vie de sainte Bathilde</data>
13      <data key="d2">13e</data>
14    </node>
15    <node id="w2">
16      <data key="d0">Jean de Vignay</data>
17      <data key="d1">Vie de saint Jean l'aumônier</data>
18      <data key="d2">entre 1315 et 1332</data>
19    </node>
20    <node id="w3">
21      <data key="d0">Anonyme</data>
22      <data key="d1">Vie de saint Louis</data>
23      <data key="d2">1245</data>
24    </node>
25    <edge source="w1" target="w2" directed="true" id="e12">
26      <data key="d3">1.5</data>
27    </edge>
28    <edge source="w2" target="w3">
29      <data key="d3">2.5</data>
30    </edge>
31  </graph>
32 </graphml>
```



Software and Programming Languages

[**Gephi**](#): Creates very visually pleasing graphs and has analysis tools, but has performance issues.

[**Palladio**](#): Simple and accessible software.

[**Cytoscape**](#): Common in biology. Complex and with extensive functionalities. Visualisation is not very attractive, but performance is good.

[**GraphCommon**](#): Online environment to create and analyse networks. Simple but not always intuitive and certainly restricted

[**Nodegoat**](#): Online toolkit for network analysis. It requires extensive setup of a data model and data entry. Has very interesting functionality and can generate web applications.

[**Neo4J**](#): Powerful graph database.

[**Minivan**](#): Online software for network visualisation.

Programming Languages

[**Networkx**](#) (Python)

[**Igraph**](#) (R and Python)

Hands on

Create some networks and analyse them using Network Analysis Software. Instructions on GitHub

- Gephi or Cytoscape: Upload a GraphML
- Graph Commons: Upload [GraphCommons_Hamlet.csv](#)

