

SOCIAL NETWORK ANALYSIS (SNA)

What is it,

when is it relevant,

and how do you do it (in *Gephi*)?

HANDS UP!

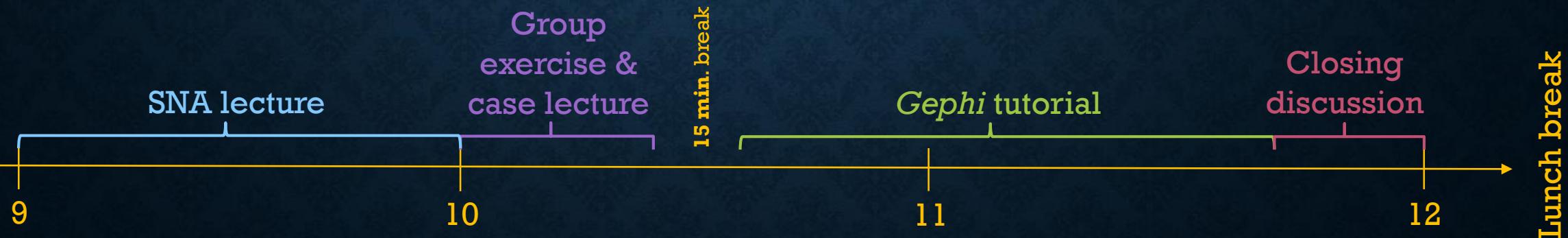
How many

- know what Social Network Analysis (or SNA) is?
- have some experience with SNA?
- have ever heard of Gephi?
- have used Gephi themselves?
- want to learn something about network analysis and how it works now?

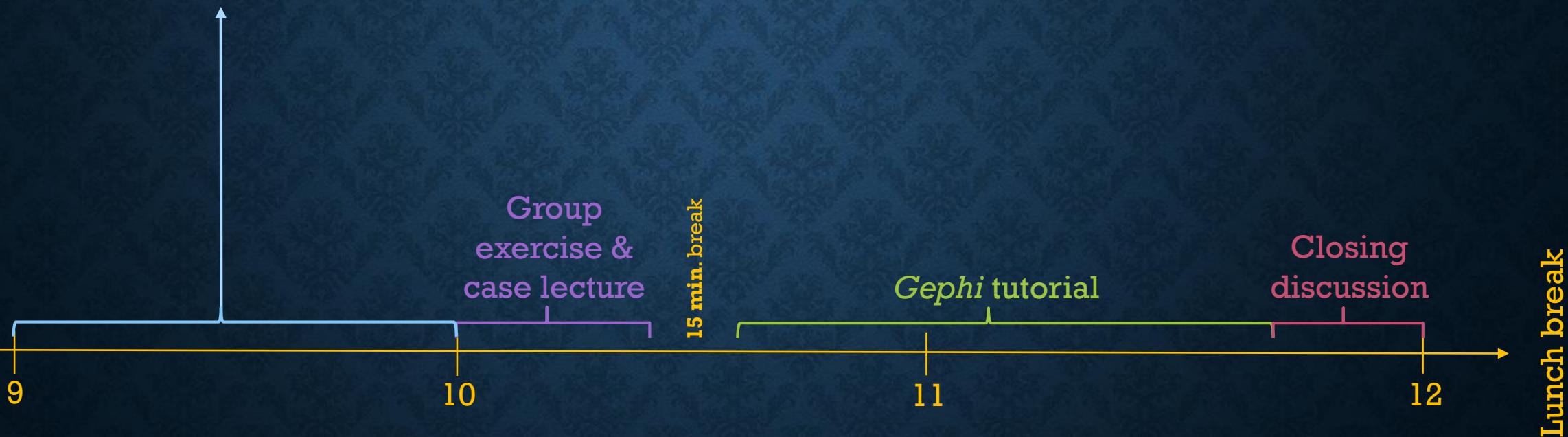


SCHEDULE

- Following an **opening lecture** on (S)NA, its relevance for historical and archaeological research and *Gephi*, we will:
 - consider how we could go about **extracting data for SNA from an ancient text** (in groups) and
 - acquaint ourselves with the **case study** and dataset to be exploring in this class (provided by lecturer)
 - **stretch our legs**
 - complete a **hands-on tutorial in Gephi** (individually)
 - collect our thoughts in a **plenary discussion** on the exercise and potential SNA holds for studying the (distant) past



SNA lecture



SNA – WHAT IS IT?

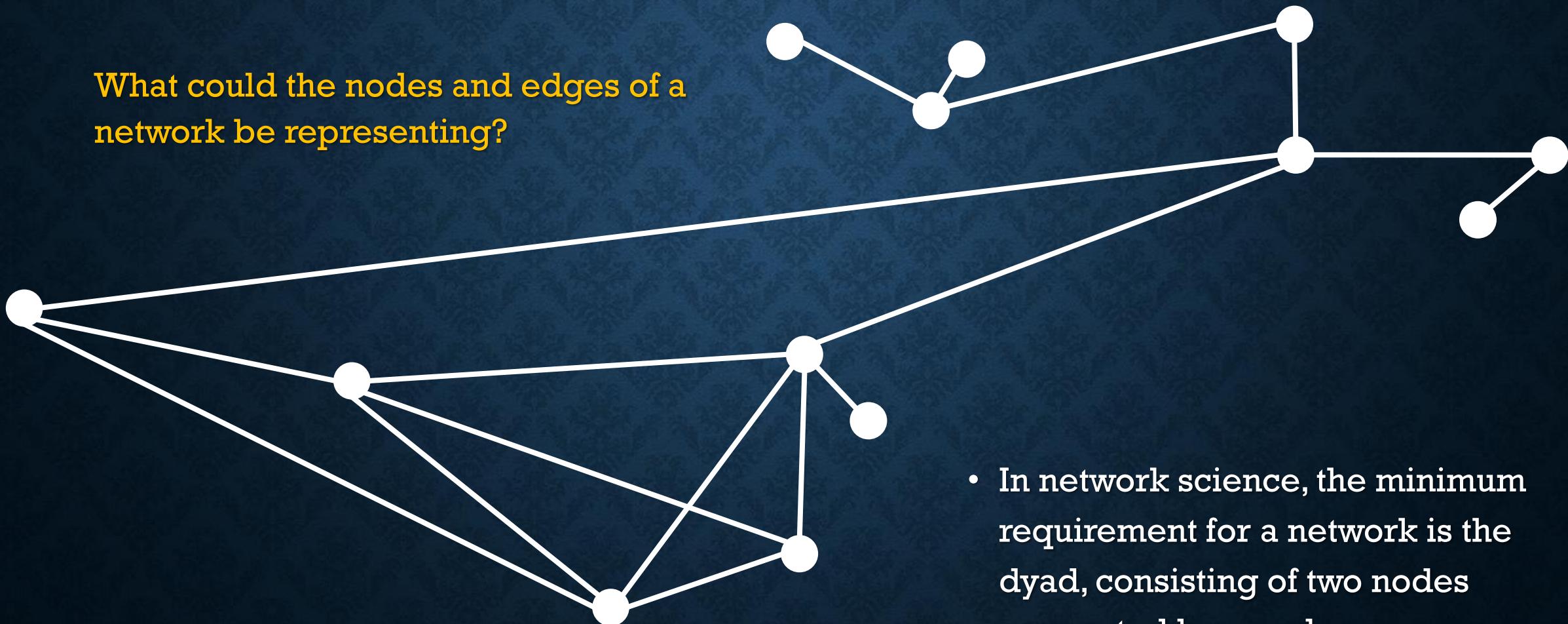
- Network science developed in other fields (esp. in sociology, anthropology, mathematics and physics)
- *Social Network Analysis* (SNA) is said to have started in social sciences around 1930
- Modern day SNA consists of four features (Freeman 2004: 10):
 1. It involves the intuition that links among social actors are important
 2. It is based on the collection and analysis of data that record social relations that link actors
 3. It draws heavily on graphic imagery to reveal and display the patterning of those links
 4. It develops mathematical and computational models to describe and explain those patterns

NETWORK GRAPHS – WHAT ARE THEY?

- In network science, the minimum requirement for a network is the dyad, consisting of two nodes connected by an edge

NETWORK GRAPHS – WHAT ARE THEY?

What could the nodes and edges of a network be representing?

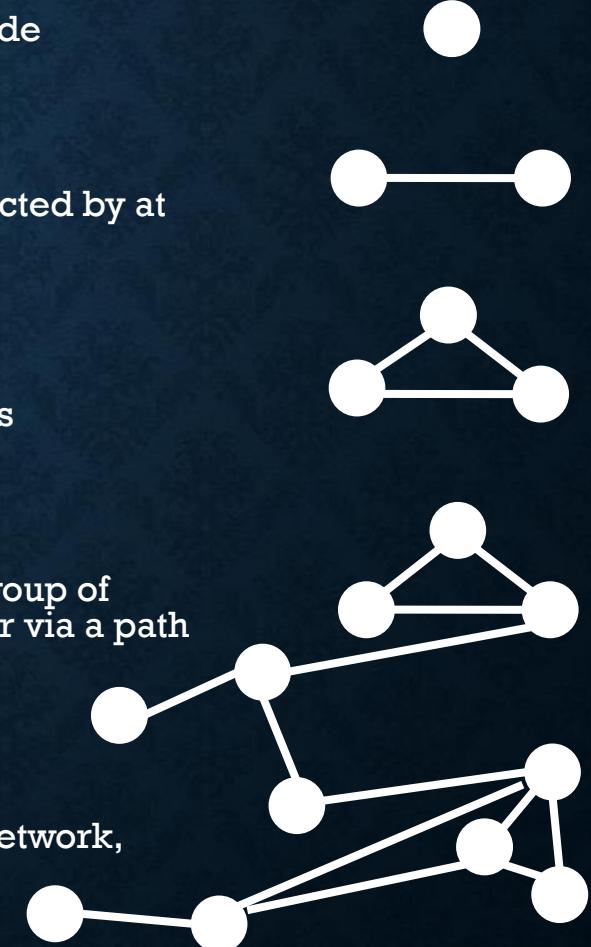


SOME NETWORK TERMS

- **node / actor / agent / point / vector** = the entities of the network
- **edge / tie / relation / link / arc** = a relationship that link pairs of nodes of the network
- **self-loop** = a relationships that goes from and to the same node
- **node attribute** = quantitative or qualitative data that describe individual nodes
- **edge attribute** = quantitative or qualitative data that describe individual edges



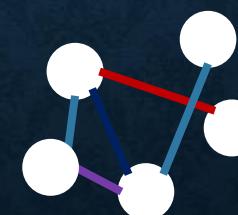
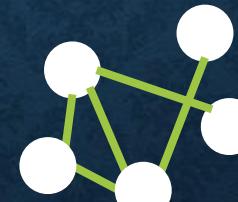
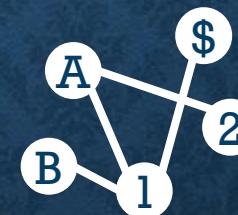
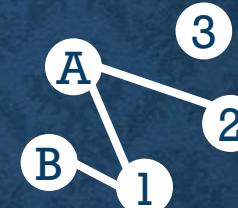
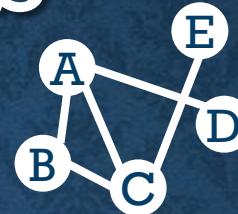
- an **isolate** = a disconnected node
- a **dyad** = a pair of nodes connected by at least one edge
- a **triad** = a group of three dyads
- a **connected component** = a group of nodes that can reach each other via a path of edges
- a **whole network** = the entire network, including all its component



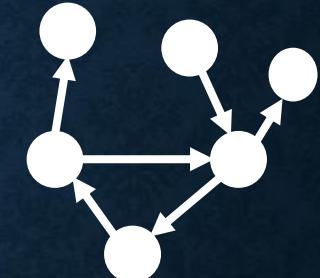
SOME NETWORK TYPES

- **1-mode / monopartite / monomodal network** = a network with only one node type
- **2-mode / bipartite / bimodal network** = a network with two node types
- **multimodal / k-partite network** == a network with several node types

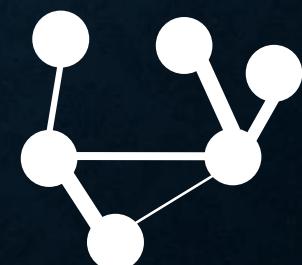
- **monoplex / single-layered network** = a network with only one edge type
- **multiplex / multi-layered network** = a network with more than one edge type



- a **directed network** = a network with directed edges



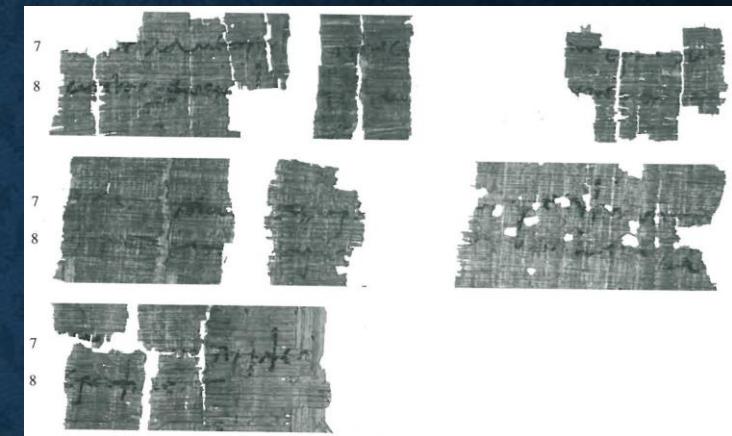
- a **weighted network** = a network with weighted edges



AN EXAMPLE FROM MY RESEARCH

TM_45846 (P. Erbstreit [2017] 7)

