

# NETWORK ANALYSIS IN ARCHAEOLOGY THEORY, PRACTICE, AND APPLICATIONS

Mycenae

Gordion

Pompeii

Uruk

Knossos

Troy

Uruk

Amarna

Chichen Itza

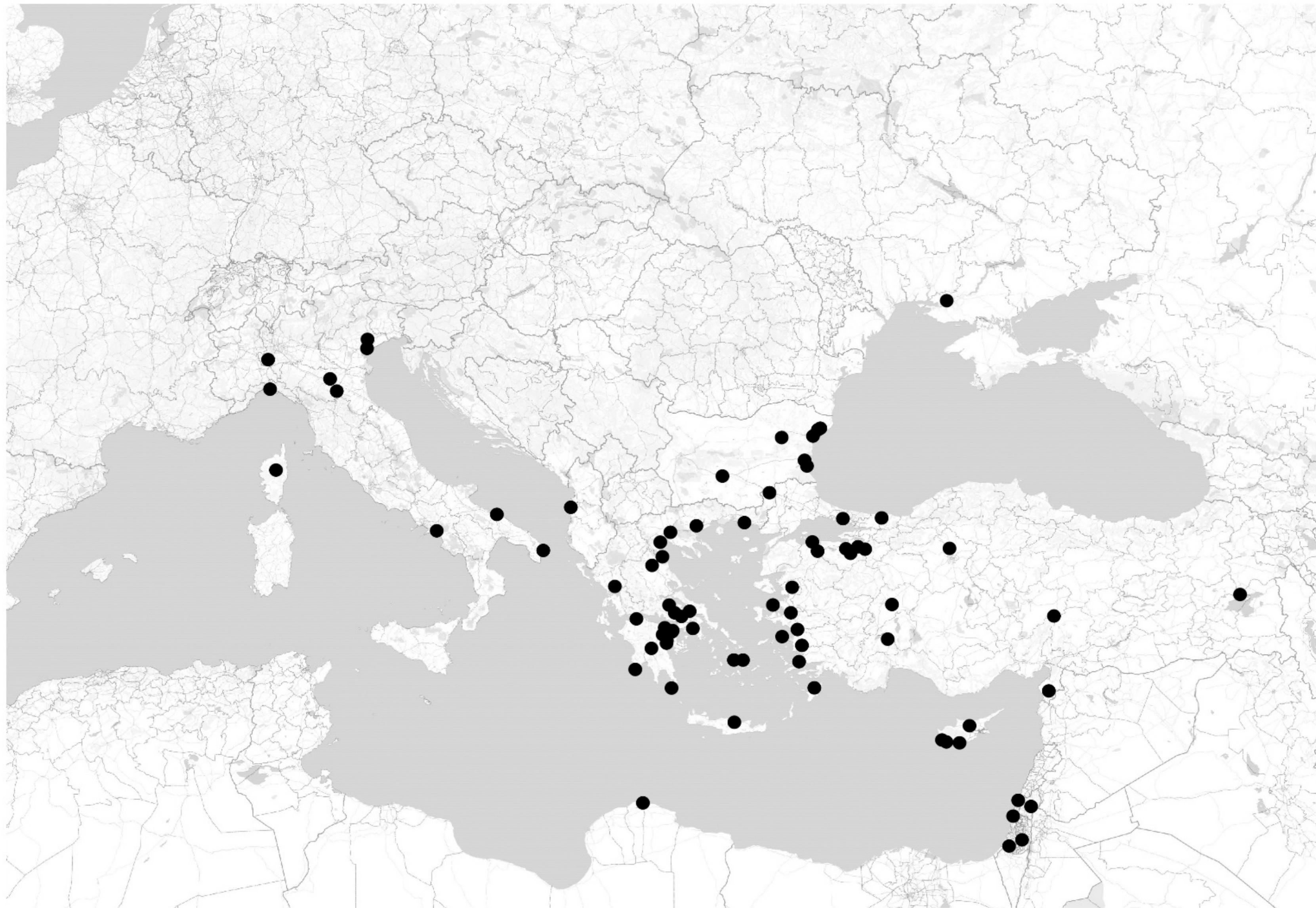
# Structure

- Ceramics as a Window to Connectivity
- Getting Accustomed with visone software
- Easter Neighbour Networks of the castles of the Peloponnese using the visone software
- Tutorials and informations can be find at: <http://visone.info/>

# Ceramics as a Window to Connectivity



# Ceramics as a Window to Connectivity

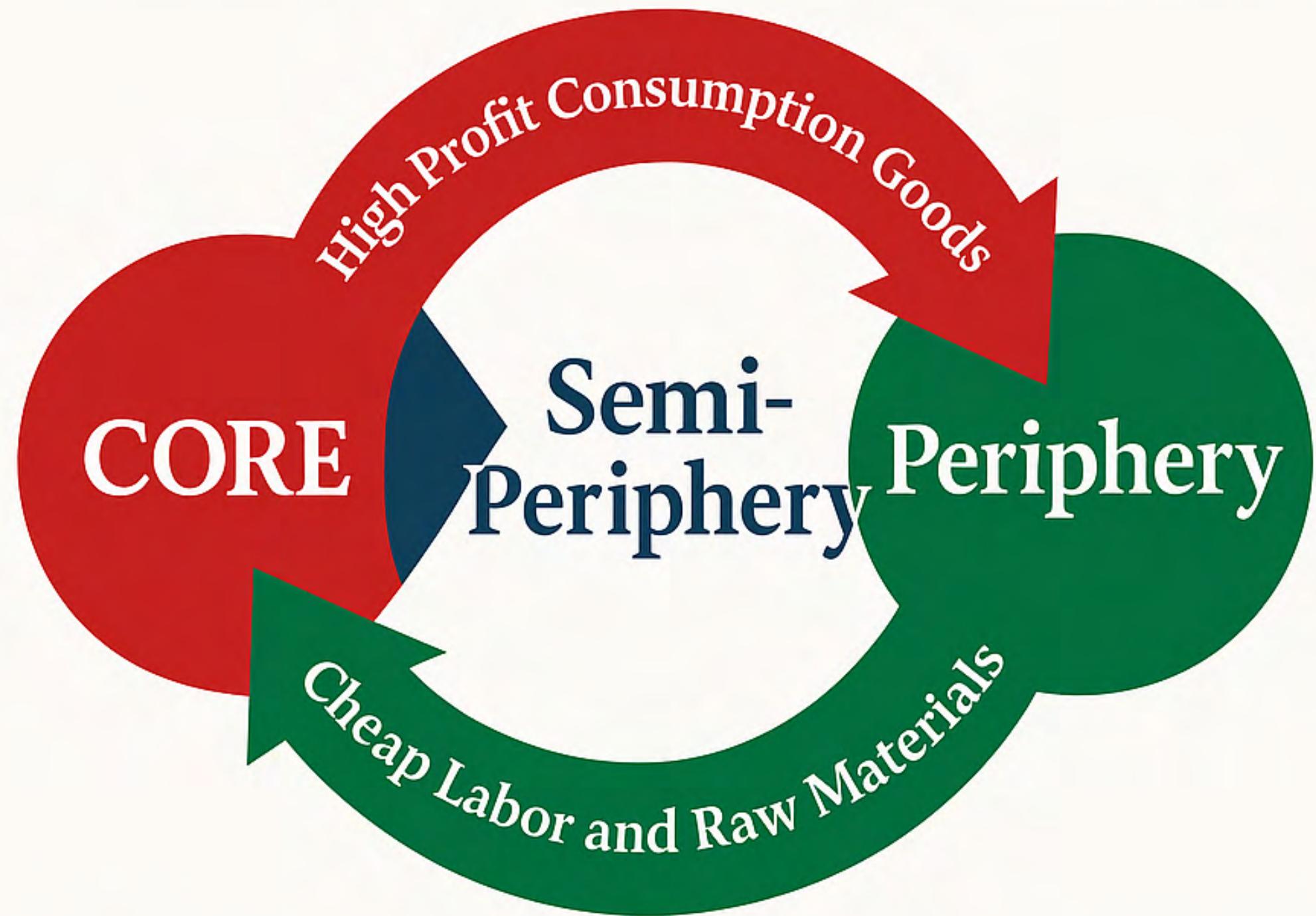


Late 12th-mid  
13th century

(K.Ragkou)