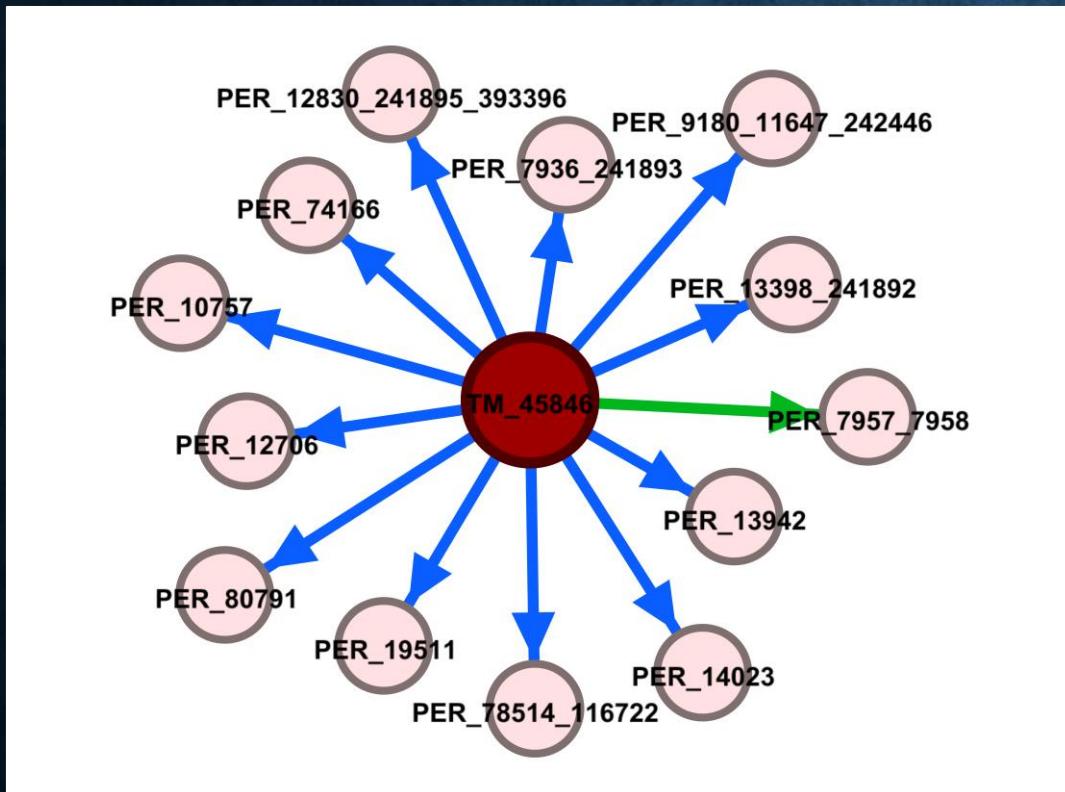
- Demotic land sales document & Greek sales tax receipt
- Dated Jul. 14th 140 BCE & Aug./Sep. 139 BCE
- Part of lawsuit dossier



AN EXAMPLE FROM MY RESEARCH

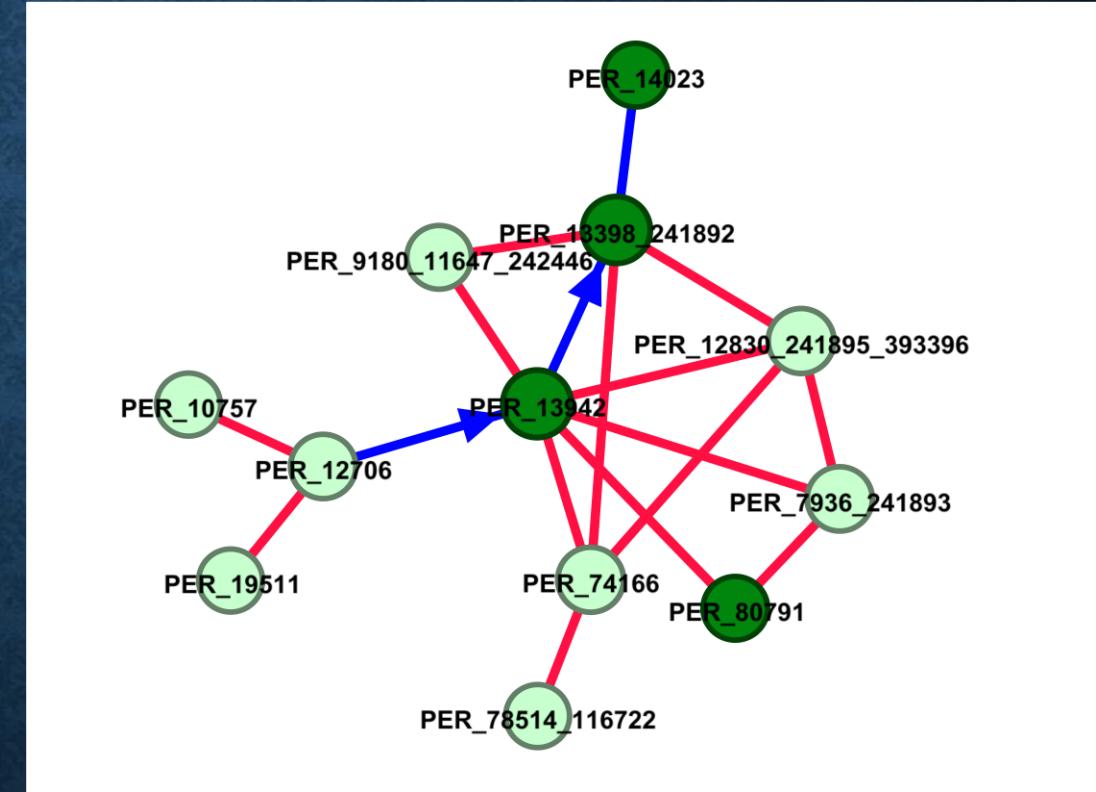
Source:

A Demotic land sales contract with a Greek tax receipt from 14 July 140 BCE
(TM_45846 / P. Erbstreit [2017] 7)



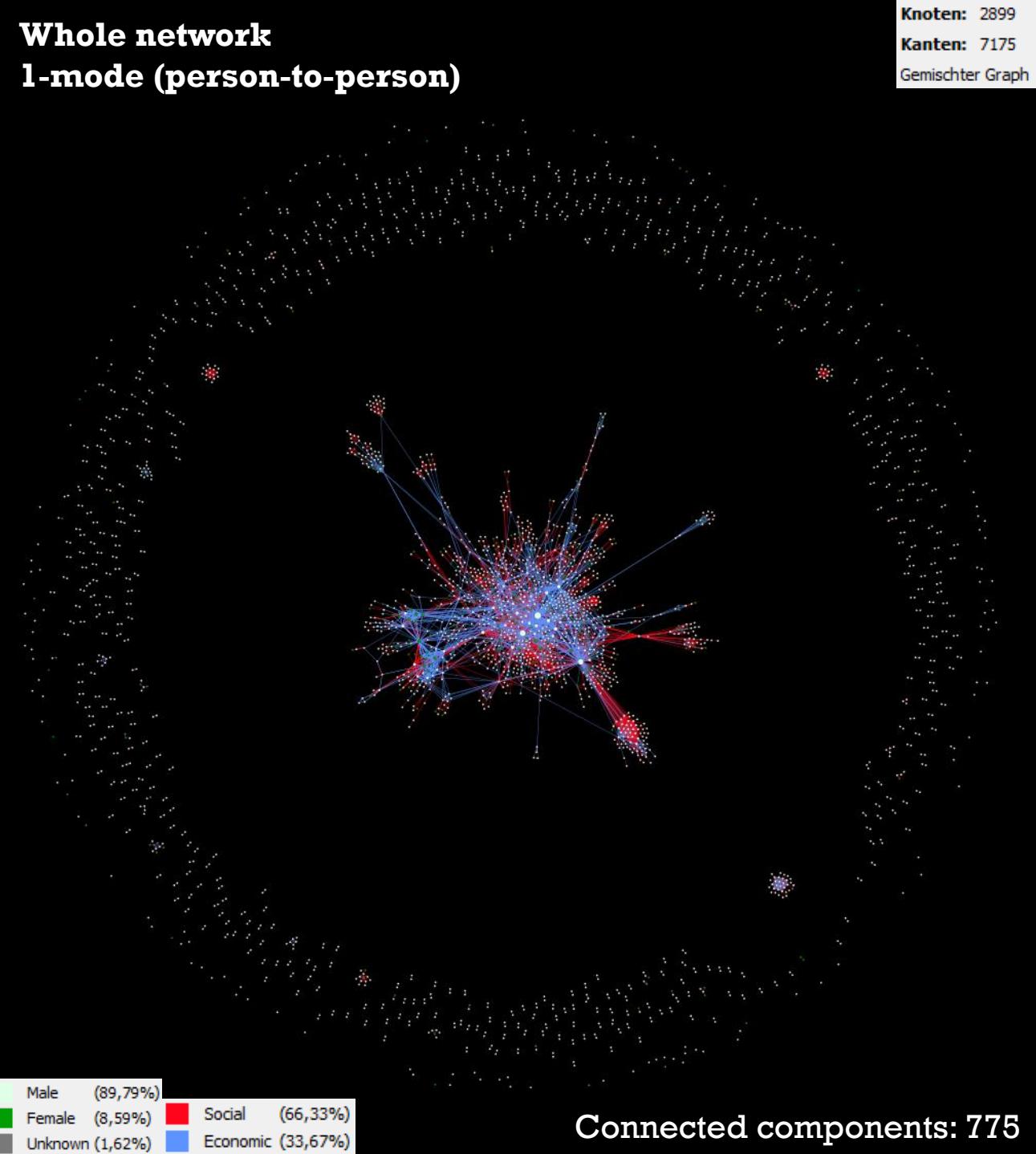
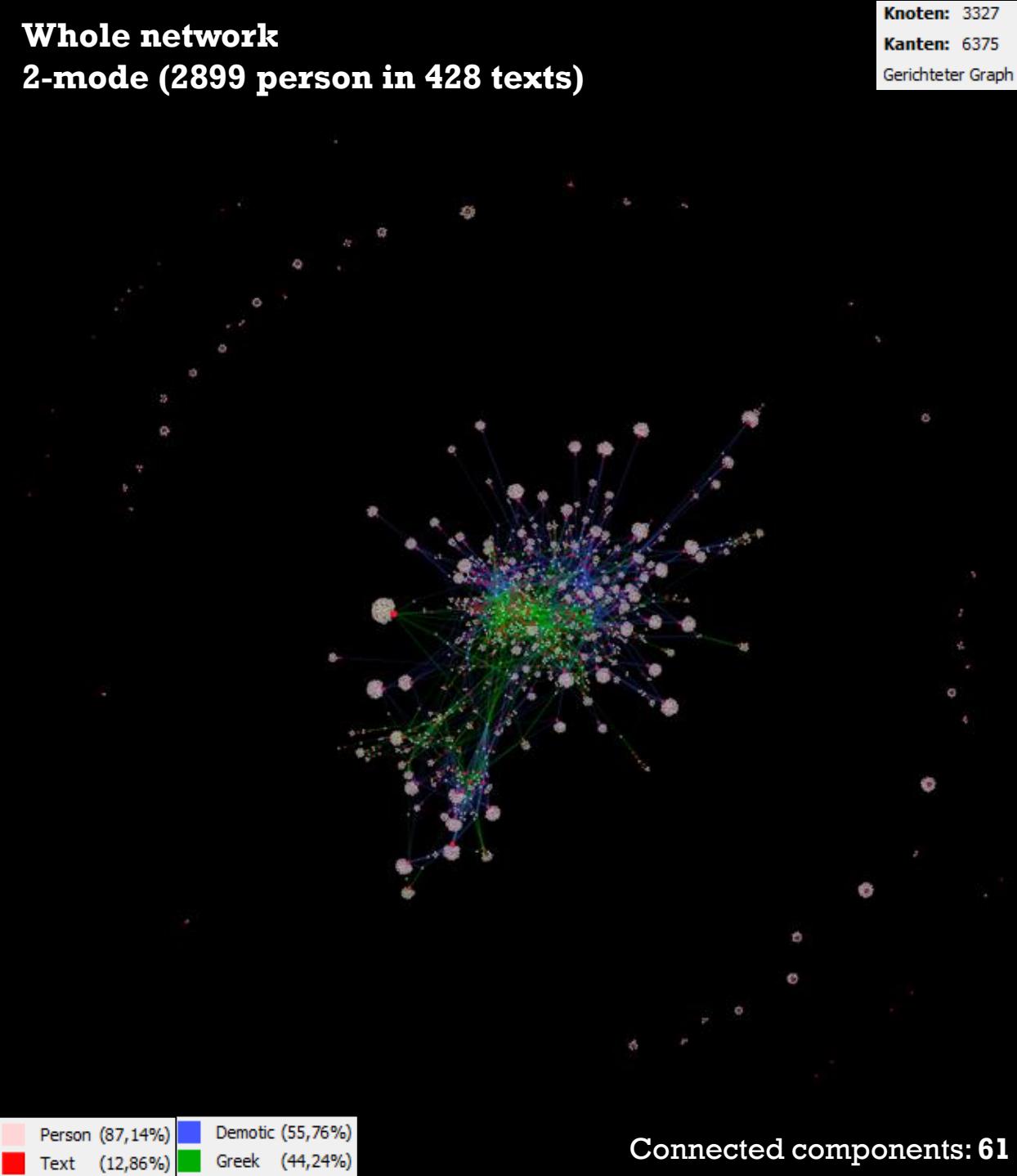
The text represented as a 2-mode, monoplex,
directed, unweighted network

- **Nodes** = texts & persons
- **Edges** = attestations in texts



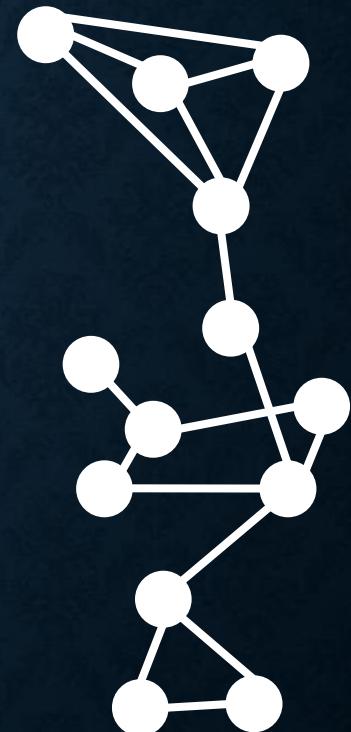
The same text represented as a 1-mode, multiplex,
mixed, unweighted network

- **Nodes** = persons
- **Edges** = various kinds of social and economic ties



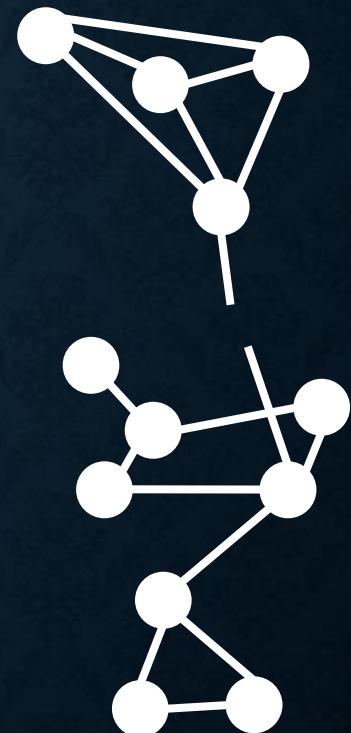
ANALYSING NETWORKS ON THE MICRO, MESO AND MACRO SCALE

- a **broker / hub** = a node without which the paths between its neighbours become significantly longer (or broken)
- a **bridge** = an edge connecting otherwise unconnected communities
- a **clique** = a maximally dense section of the network (= LCC of 1)
 - e.g. closed triads
 - NB: nodes may also have out-group connections
- a **community** = a well-connected section of the network
 - communities *may* overlap
 - NB: several definitions and available community detection measures (e.g. modularity)
- a **connected component** = a group of nodes that can reach each other via a continuous path of edges



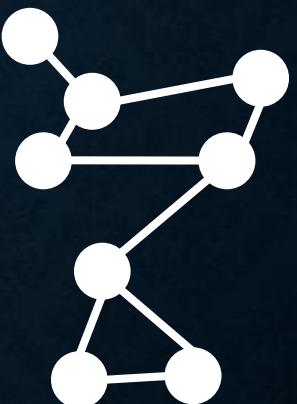
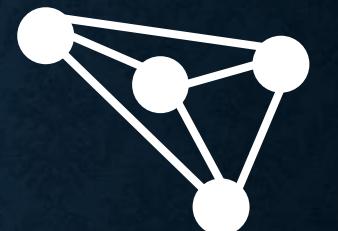
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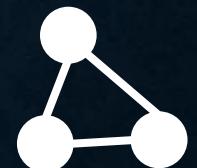
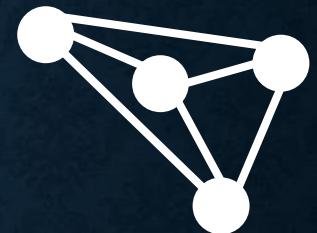
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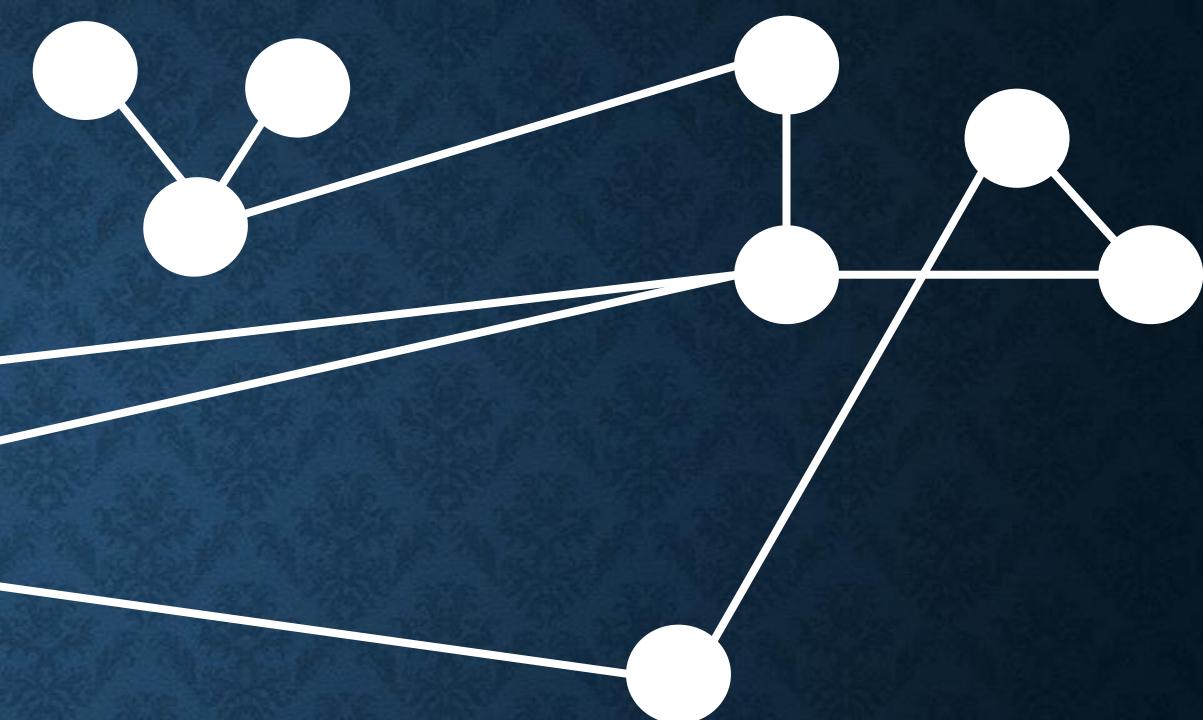
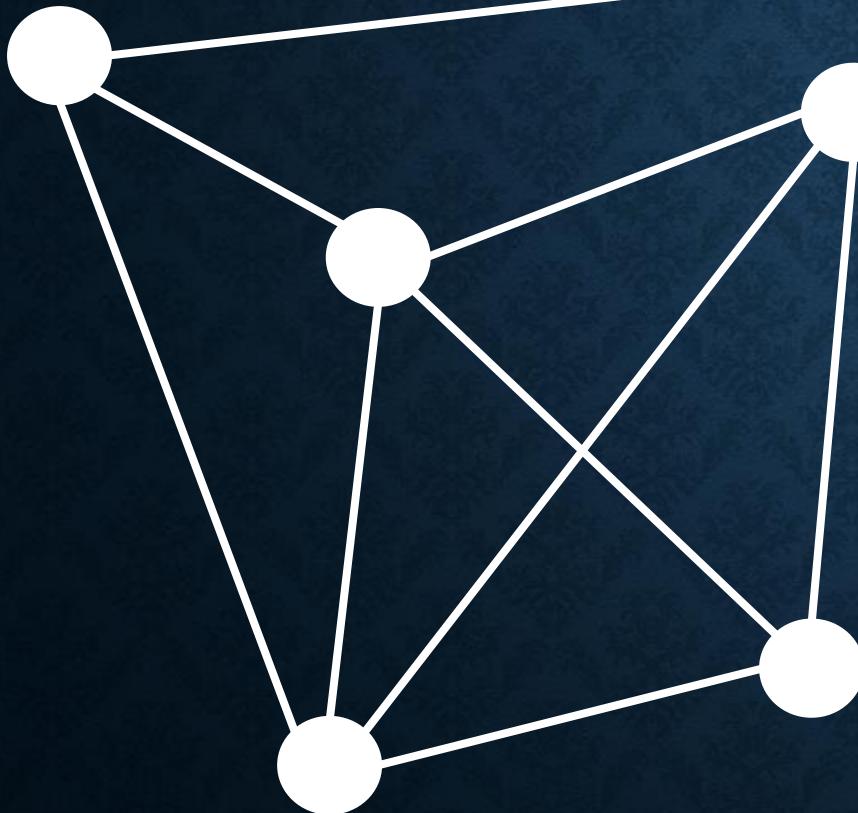


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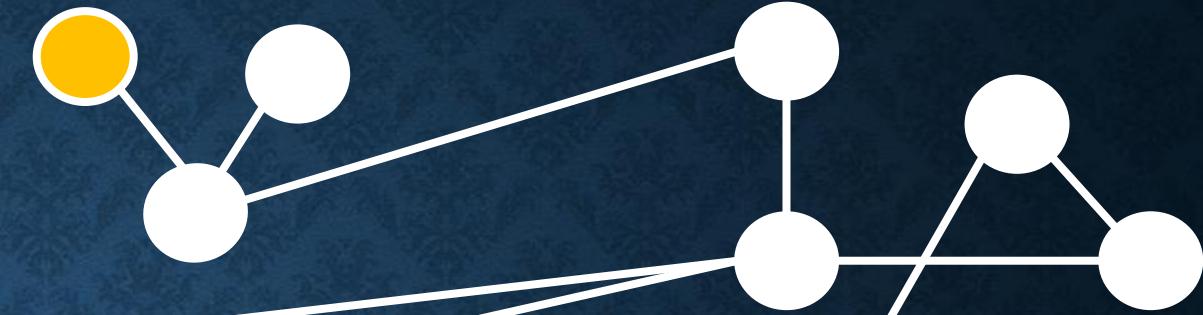
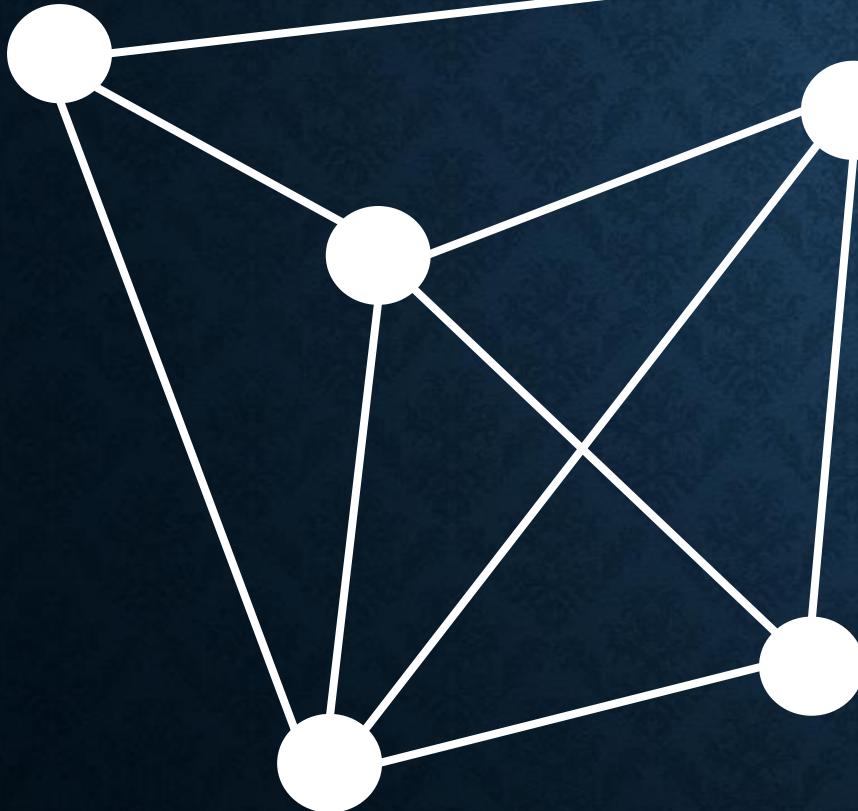


LEVEL OF ANALYSIS



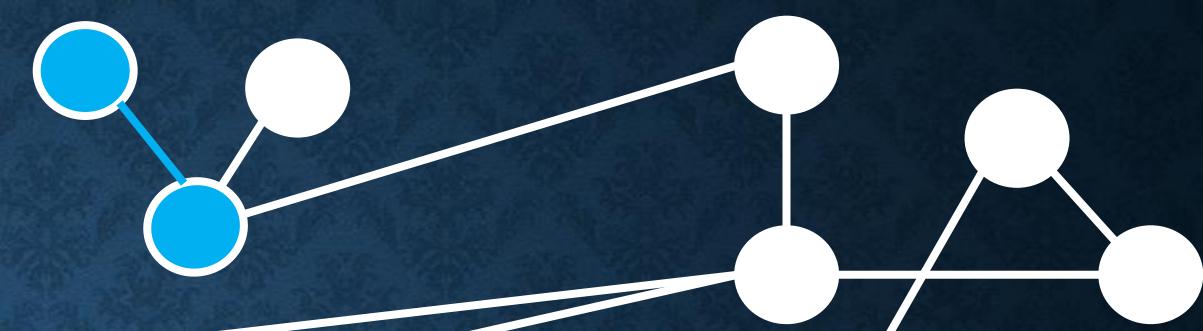
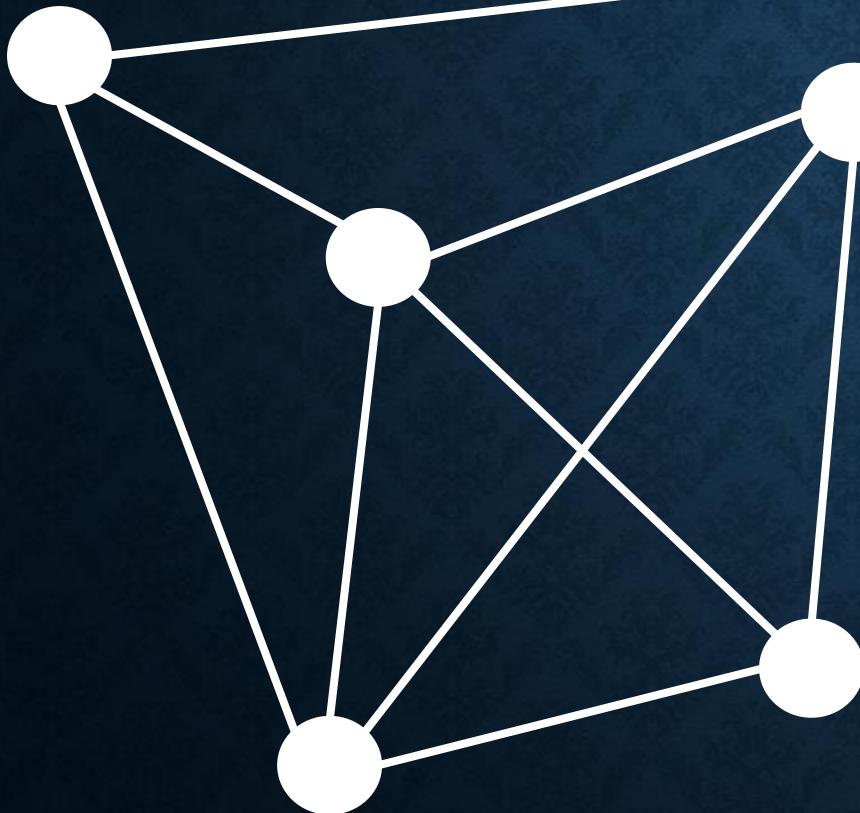
- Useful to distinguish between three levels of analysis:

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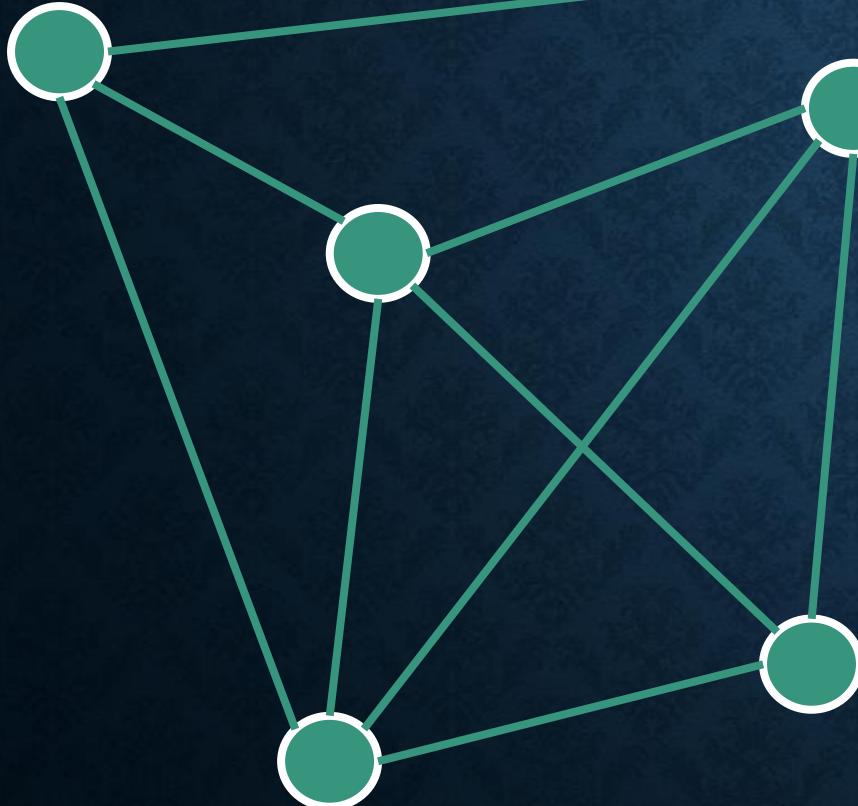
- Useful to distinguish between three levels of analysis:
 - The node