# A World Systems Perspective on the Medieval Eastern Mediterranean

Wallerstein, I., 1974. *The Modern World-System I Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century, With a New Prologue*

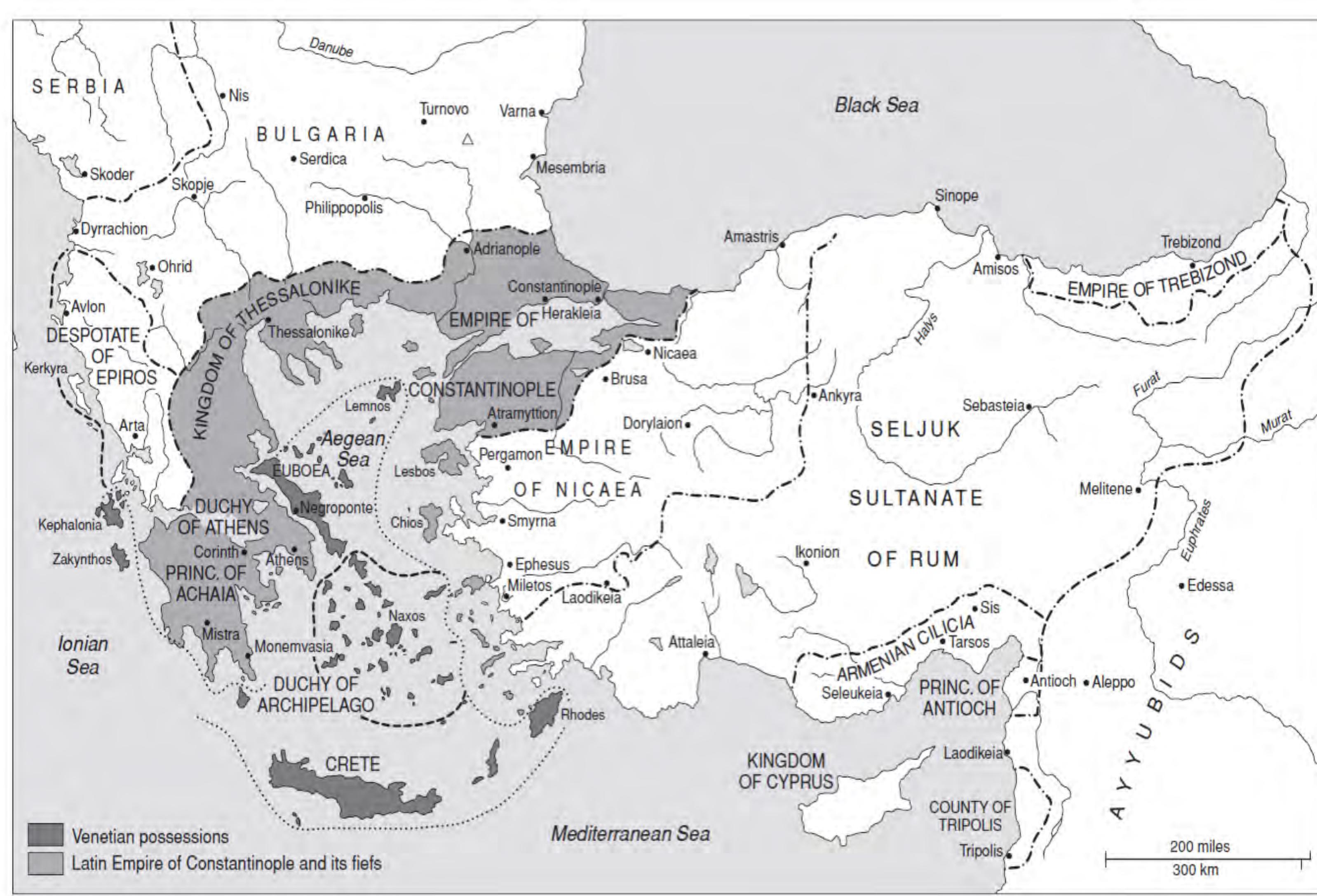


Wallerstein's World-System Theory Model

Zone	Economic Role
Core	High-Skill Capital intensive "industry"
Semi-periphery	Mix of both roles
Periphery	Low-Skill, labor intensive, raw goods

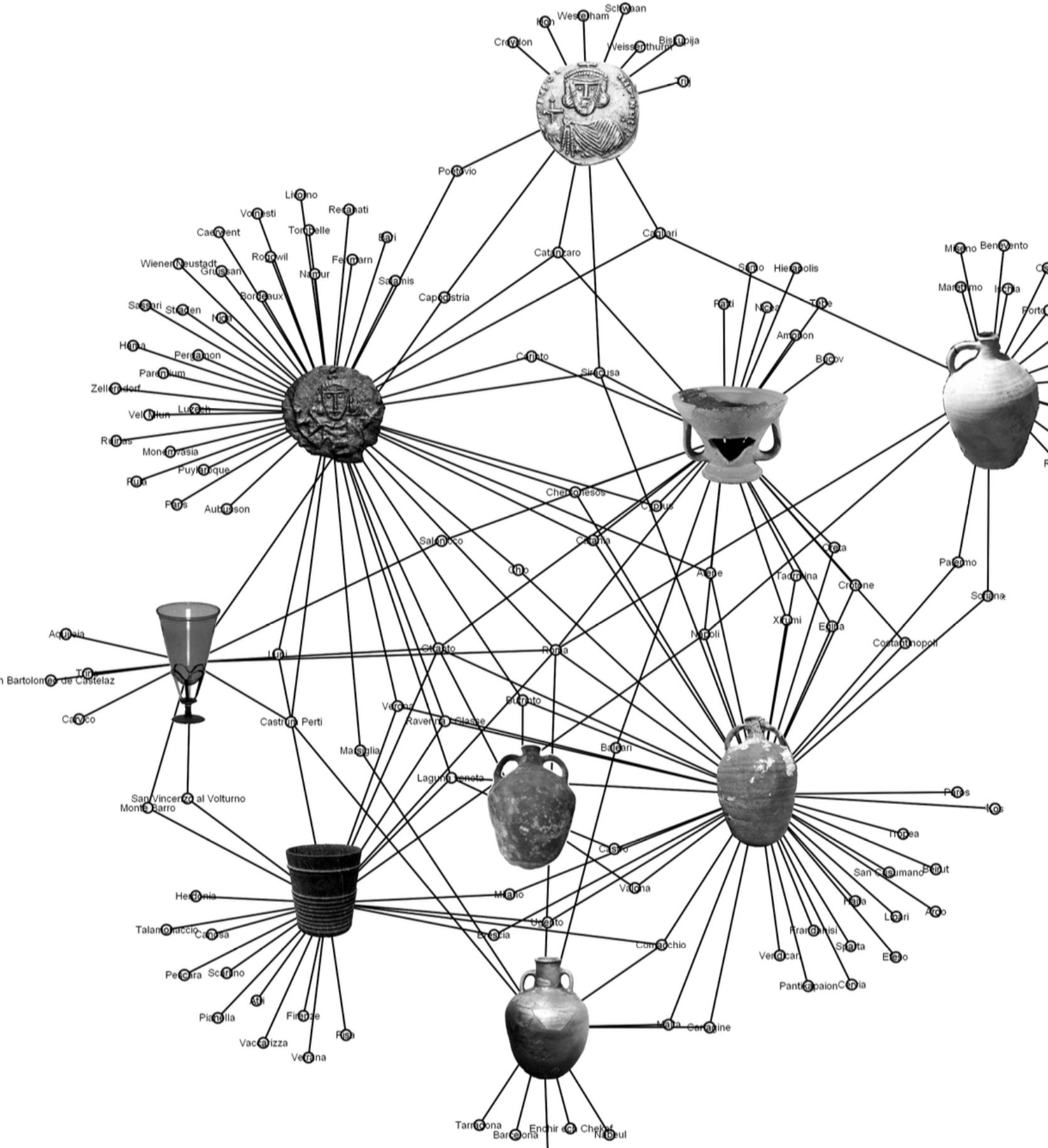
# A World Systems Perspective in the Medieval Eastern Mediterranean

## The Crusader States of the Eastern Mediterranean in the early 13th century



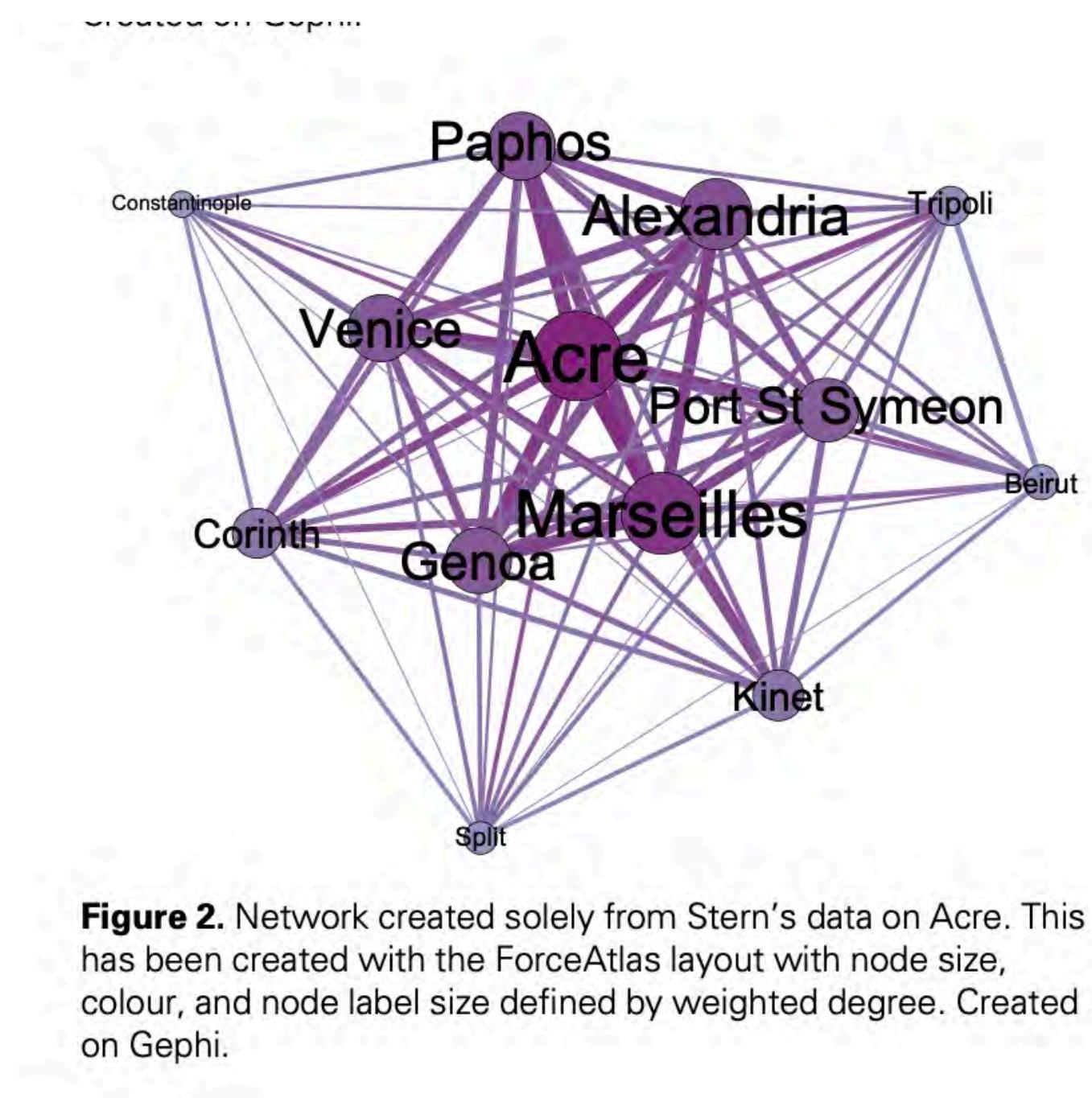
(Gregory 2005: 267)

# Ceramics as Window to Connectivity



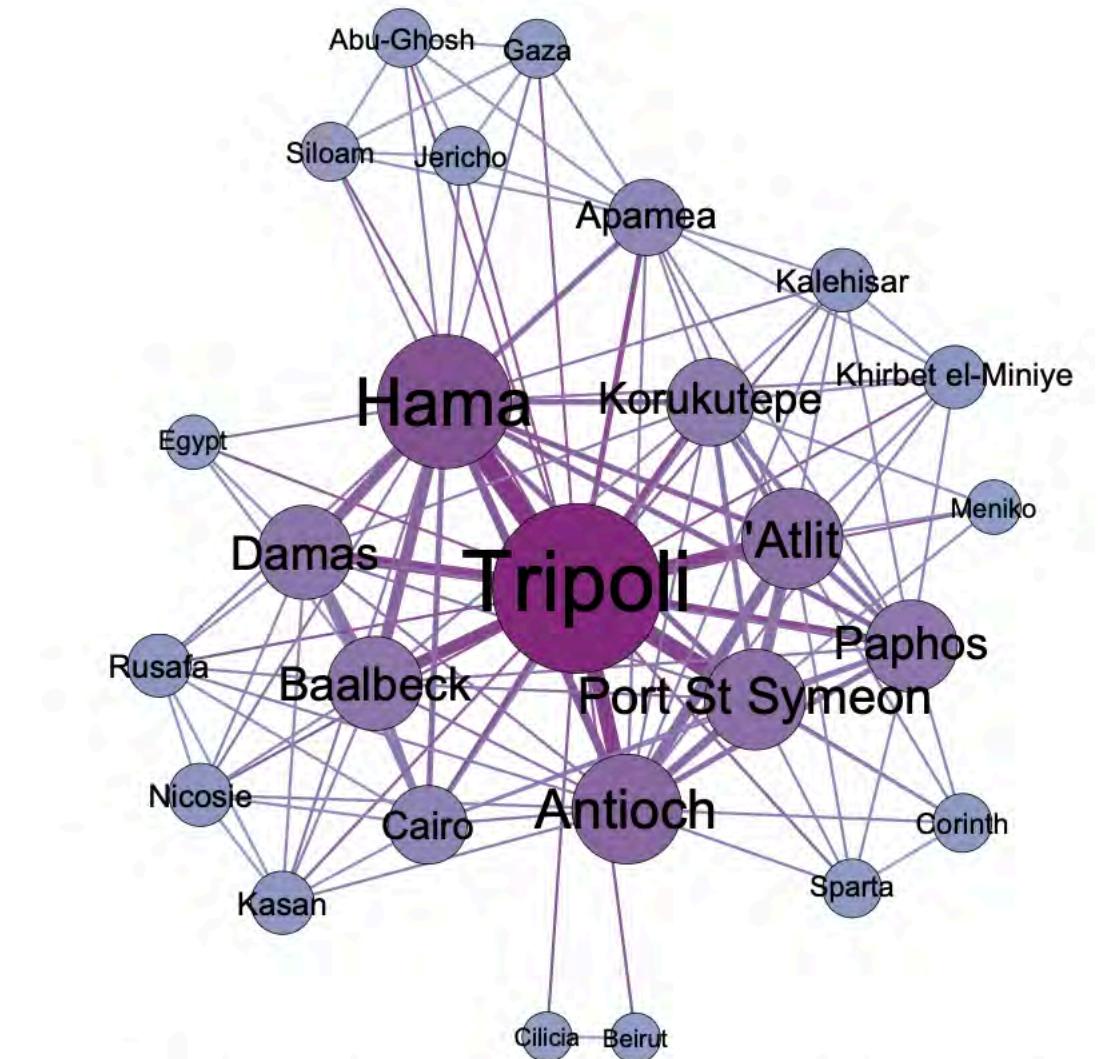
9.2. Bipartite network graph of selected Byzantine artifacts and their site associations.

Arthur 2018.