LEVEL OF ANALYSIS



- Useful to distinguish between three levels of analysis:
 - The node
 - The dyad

LEVEL OF ANALYSIS

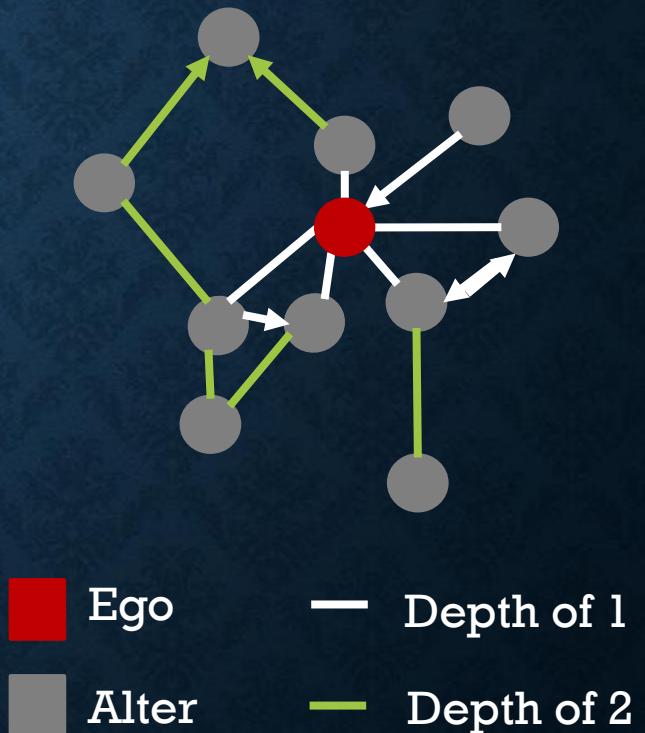


- Useful to distinguish between three levels of analysis:
 - The node
 - The dyad
 - The network
- But several metrics serve to bridge scales

PERSONAL (OR EGO) NETWORKS

Data collection:

- From the perspective of the ego
 - Define network boundaries with ego at the centre
- From a whole network perspective
 - Extract personal networks from a larger dataset



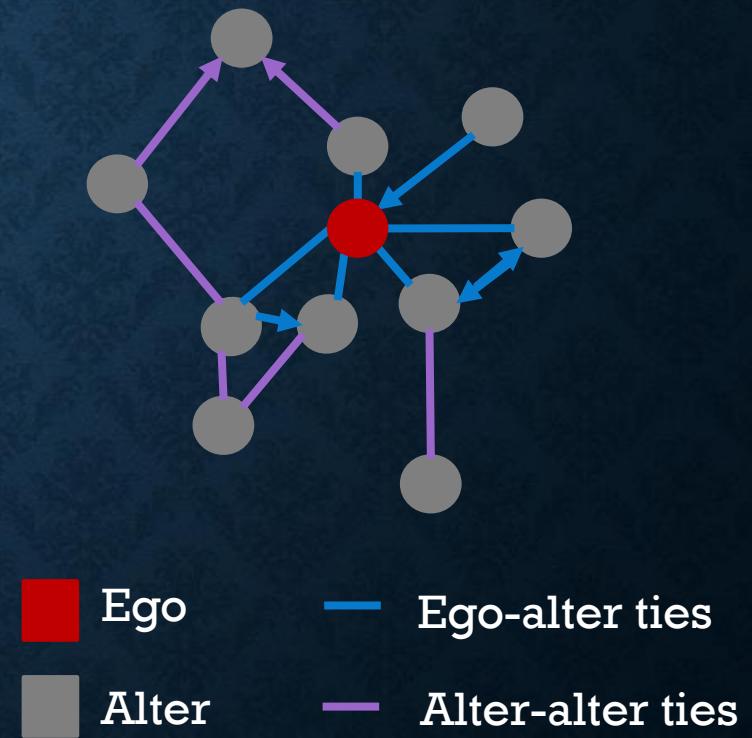
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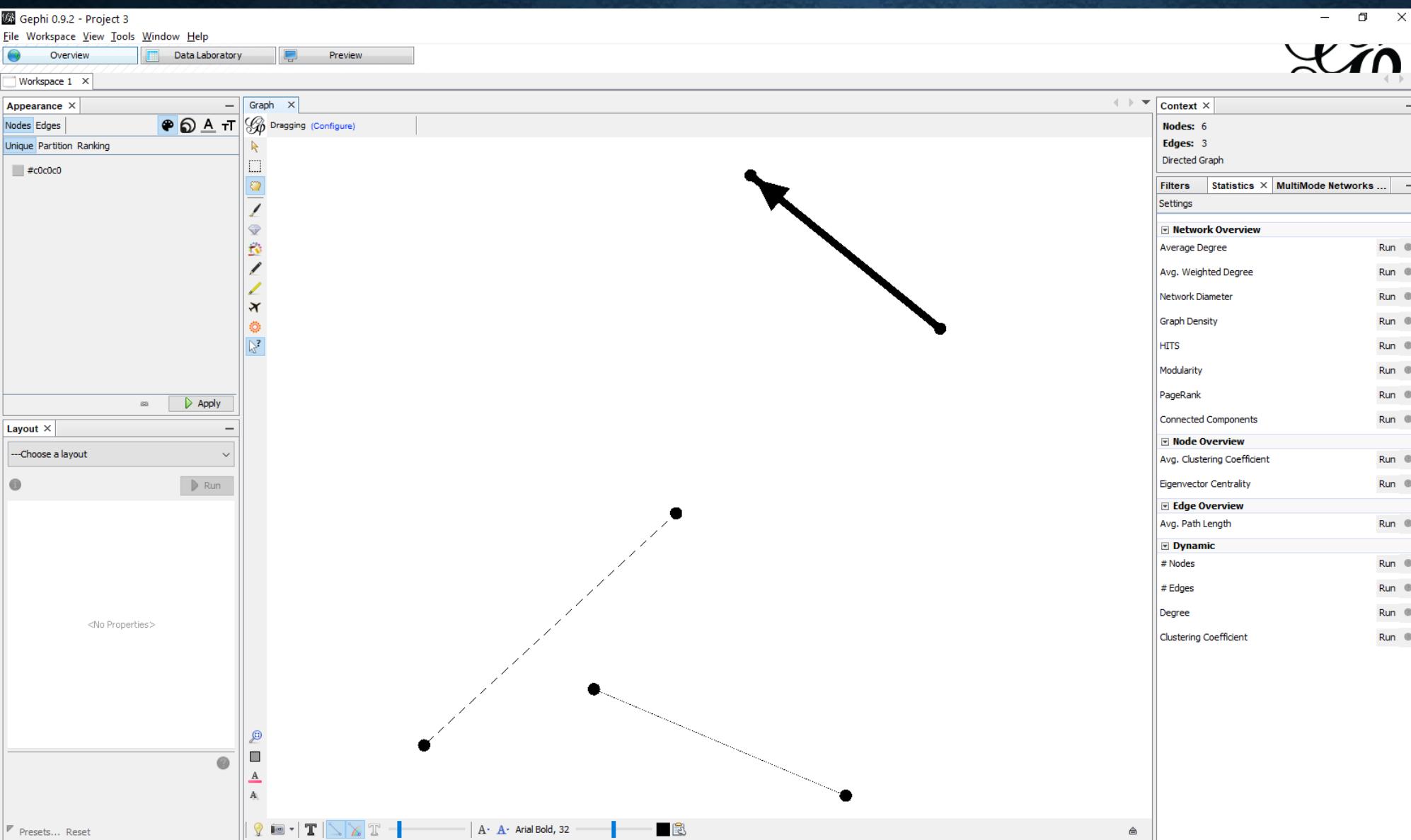
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Analysis of ego networks often involves:

- Measuring and describing ego networks through
 - alter analysis, ego-alter comparison, tie analysis and structural measures
- Comparing results against other actor-level variables
 - like demographics, behaviour, wealth, location

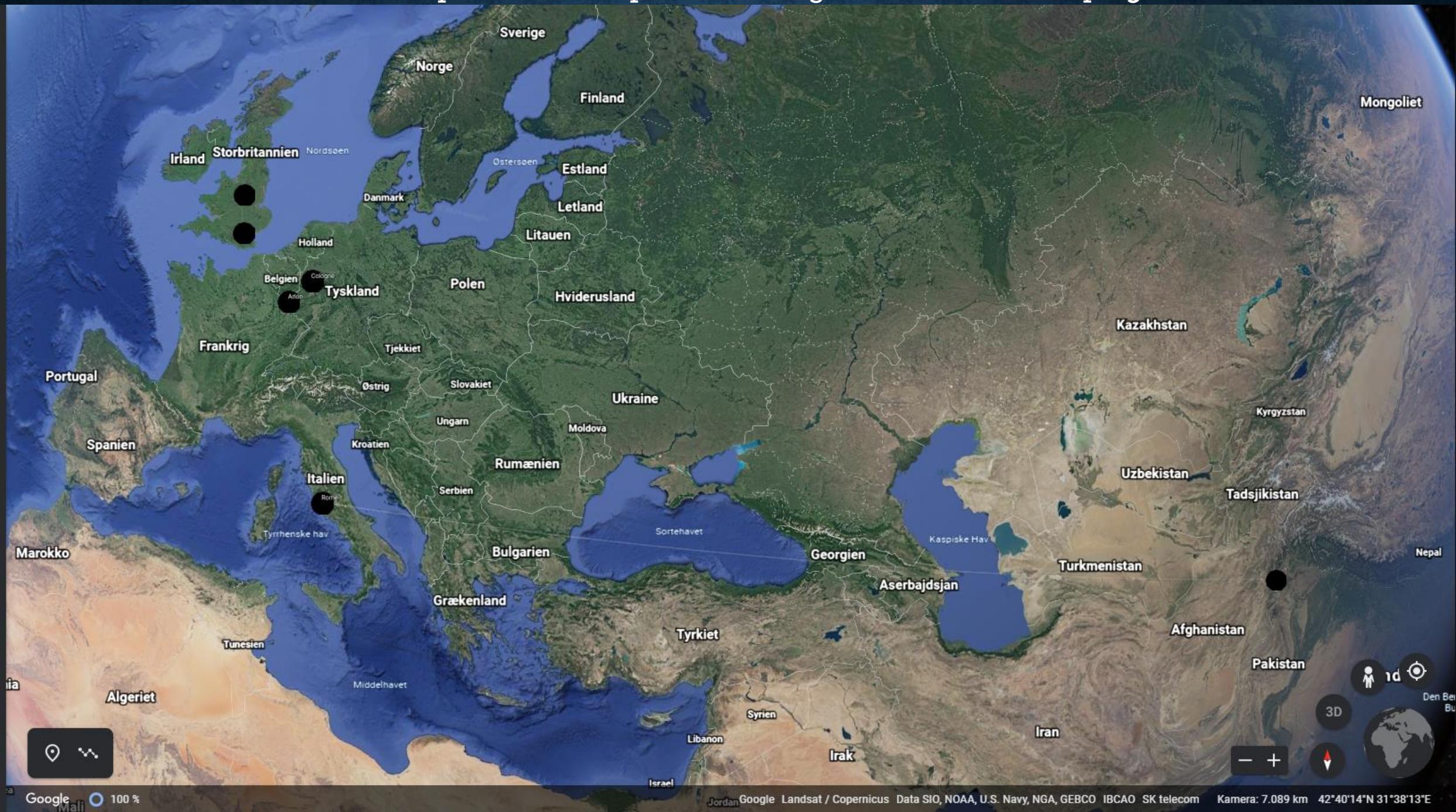


NETWORKS IN SPACE



Data with coordinates visualised as a monoplex, 1-mode, directed, weighted network model in Gephi