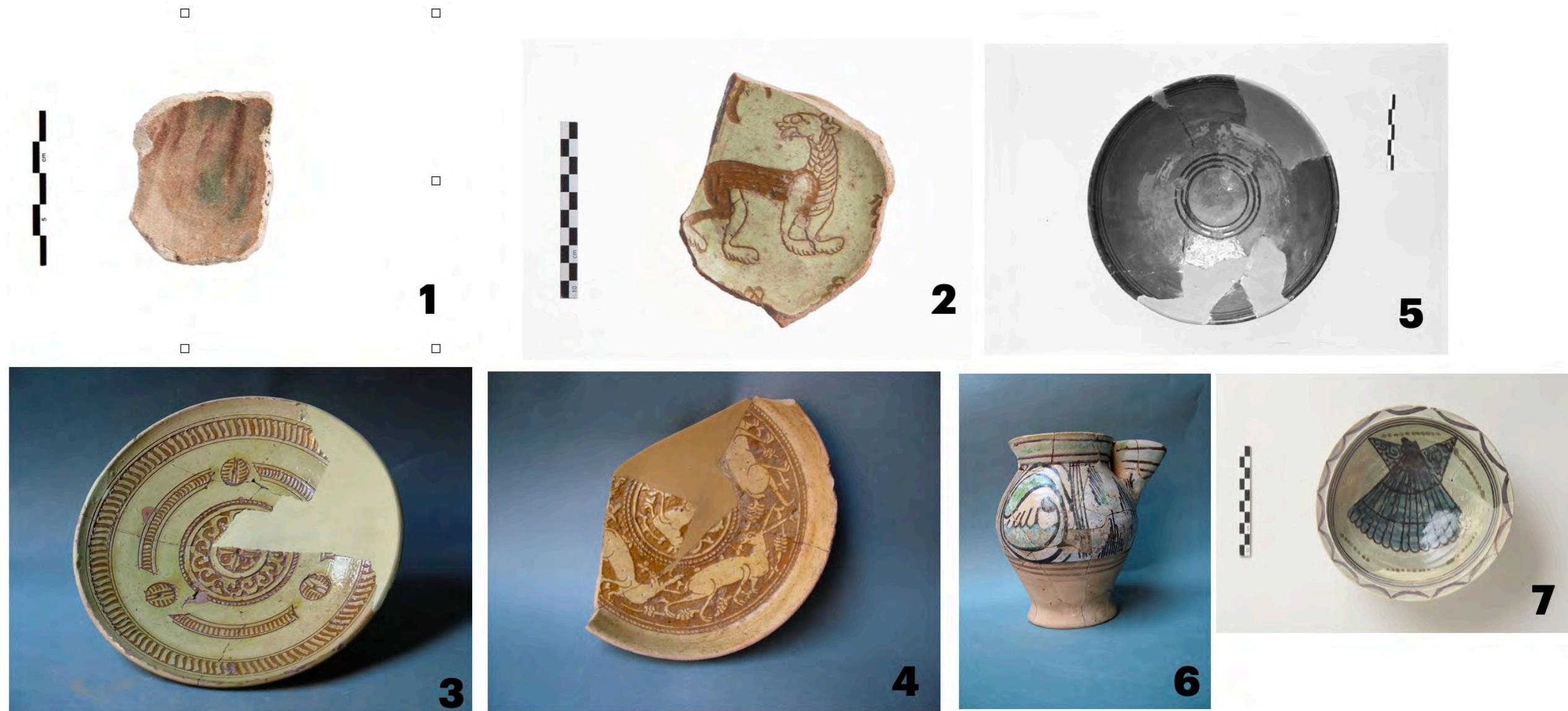
**Figure 2.** Network created solely from Stern's data on Acre. This has been created with the ForceAtlas layout with node size, colour, and node label size defined by weighted degree. Created on Gephi.

Hancock 2023.



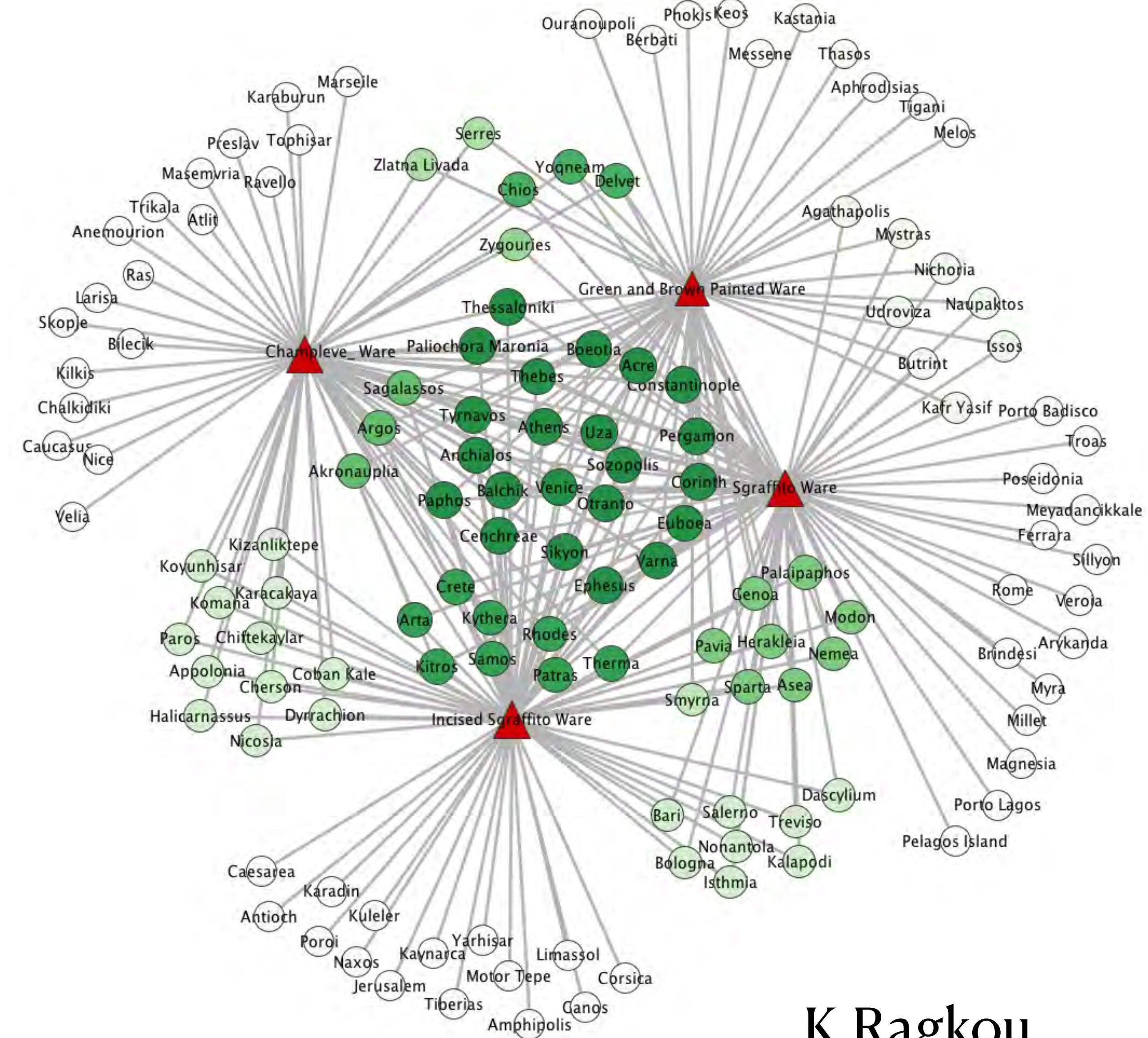
**Figure 3.** Network created solely from Salamé-Sarkis' table of connections for Tripoli, Lebanon. This has been created with the ForceAtlas layout with node size, colour, and node label size defined by weighted degree. Created on Gephi.

# Ceramics as Window to Connectivity



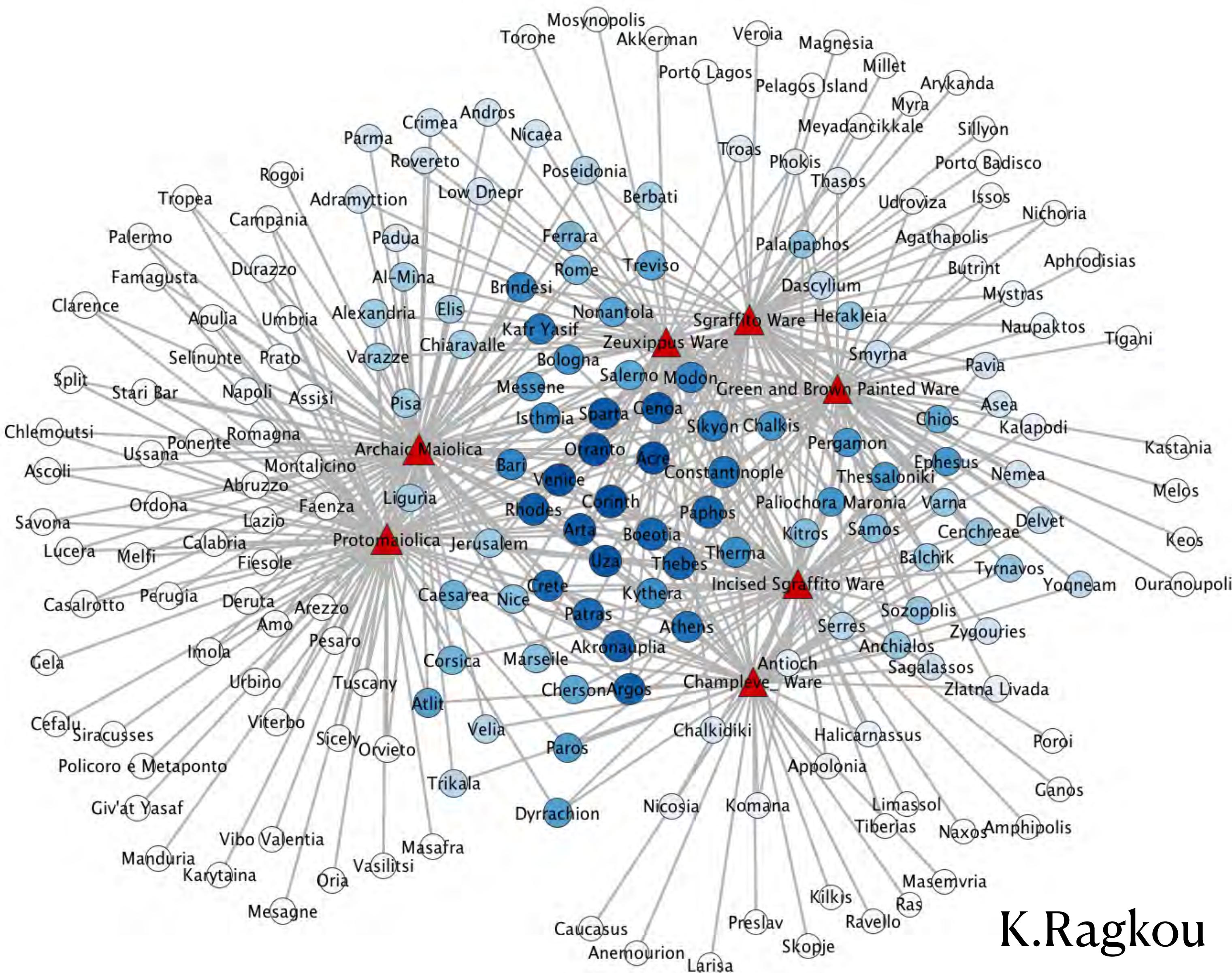
Glazed Wares	Region of Production	Date
1. Green and Brown Painted Ware	Byzantine Empire	Late 11th to early 13th century
2. Fine Sgraffito	Byzantine Empire	Mid-12th to mid-13th century
3. Incised Sgraffito Ware	Byzantine Empire	Late 12th to mid-13th century
4. Champlevé Ware	Byzantine Empire	Late 12th to mid-13th century
5. Zeuxippus Ware	Byzantine Empire	Mid-13th to early 14th century
6. Protomaiolica	Italy	Second quarter of the 13th to mid-14th century
7. Archaic Maiolica	Italy	Mid 13th to mid-14th century