The small example network exported to *Google Earth* with use of plugin



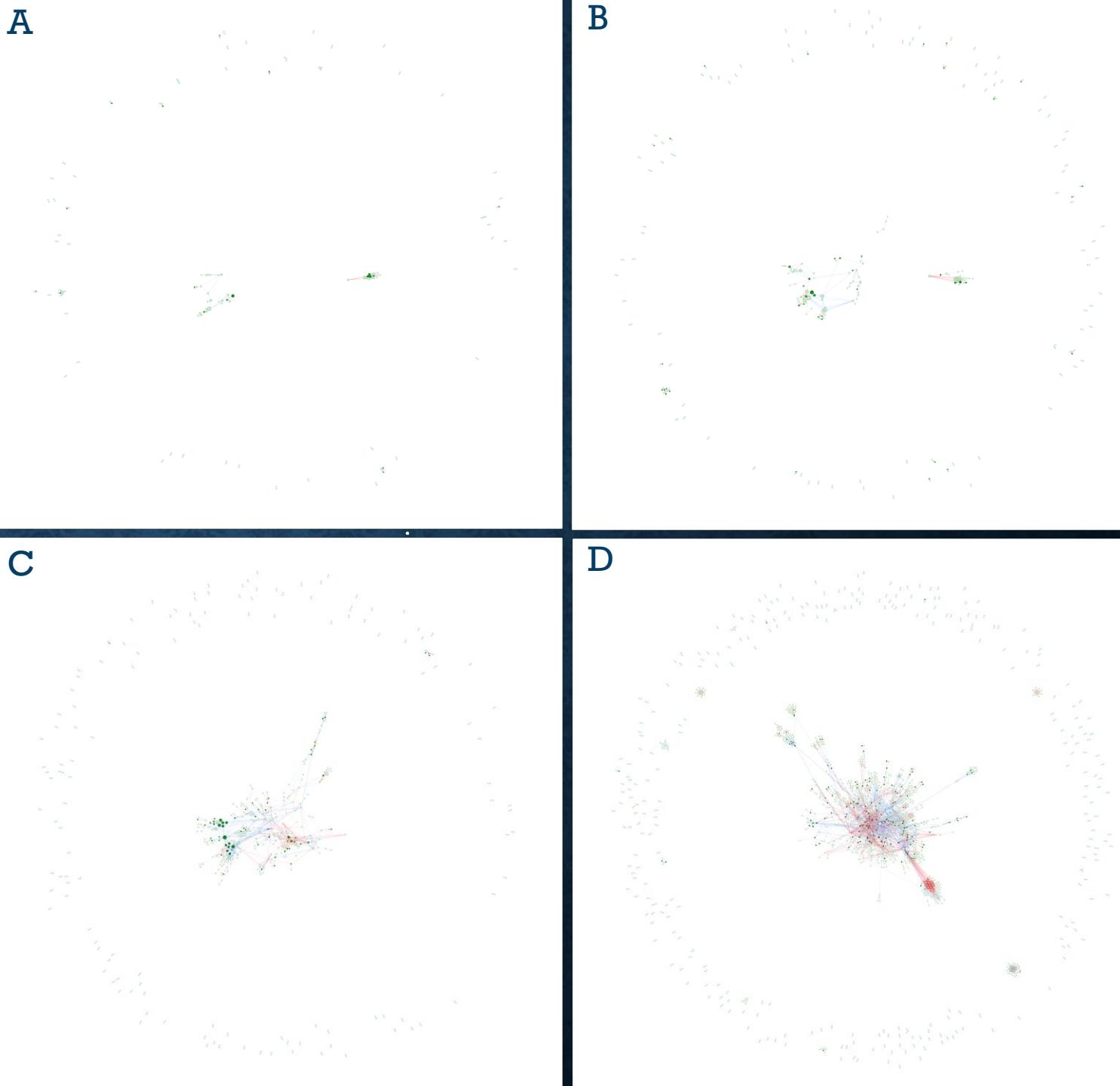
Google 100 %

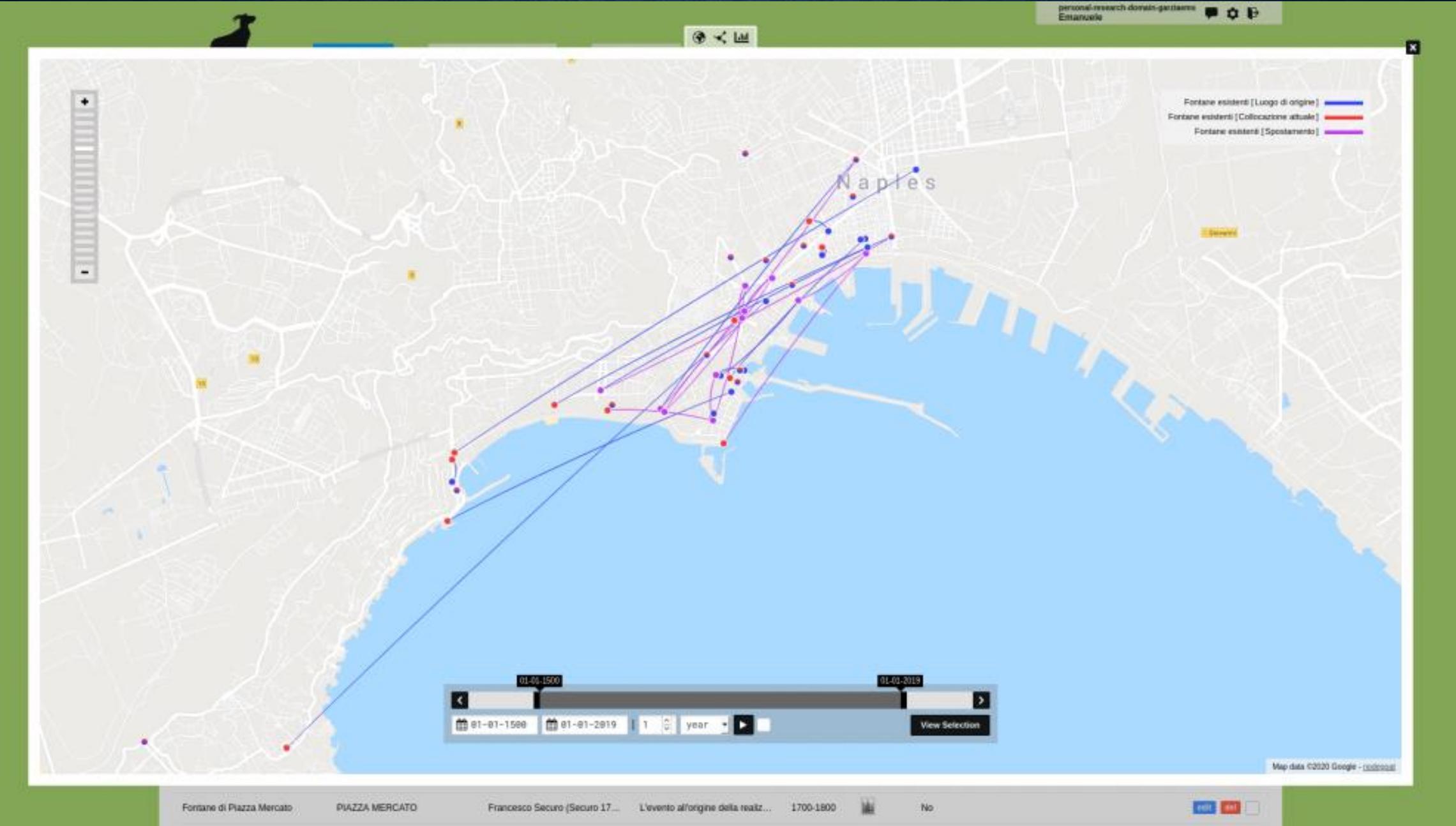
Jordan Google Landsat / Copernicus Data SIO, NOAA, U.S. Navy, NGA, GEBCO IBCAO SK telecom Kamera: 7.089 km 42°40'14"N 31°38'13"E

NETWORKS AND TIME

Common solutions:

- create a static network, **aggregating** all the data from the entire period of time
- build a network that grows with time by **building it gradually** and creating snapshots along the way, that aggregate all data up until this period of time
- define ***time slices*** and analyse successive snapshots containing only data from these specific windows of time
- create and explore ***dynamic network models*** (e.g. with sliding timelines)





(<https://e.nodegoat.net/cache/img/WzEwMDAsMF0=/L0NNUy91cGxvYWQvdXNIY2FzZV9nYXJ6aWFfMi5wbmc=>)

connected component

node-link visualisation

average path length

matrix visualisation

multiplex / multilayered network

local clustering coefficient (LCC)

isolate

SOME NETWORK TOOLS AND CONCEPTS



node / actor / agent / point / vector

weak tie

global clustering coefficient

node attribute

bridge



density

path length

community

whole network

clique

hypergraph

network diameter

dyad

homophily / assortativity

directed edge

shortest path

weighted network

closeness centrality

transitivity

small world

directed network

connected component

reciprocity

unweighted network



eigenvector centrality

degree centrality

edge attribute

triad

weighted edge

undirected edge

betweenness centrality

mixed network

1-mode / monopartite / monomodal network

transitivity

multiplex network



edge / tie / relation / link / arc



modularity

undirected network

string

structural hole

self-loop

2-mode / bipartite / bimodal network



unweighted edge

multigraph

weighted degree centrality

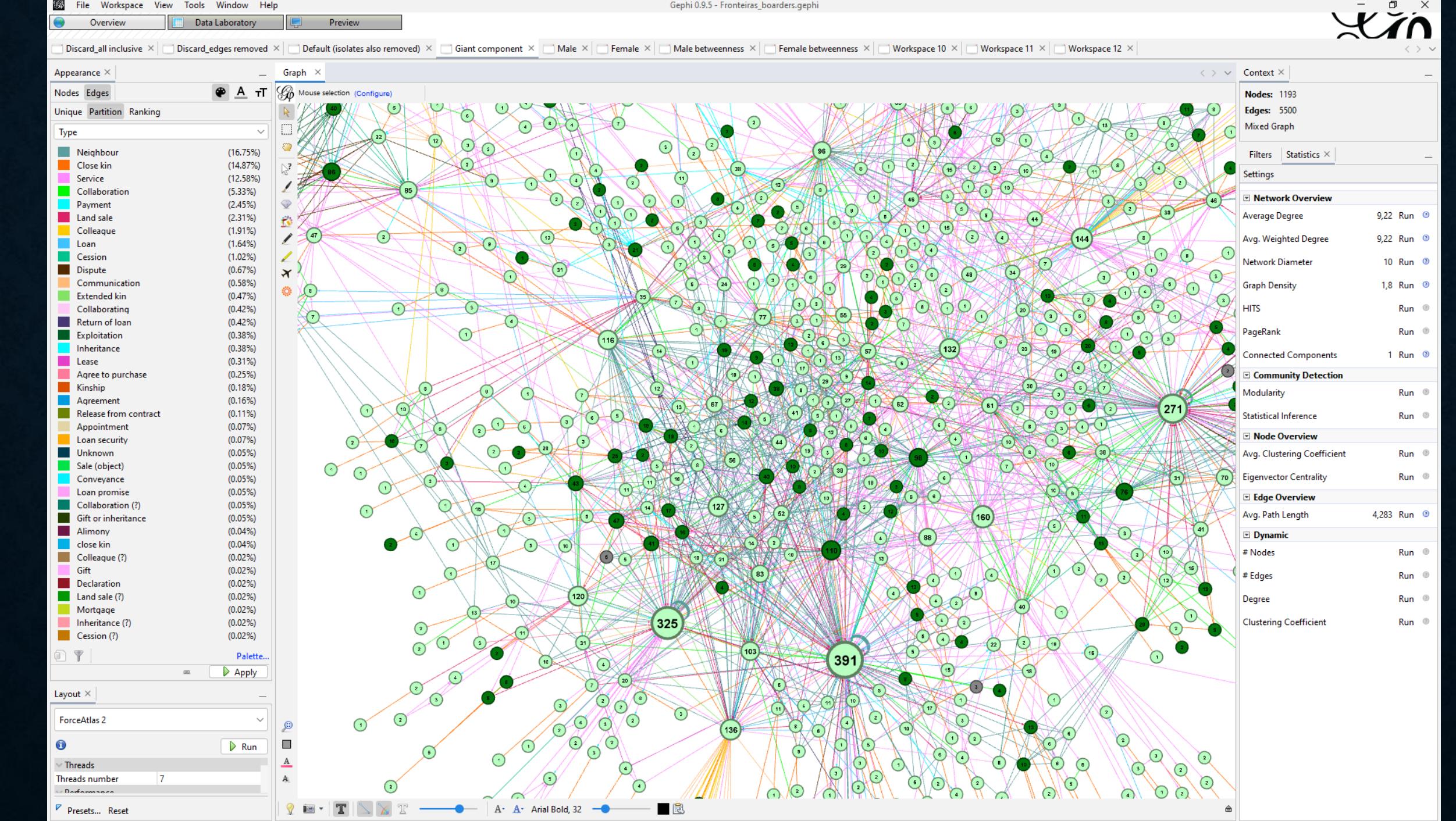
multimodal / k-partite network

broker / hub

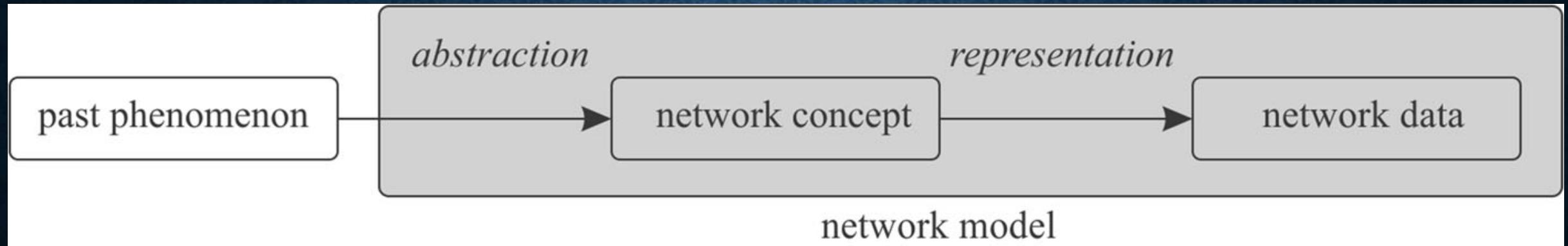
scale-free / power law

reciprocity

monoplex / monolayered network

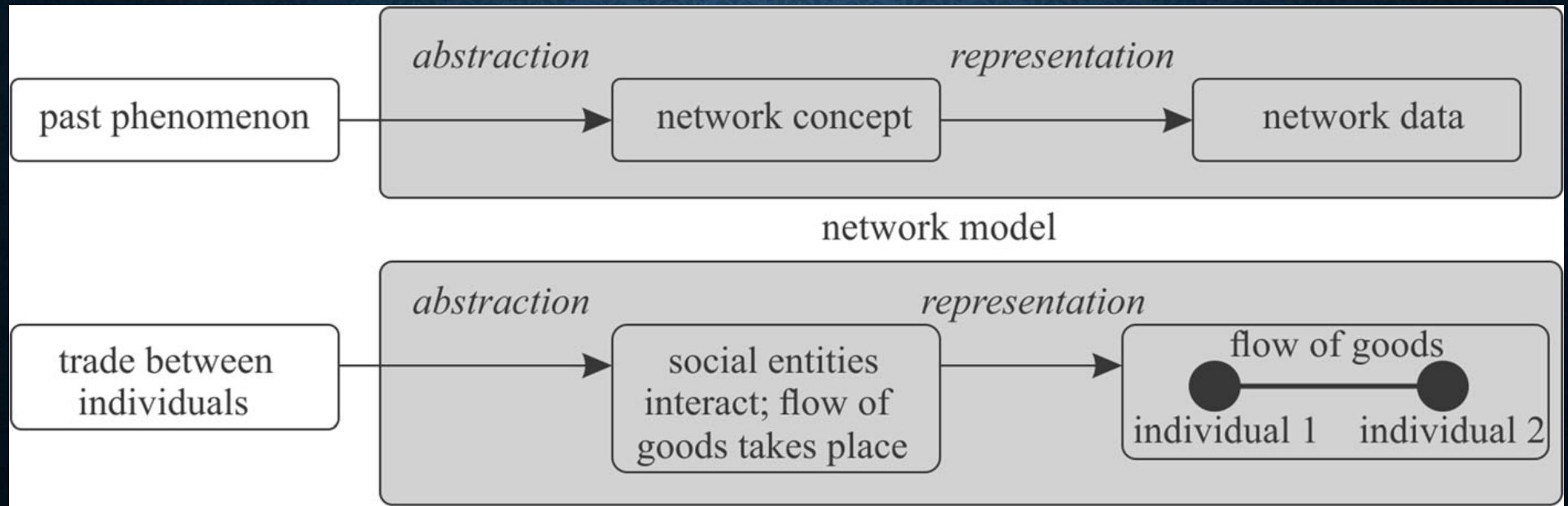


WHAT DO WE DO WHEN WE MODEL (PAST) NETWORKS ?



Collar et al. (2015), Fig. 3

WHAT DO WE DO WHEN WE MODEL (PAST) NETWORKS ?



Collar et al. (2015), Fig. 3

SNA – HOW DO YOU DO IT?