# Ceramics as Window to Connectivity

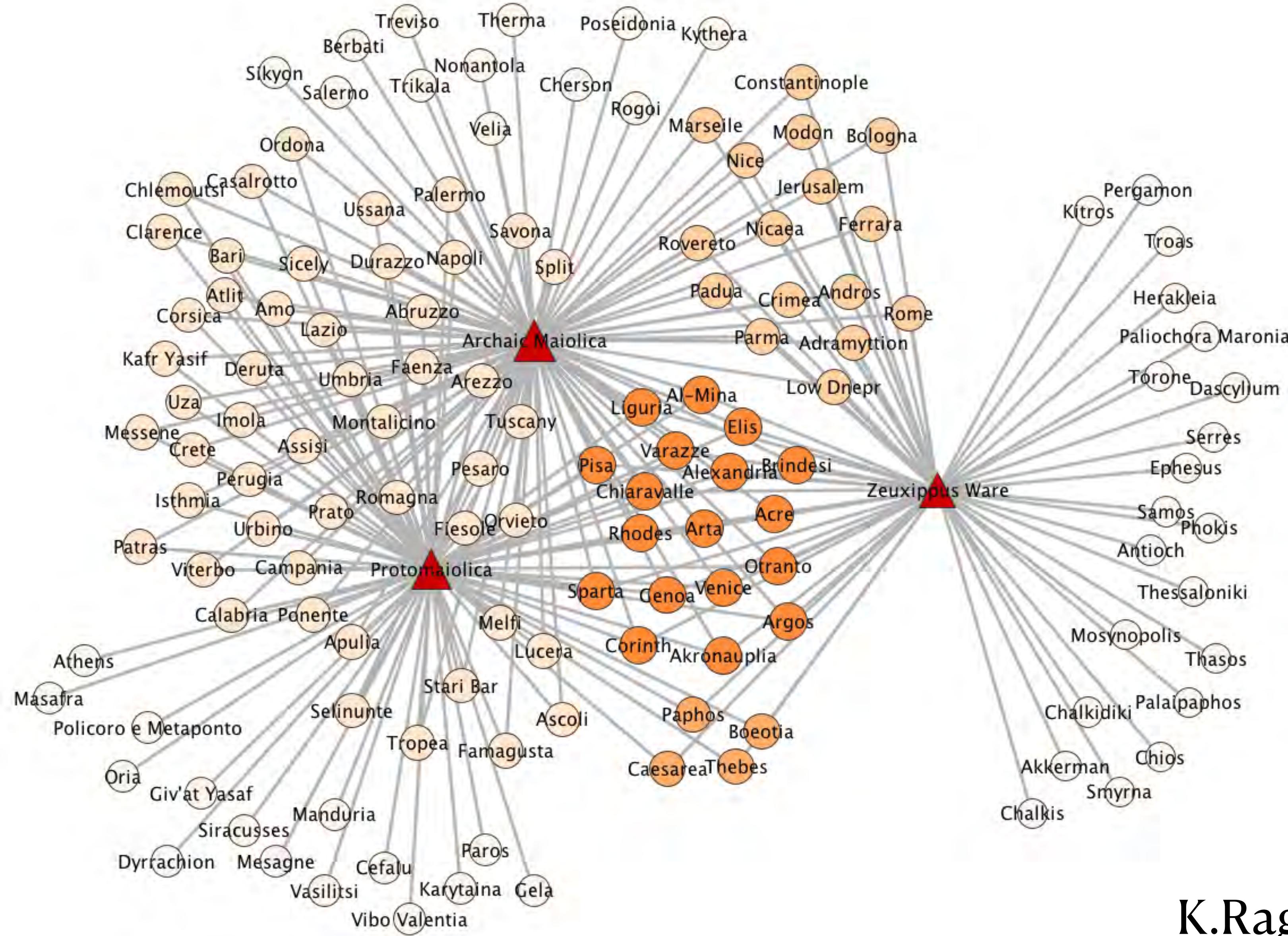


K.Ragkou

# Ceramics as a Window to Connectivity

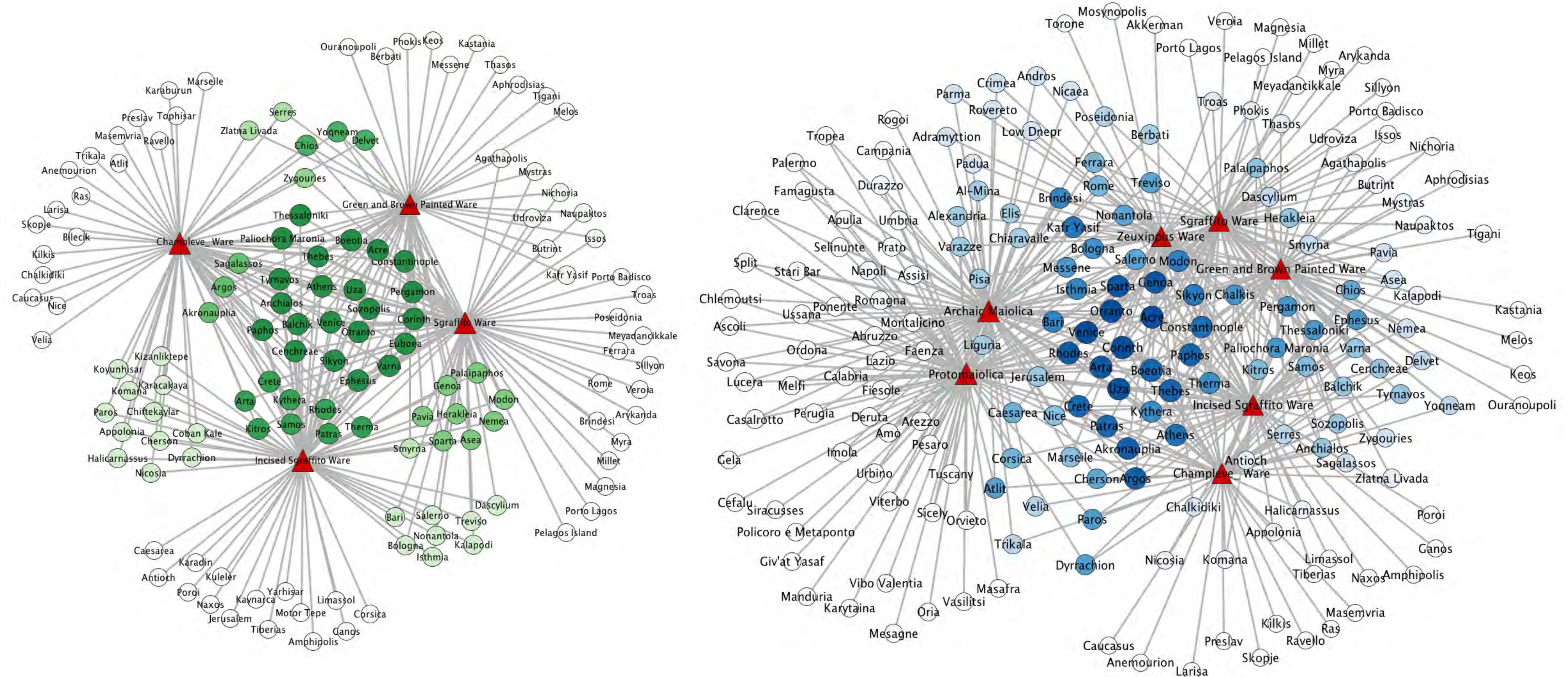


# Ceramics as a Window to Connectivity



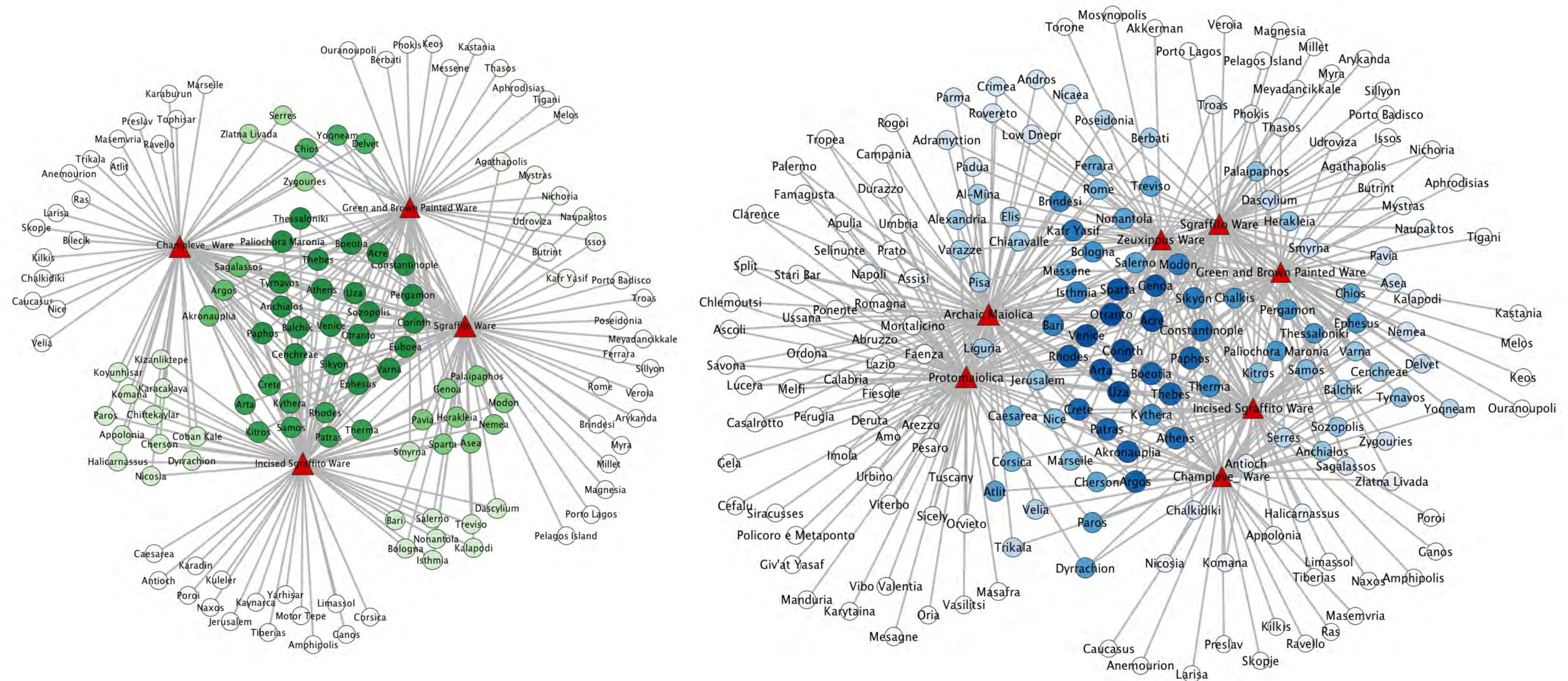
K.Ragkou

# Ceramics as Window to Connectivity



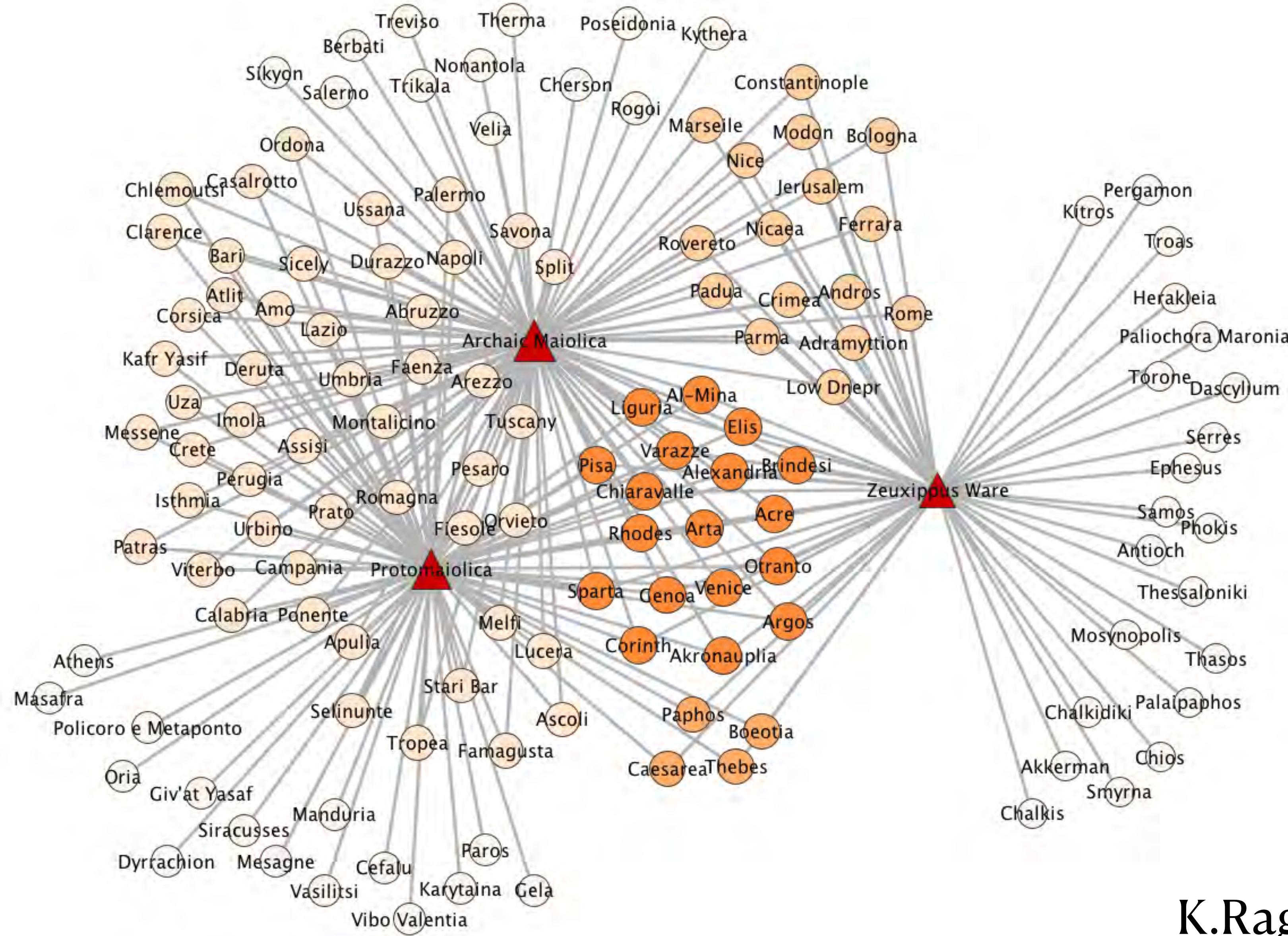
K.Ragkou

# Ceramics as Window to Connectivity



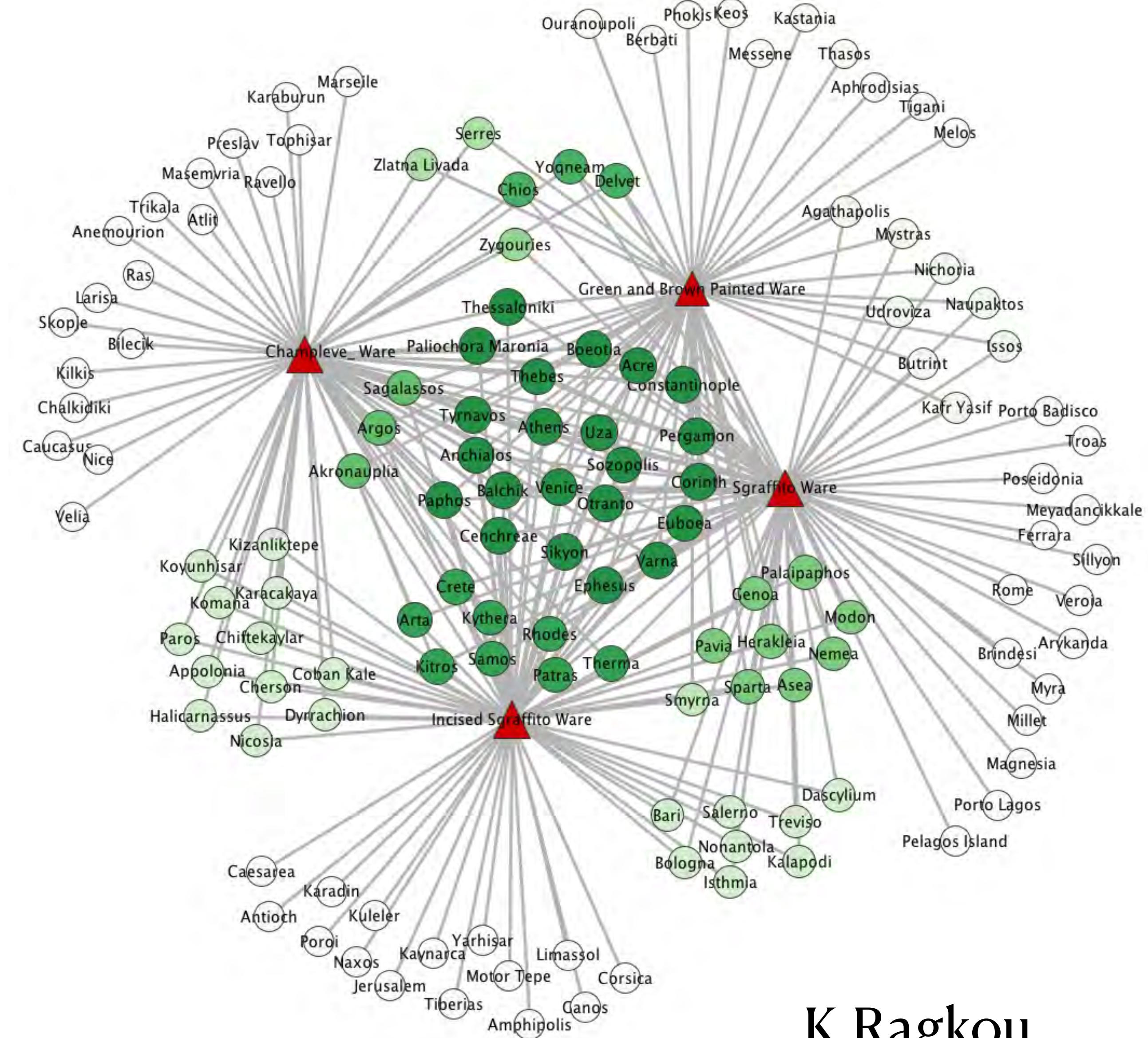
K.Ragkou