Common workflow:

1. Define the research questions you intend to use (S)NA for
2. Conceptualise your network and decide on network boundaries and characteristics
 - What will the nodes and edges represent, which attribute data will qualify them, where do you draw the line, etc.?
3. Identify your source material and plan which data to record and how to manage it
 - Think long-term and create a database if needed
 - For smaller projects, be aware that you can also build your node and edge lists directly in software like *Gephi*
4. Start build your datasets and make a test run
 - Picking a network analytical software early on allows you to keep potential peculiarities of the software in mind as you build your dataset. That will help modelling the network run smoothly
 - NB: rather than collecting all the data first, make a test run as soon as you have gathered a bit of data, to see that the software reads the data the way you intend it to
5. Finish building your datasets and model it as a network graph
6. Explore your network and answer your research questions with formal network analyse
7. Critically asses and interpret the results

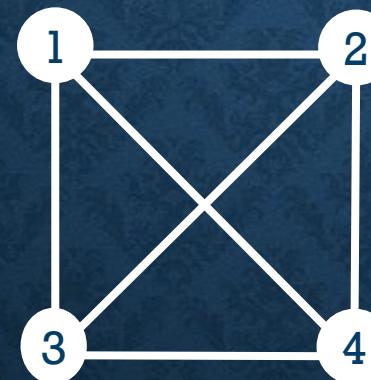
SNA DATASETS – HOW DO THEY LOOK?

To model a (social) network you need information on:

- the studied entities (nodes) and
- how they relate to one another (edges)

Node list

Id	Label	Sex	Age
P_1	Bob	Male	56
P_2	Eva	Female	58
P_3	Einar	Male	10
P_4	Alma	Female	5



Edge list

Source	Target	Kind	Year
P_1	P_2	Marriage	2011
P_1	P_3	Parent-child	2012
P_1	P_4	Parent-child	2017
P_2	P_3	Parent-child	2012
P_2	P_4	Parent-child	2017
P_3	P_4	Siblings	2017

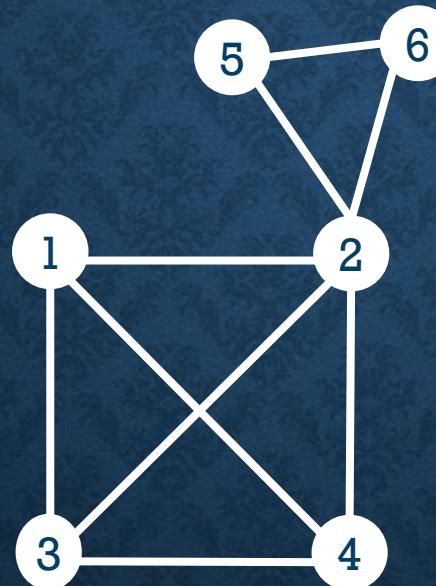
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P_5	Tor	Male	83
P_6	Marie	Female	77



Edge list

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P_2	P_3	Parent-child	2012
P_2	P_4	Parent-child	2017
P_3	P_4	Siblings	2017
P_5	P_6	Marriage	1960
P_5	P_2	Parent-child	1964
P_6	P_2	Parent-child	1964

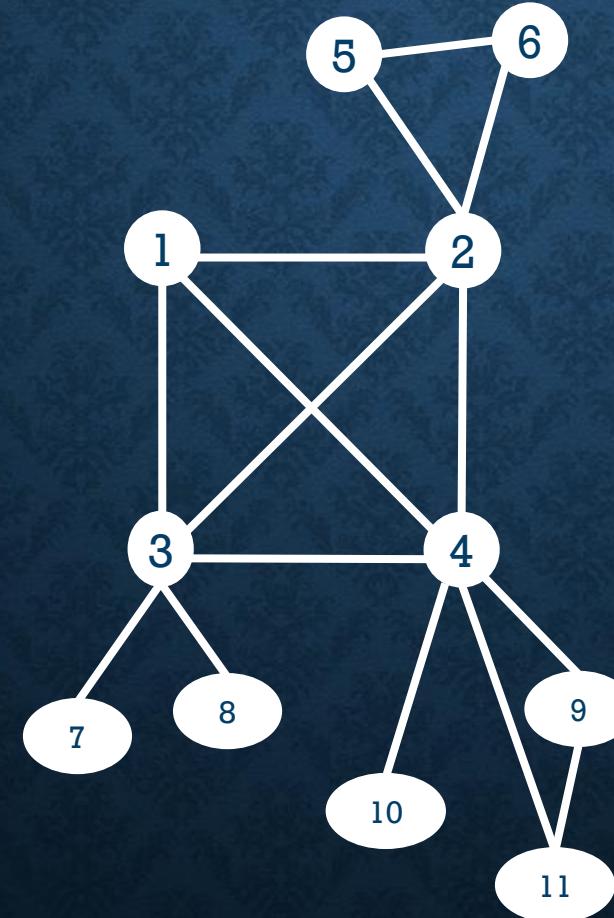
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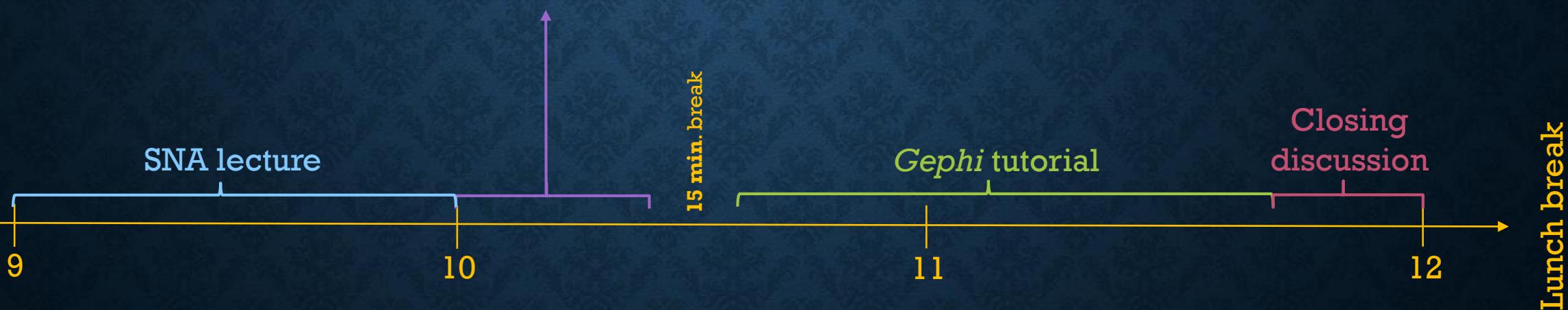
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P_5	Tor	Male	83
P_6	Marie	Female	77
P_7	Ole	Male	12
P_8	Freddy	Male	10
P_9	Silje	Female	5
P_10	Ole	Male	5
P_11	Elin	Female	5



Edge list

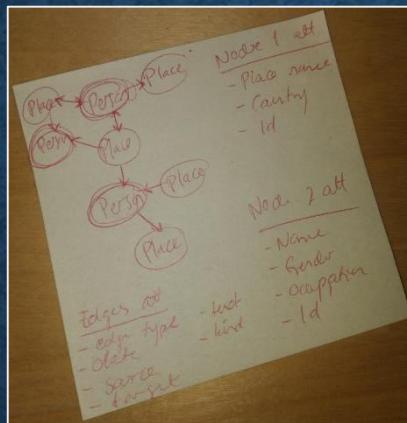
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P_5	P_6	Marriage	1960
P_5	P_2	Parent-child	1964
P_6	P_2	Parent-child	1964
P_3	P_7	Friendship	N/A
P_3	P_8	Friendship	N/A
P_4	P_9	Friendship	N/A
P_4	P_10	Friendship	N/A
P_4	P_11	Friendship	N/A
P_9	P_11	Friendship	N/A

Group exercise & case lecture



GROUP EXERCISE: CONCEPTUALISE AND COLLECT NETWORK DATA FROM AN ANCIENT TEXT (TM_135)

- Instructions:
 - Form groups
 - Read the excerpt
 - Discuss how you could build a social network with information provided by this source
 - What would be the nodes?
 - What would be the edges?
 - Which attribute data would you record for the nodes and edges respectively?
 - What sort of questions could the mode help you answer?
 - Draw up a schematic plan of your network model that you can share with the others



Tambor

DAA Nordic Summer School

2022

Excerpt of P. Rylands Dem. 20 (TM_135)

As an example, we will consider a marriage contract written on papyrus by Espnoutis son of Teos, who worked as a scribe in the temple of Sobek in Krokodilopolis, on 29 Oct. 116 BCE. The document is believed to have formed part of the family archive of Pelaia son of Eunous alias Nechoutes in antiquity, and the acting parties are well known to us since they reappear in a number of surviving texts from Pathyrus.¹

Translation/transliteration, after Griffith, F. L. (1909), pp. 149-150/277-278²

Only the parts of the contract of particular interest to us are presented below.

Lines

Formulaic introduction and dating

3

... The man who receiveth rations amongst the men of Lokhos (?), who is written to Amûr, Eunous son of Patse'ô, hath declared unto the woman

Tapremhit

4

These labels are if you want to add

The children that thou shalt bear unto me are the co-dividers with my children, of all that belongeth unto me, together with those things that I shall

gain Behold

5-7

list of the women's gift and estimation of their values

8

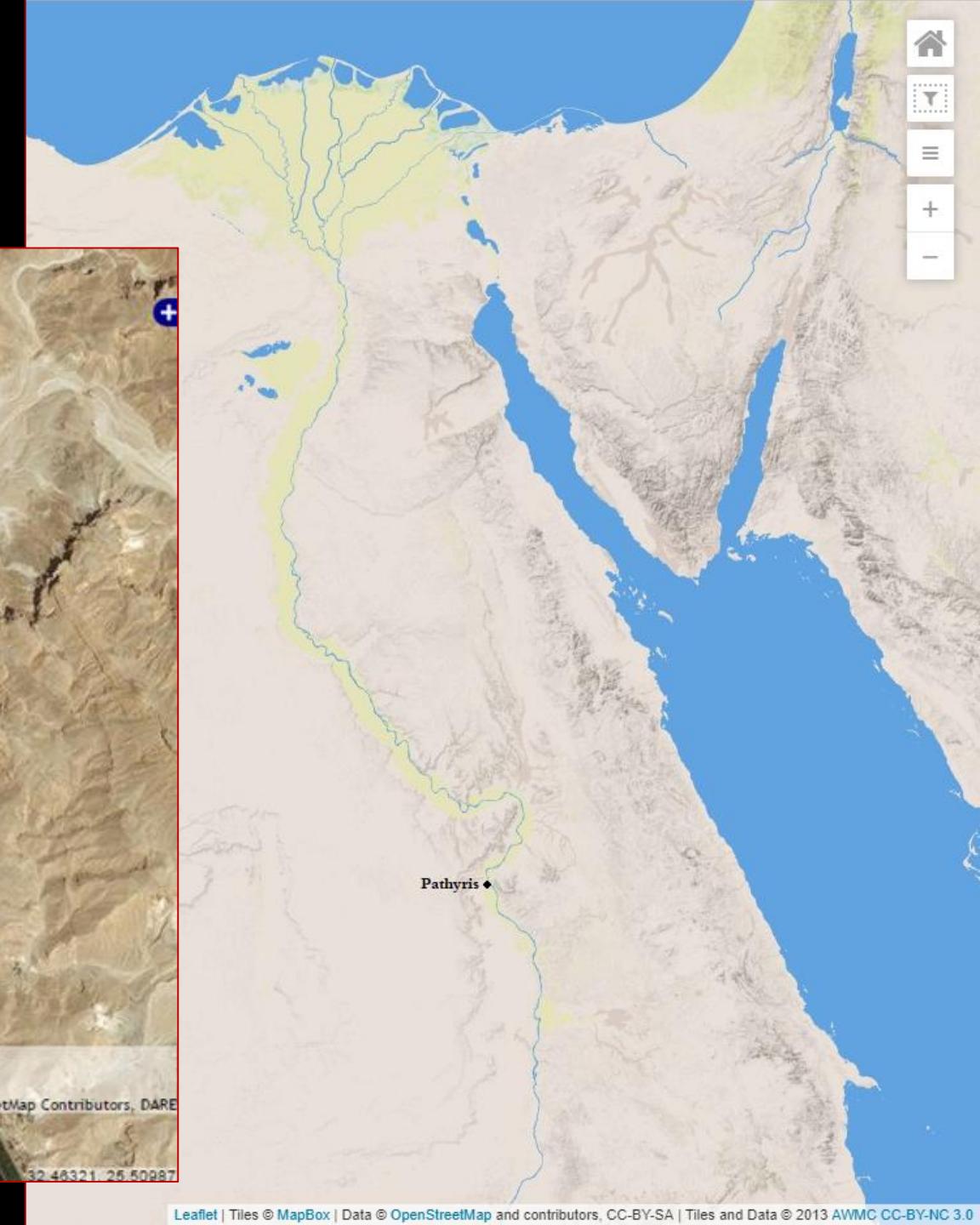
Written by Espniti son of Zeho, who writes in the name of the priests of Sobk lord of Amur of the 5 orders.

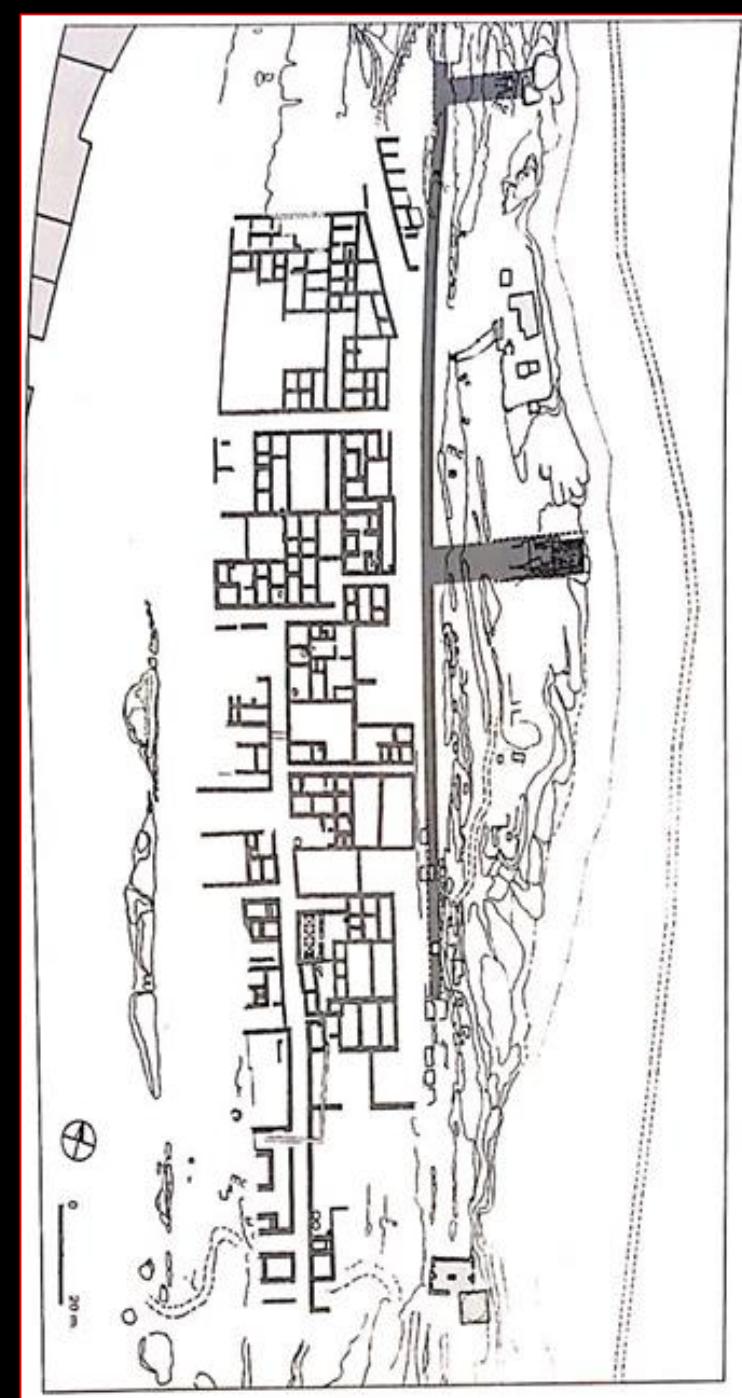
'On the back are the signatures of 16 witnesses.' 3

¹ For the archive, people and site, see esp. Tambs, L. (2022). Socio-Economic Relations in Ptolemaic Pathyris: A Network Analytical Approach to a Bilingual Community. *Probleme der Ägyptologie* 40.1-40.2, Leiden: Brill.

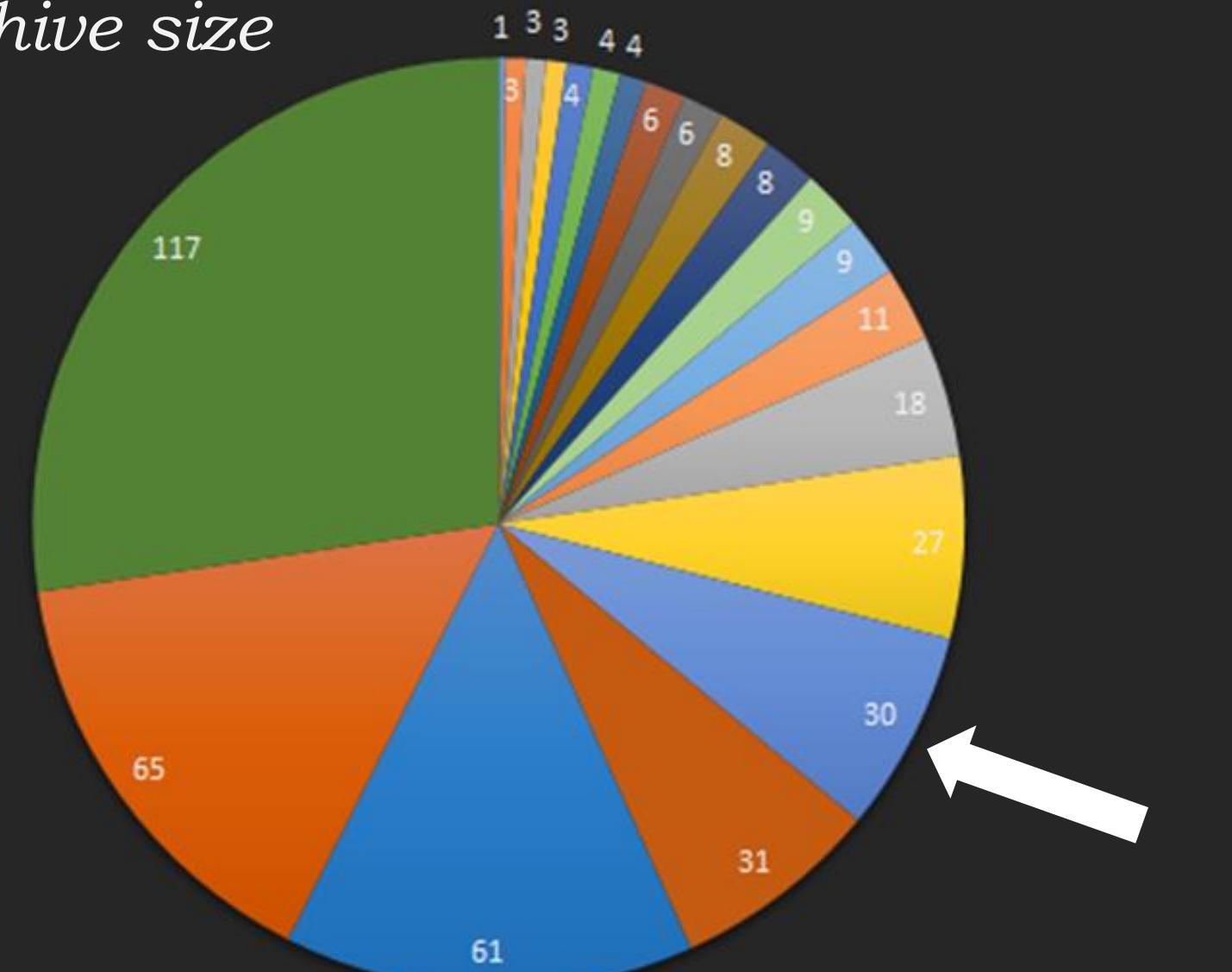
² Griffith, F. L. (1909). *Catalogue of the Demotic Papyri in the John Rylands Library Manchester. With Facsimiles and Complete Translations*, Vol. III [repr.]. Hildesheim: Georg Olms Verlag.

PATHYRIS (GEBELEIN) IN UPPER EGYPT

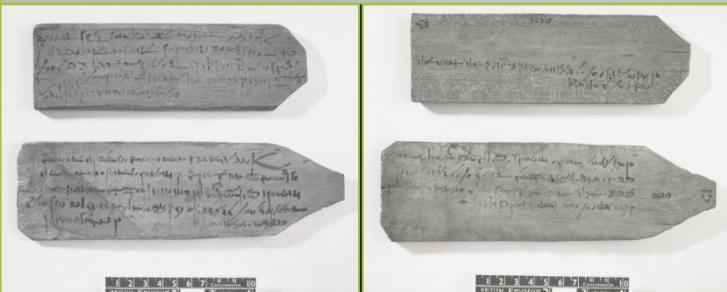
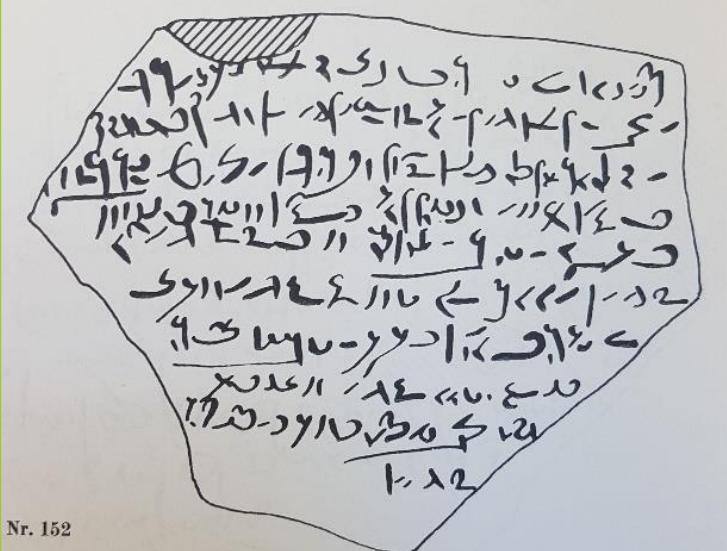




Archive size



Legend:
 ■ TM_Arch_481 ■ TM_Arch_486 ■ TM_Arch_493 ■ TM_Arch_495 ■ TM_Arch_482 ■ TM_Arch_491 ■ TM_Arch_492
 ■ TM_Arch_484 ■ TM_Arch_494 ■ TM_Arch_487 ■ TM_Arch_489 ■ TM_Arch_059 ■ TM_Arch_483 ■ TM_Arch_098
 ■ TM_Arch_488 ■ TM_Arch_485 ■ TM_Arch_180 ■ TM_Arch_081 ■ TM_Arch_106 ■ TM_Arch_074 ■ TM_Arch_183





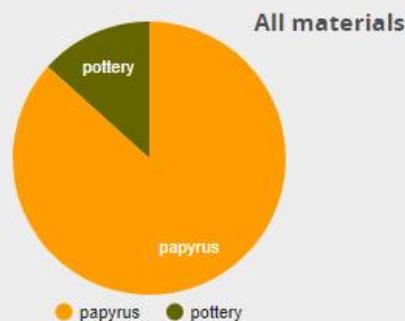
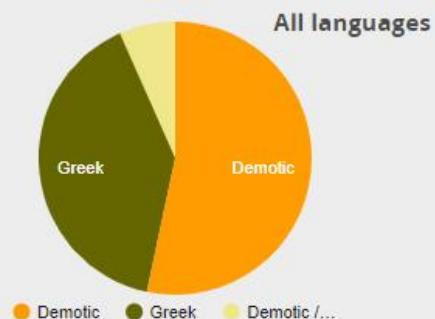
⬇ 30 texts (of which 23 certain, 2 uncertain, 5 related)

(source limitations: -800 to 800)

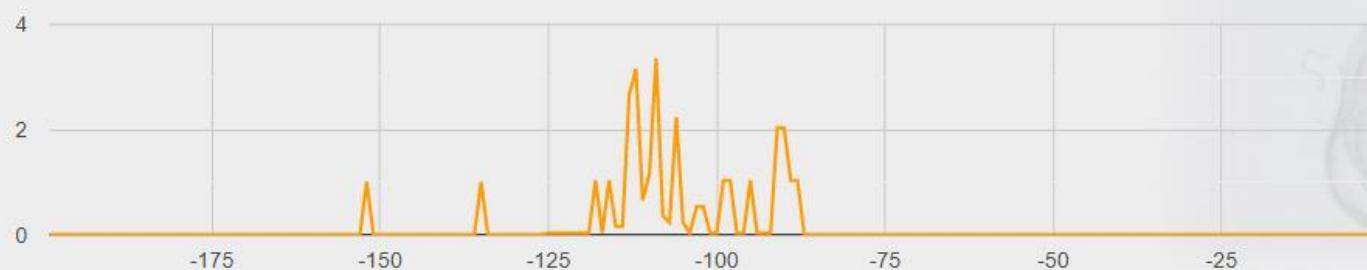
💡 Click on the appropriate section of the charts to limit your search to a specific language or material.

Chart type:

Pie Table



Chronological overview





Information mentioned in this text

Words (0)

2 [a] hrmyps

[b] grytn

[c] ptlwmys

[d] ptlwmys

3 [a] lwsny�

[b] hyrnwmws

[c] Swgrts

[d] nygntrs

[e] hrms

[f] tmtrys

[g] ȝsnws

[h] lqwprn

[i] Tytwmws

4 [a] ȝpwł'nyś

[c] gtsy়়়া

People (61)

Places (6)

Text Irregularities (0)

Abbreviations (0)

Dates (0)

Attestation

TM Ref 39605

H̄nsw-D̄hwty

act: gets married / husband

ethnic: Blhm ms n Kmy

Person

TM Per 19628

Chesthoytes

♂ BC 152 # attestations: 1

father: Harpaesis (TM Per 19629)

mother: Senpoeris (TM Per 19630)

Names

H̄nsw-D̄hwty invariable of H̄nsw-D̄hwty (TM NamVar 5593) variant of Chesthotes (TM Nam 127)

CASE STUDY: SOCIAL NETWORK OF THE ARCHIVE OF PELAIAS, SON OF EUNOUS ALIAS NECHOUTES (TM_ARCH_180)

Network boundaries

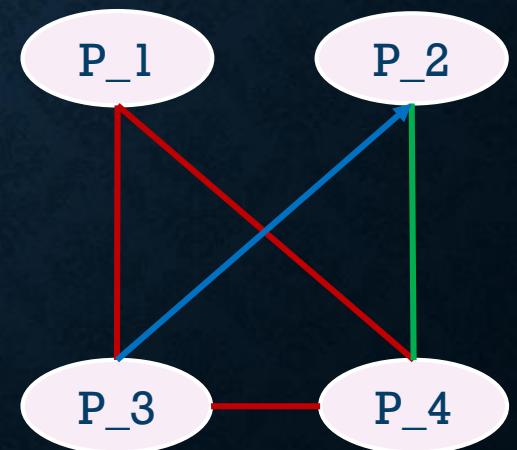
- Prosopographical, attribute and relational data revealed by the 30 texts of the ancient archive

The building blocks

- Nodes = persons
 - ID, Label, Name, Sex
- Edges = interpersonal social and economic relationships
 - Source, Target, Text ID, Category, Kind, Sub-kind, Time-slot, Language, Type (+ Material and Relation to archive)

Network characteristics

- 1-mode, multiplex, unweighted, mixed, whole network



FILES FOR GEPHI IMPORT

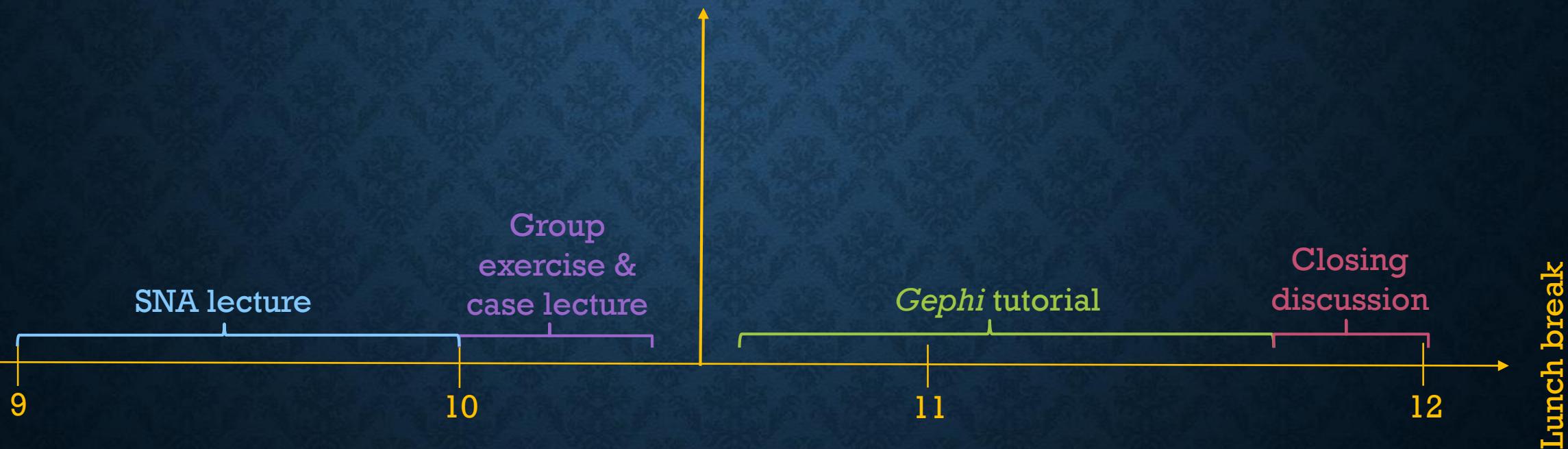
Nodes table(s)

1	Id,Label,Name,Sex				
2	PER_37_180548_183705,PER_37_180548_183705,Heliodoros,Male				
3	PER_53862_73544_73598,PER_53862_73544_73598,Nahomsesis,Female				
4	PER_18712,PER_18712,Spemminis,Male				
5	PER_18713,PER_18713,Taesisis,Female				
6	PER_18714,PER_18714,Harsiesis,Male				
7	PER_18713,PER_18713,Taesisis,Female				
8	PER_53862_73544_73598,PER_53862_73544_73598,Nahomsesis,Female				
9	PER_53862_73544_73598,PER_53862_73544_73598,Nahomsesis,Female				
10	PER_18713,PER_18713,Taesisis,Female				
11	PER_18713,PER_18713,Taesisis,Female				
12	PER_37_180548_183705,PER_37_180548_183705,Heliodoros,Male				
13	PER_53862_73544_73598,PER_53862_73544_73598,Nahomsesis,Female				
14	PER_18712,PER_18712,Spemminis,Male				
15	PER_19146,PER_19146,Patseous,Male				
16	PER_19147,PER_19147,Sales,Male				
17	PER_53862_73544_73598,PER_53862_73544_73598,Nahomsesis,Female				
18	PER_53862_73544_73598,PER_53862_73544_73598,Nahomsesis,Female				
19	PER_19146,PER_19146,Patseous,Male				
20	PER_37_180548_183705,PER_37_180548_183705,Heliodoros,Male				

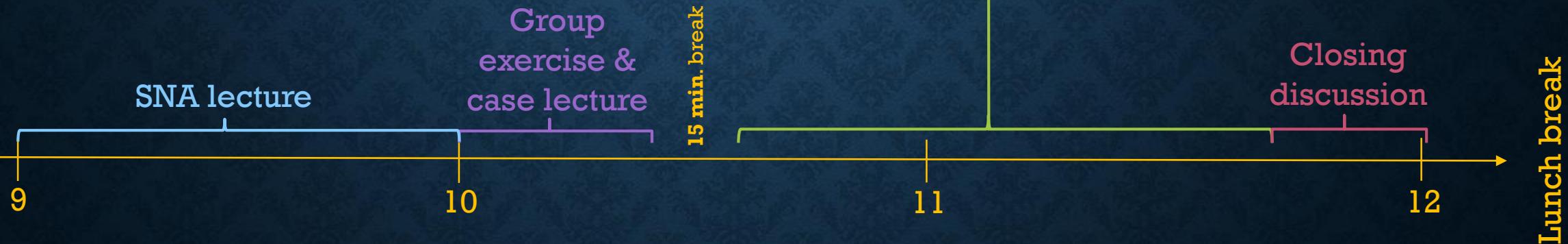
Edge table(s)

1	Source,Target,Type,Category,Kind,Sub-kind,Text ID,Time-slot,Language,Material,Relation to archive
2	PER_37_180548_183705,PER_53862_73544_73598,Directed,Economic,Service,Scribe,TM_121,115-88 BCE,Greek,Papyrus,Certain
3	PER_37_180548_183705,PER_18713,Directed,Economic,Service,Scribe,TM_121,115-88 BCE,Greek,Papyrus,Certain
4	PER_53862_73544_73598,PER_18713,Directed,Economic,Loan,Grain,TM_121,115-88 BCE,Greek,Papyrus,Certain
5	PER_37_180548_183705,PER_19146,Directed,Economic,Service,Scribe,TM_122,115-88 BCE,Greek,Papyrus,Certain
6	PER_37_180548_183705,PER_53862_73544_73598,Directed,Economic,Service,Scribe,TM_122,115-88 BCE,Greek,Papyrus,Certain
7	PER_53862_73544_73598,PER_19146,Directed,Economic,Loan,Grain,TM_122,115-88 BCE,Greek,Papyrus,Certain
8	PER_73_242437_351540,PER_53862_73544_73598,Directed,Economic,Service,Scribe,TM_123,115-88 BCE,Greek,Papyrus,Certain
9	PER_73_242437_351540,PER_15041,Directed,Economic,Service,Scribe,TM_123,115-88 BCE,Greek,Papyrus,Certain
10	PER_53862_73544_73598,PER_15041,Directed,Economic,Loan,Wine,TM_123,115-88 BCE,Greek,Papyrus,Certain
11	PER_338817,PER_53862_73544_73598,Directed,Economic,Service,Taking measurements,TM_123,115-88 BCE,Greek,Papyrus,Certain
12	PER_338817,PER_15041,Directed,Economic,Service,Taking measurements,TM_123,115-88 BCE,Greek,Papyrus,Certain
13	PER_7769,PER_8170_78233_160275_242017,Directed,Economic,Loan,Money,TM_124,115-88 BCE,Greek,Papyrus,Certain
14	PER_7769,PER_19150,Directed,Economic,Loan,Money,TM_124,115-88 BCE,Greek,Papyrus,Certain
15	PER_8170_78233_160275_242017,PER_19150,Undirected,Economic,Collaboration,Loan together,TM_124,115-88 BCE,Greek,Papyrus,Certain
16	PER_70_242438_351541,PER_7769,Directed,Economic,Service,Scribe,TM_124,115-88 BCE,Greek,Papyrus,Certain
17	PER_70_242438_351541,PER_8170_78233_160275_242017,Directed,Economic,Service,Scribe,TM_124,115-88 BCE,Greek,Papyrus,Certain
18	PER_70_242438_351541,PER_19150,Directed,Economic,Service,Scribe,TM_124,115-88 BCE,Greek,Papyrus,Certain
19	PER_400,PER_19152,Directed,Economic,Service,Scribe,TM_125,115-88 BCE,Greek,Papyrus,Certain
20	PER_400,PER_359_11831_73600,Directed,Economic,Service,Scribe,TM_125,115-88 BCE,Greek,Papyrus,Certain

15 min. break



Gephi tutorial



INDIVIDUAL EXERCISE: MODEL AND ANALYSE A SOCIAL NETWORK IN GEPHI

- **Instructions:**

- Go to the 4.1-3_SNA folder and open the tutorial (Tambs_daa_snaTutorial)
- launch *Gephi* and follow the guide closely
- grab a hold of us (esp. me, Ellie, Stefan or Seraina) if you have questions, run into problems or just want to know how you can do something, and
- have fun exploring the network and software ☺

Tambs

DAA Nordic Summer School

2022

Visualising and Analysing Network Data in *Gephi*

Instructions

Please follow this guide carefully, and let us know if you run into problems.

Installing Gephi

You should already have installed *Gephi* on your computer. If you have not, please download and install the latest version of *Gephi*, which is freely available at <https://Gephi.org/> now.

NB: if you have an older version of *Gephi* and are unable to launch the software, you might need to install Java 1.8 or higher (or upgrade to a newer version of *Gephi*).

The Archive of Pelias, son of Eunous alias Nechoutes (TM_Arch_180)

Accessing the datasets

You will create your network from one node list and two edge lists. If you participated in the '1.2 Github' section, you will already have cloned the zip-folder containing the dataset to your computer. Alternatively, you can access it by visiting the GitHub repository (<https://github.com/glow-gh/daa>) → 'files' → and download the '1-3_SNA.zip' folder. The lists we need are called 'Tambs_daa_nodes', 'Tambs_daa_edges_1', and 'Tambs_daa_edges_2'.

Glancing at the raw-data

To make a network model, you must create (at least one) node and one separate edge lists. Network data can be built in various ways, e.g. as simple spreadsheets, but to import the lists to the *Gephi* I have save our lists as .csv (or comma-separated values) files.

Try opening the .csv file entitled 'Tambs_daa_nodes' and make sure the version you have contains 644 records of persons.

You will find that each row is a case (here: a person) and that columns (in .csv separated by commas) hold various information on them. Only a unique 'ID' is required by *Gephi*; 'Label', 'Name' and 'Sex' are additional attributes that we are interested in.

NB: the ID field must contain unique identifiers, but you might have already noticed that these are not 644 unique individuals. The reason there are several duplicates in our lists is that you are currently looking at a list of 644 attestations of persons in the 30 texts associated with the archive under study. We could have removed duplicates directly in *Excel*, but for this exercise, we will rather have *Gephi* do that as we import the datasets, so you can go ahead and close the node list again.

Modelling the data as a social network in *Gephi*

We will now have *Gephi* translating our node and edge lists into network models. Since you already have the necessary data files saved in a format that *Gephi* can read, go ahead and launch *Gephi*¹¹.

You should be welcomed with a window like this:

¹¹ The screenshots of this guide reflect *Gephi* 0.9.2. If you have a different version installed on your computer, you might experience some deviations in the software's layout and functionality, but most measures and tools should still be available and relevant.

Closing discussion



POINTS TO REFLECT UPON

The Gephi-exercise

- Was the tutorial manageable?
- What was particularly difficult?
- What did you find useful/unuseful?
- Can you imagine using *Gephi* (or another network analytical software) in your own research?

The SNA module

- What do you take away from this module?
- Was there anything you hoped to learn that was not covered?
- Do you imagine that you might conduct network research of your own in the future?

SUGGESTED READINGS

Digestable introduction to SNA with historical focus

- Ch. 6 of Graham, S., Millian, I., & Weingart, S. (2016). Exploring Big Historical Data: The Historian's Macroscope. London: imperial College Press, pp. 195-234 (in GitHub _files folder)

Concepts and applications of SNA in history and archaeology

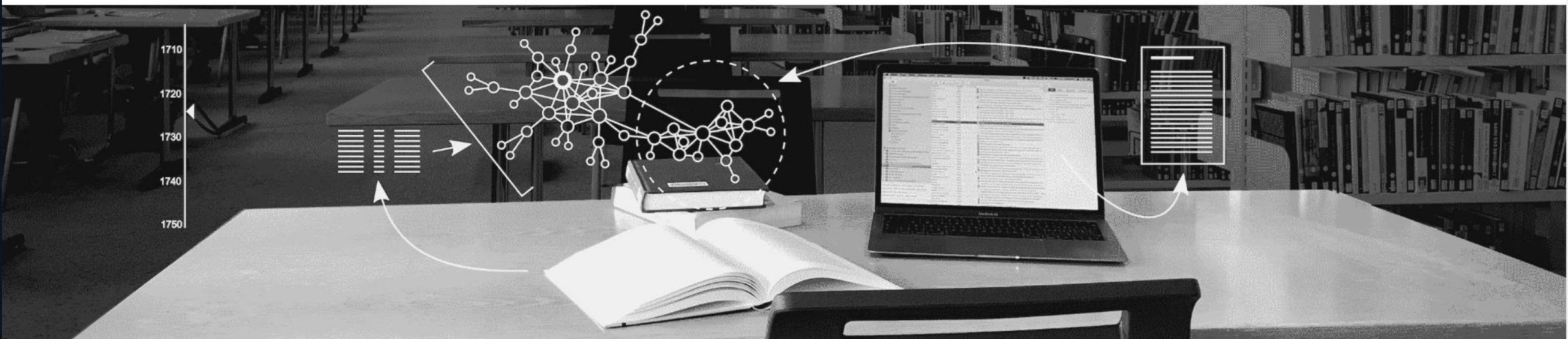
- Collar, A., Coward, F., Brughmans, T., & Mills, B. J. (2015). Networks in Archaeology: Phenomena, Abstraction, Representation. *Journal of Archaeological Method and Theory*, 22, pp. 1–32. <https://doi.org/10.1007/s10816-014-9235-6>
- Crabtree S.A., Borck L. (2019). Social Networks for Archaeological Research. In: C. Smith (ed), *Encyclopedia of Global Archaeology*. Springer: Cham, pp. 1-12. https://doi.org/10.1007/978-3-319-51726-1_2631-2
- Rollinger, C. (2020). Prolegomena. Problems and Perspectives of Historical Network Research and Ancient History. *Journal of Historical Network Research*, 4, pp. 1-35. <https://doi.org/10.25517/jhnrv4i0.72>

Handbooks

- Prell, C. (2012). *Social Network Analysis. History, Theory & Methodology*. Los Angeles: SAGE
- Scott, J. (2017). *Social Network Analysis*, 4th edition. Los Angeles: SAGE
- Wasserman, S. & Faust, K. (1994). *Social Network Analysis. Methods and Applications*. Structural analysis in the social sciences. Cambridge: Cambridge University Press

Gephi

- Khokhar, D. (2015). *Gephi Cookbook. Over 90 Hands-On Recipes to Master the Art of Network Analysis and Visualization with Gephi*. Birmingham: Packt Publishing (NB: for an older version of Gephi, but still useful)
- various tutorials available (with datasets) at <https://gephi.org/users/>



HNR Bibliography

vol. 7 2021

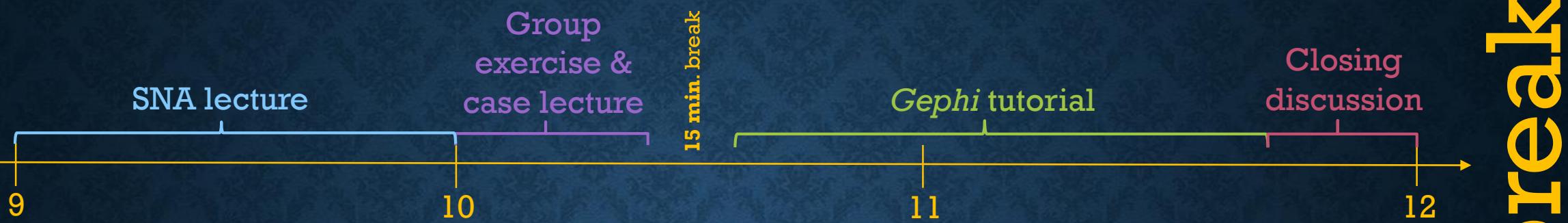
We are in the process of reorganizing the tree structure of the bibliography categories, so we offer here a version sorted by publication date. You can still temporarily use [the old categories here](#) or directly in Zotero.

About the bibliography

On this page you will find the to-date largest collection of articles related to the application of Social Network Analysis in the historical disciplines. However, it is neither complete nor perfect.

Stay informed:

- The Historical Network Research Community (<https://historicalnetworkresearch.org/>)
- The Connected Past (<https://connectedpast.net/>)
- Archaeological Networks (<https://archaeologicalnetworks.wordpress.com/>)



Thank you & best of luck for your
future network research!

L. Tambs & E. Bennett
(lena.tambs@Helsinki.fi / eleanor.bennett@helsinki.fi)