# Ceramics as a Window to Connectivity



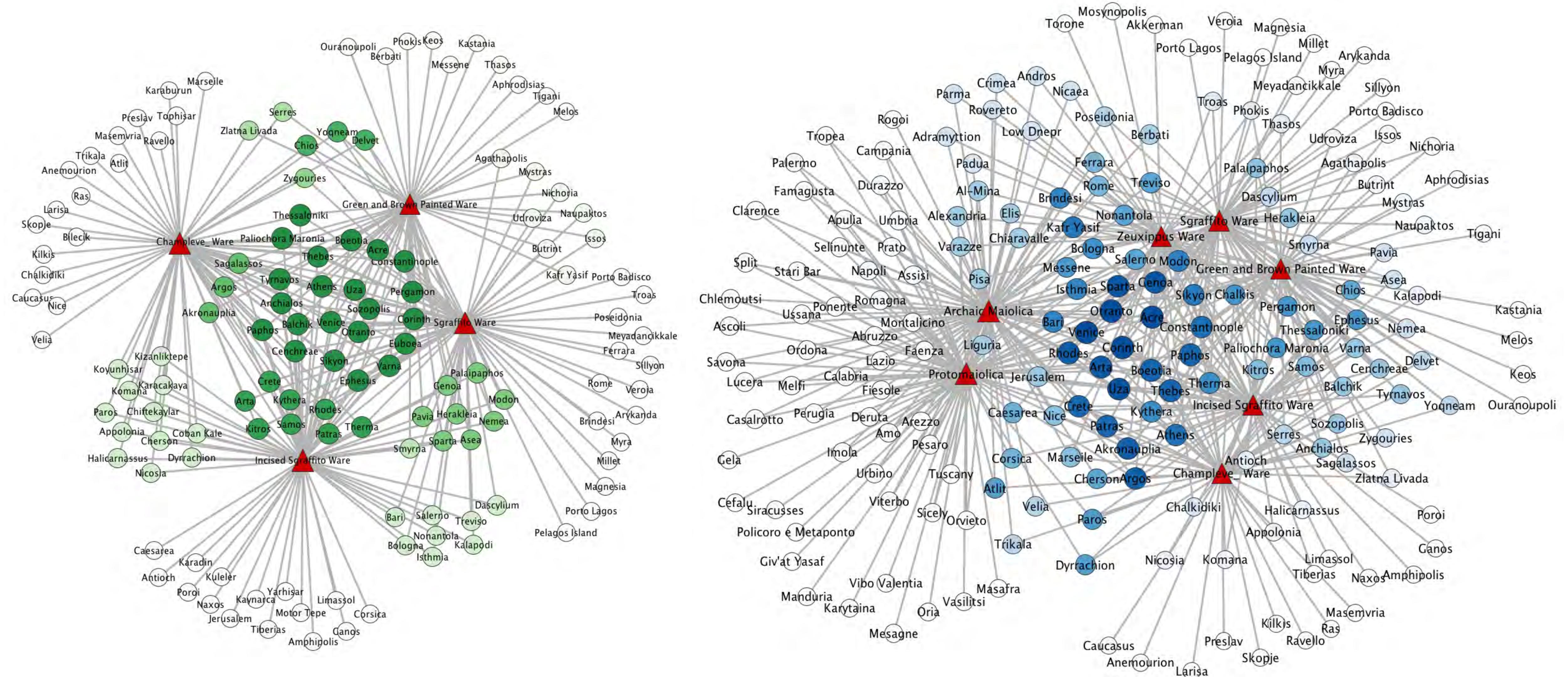
K.Ragkou

# Ceramics as Window to Connectivity



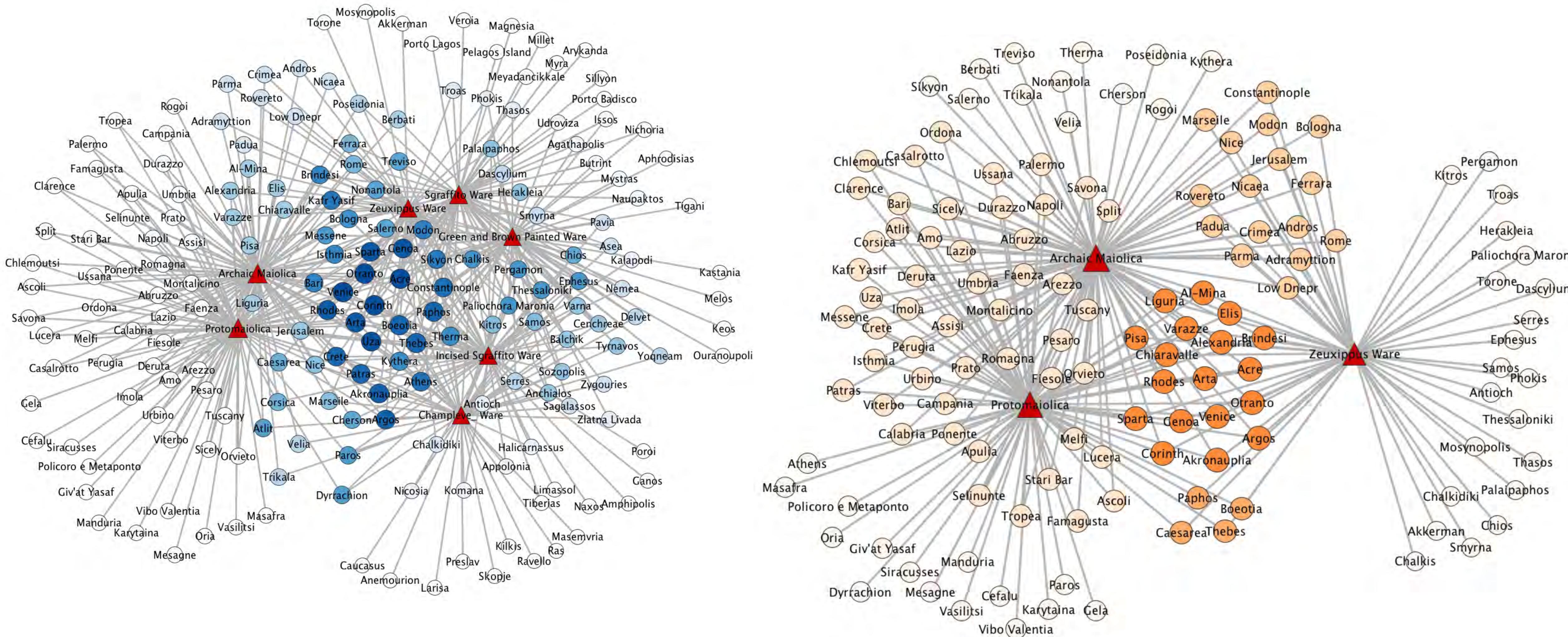
K.Ragkou

# Ceramics as Window to Connectivity

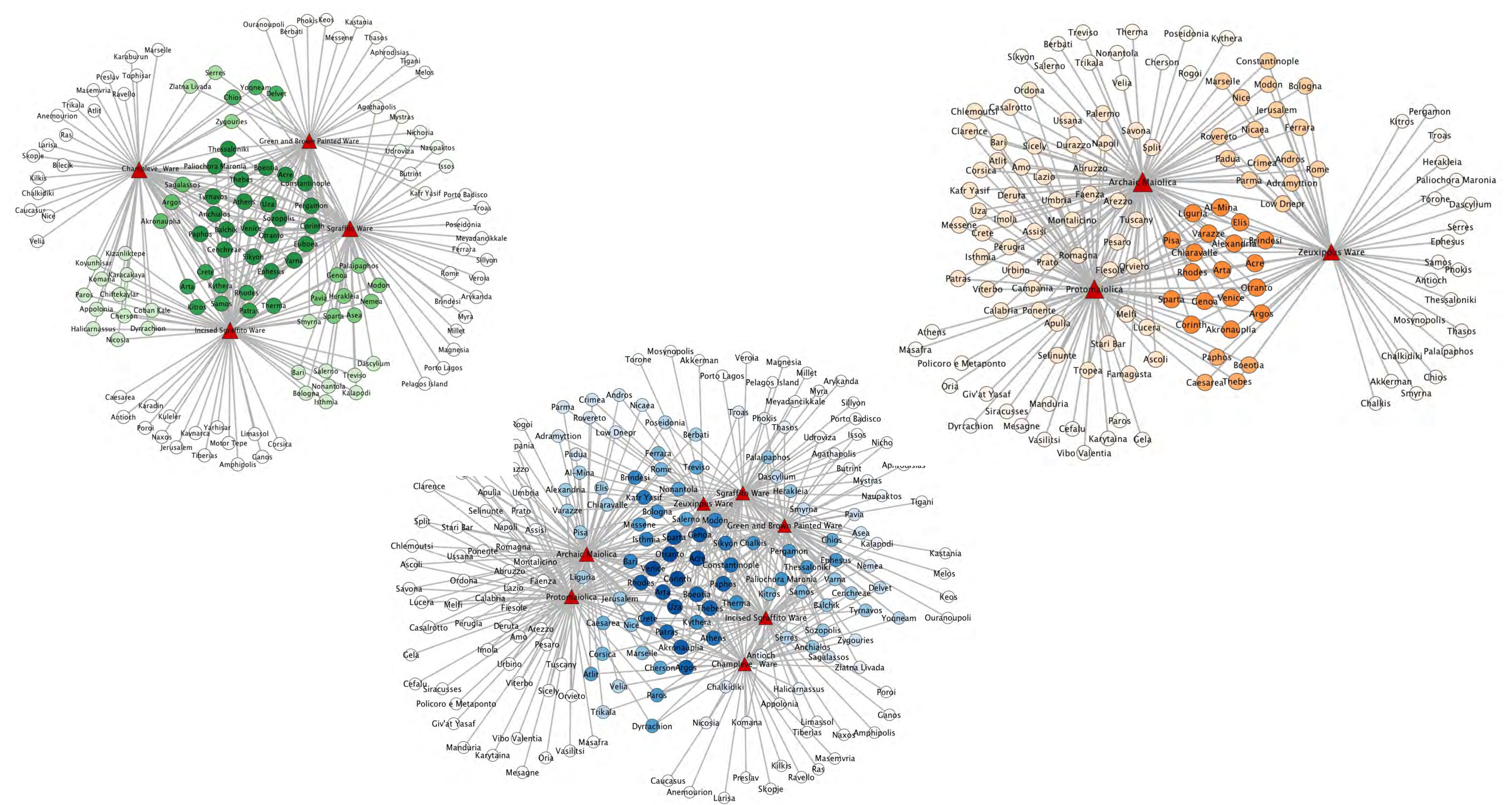


K.Ragkou

# Ceramics as Window to Connectivity



K.Ragkou



# K.Ragkou

# Final Remarks: Ceramics as a Window to Connectivity

## Key Findings:

- Byzantine Dominance: Initially, the network reveals a Byzantine-dominated system, with Constantinople as a central hub. Key Byzantine centers include Corinth, Thebes, Sagalassos, Ephesus, and Uza. Figure 7 illustrates Constantinople's high centrality.
- The 1204 Shift: The pivotal events of 1204 mark a transition to a more fragmented system, with the rise of Italian maritime powers.
- Italian Ascendancy: The centrality shifts from Constantinople to Venice (Figures 7 & 8), demonstrating the growing influence of Venice and Genoa. Italian and Crusader ports like Otranto, Brindisi, Acre, and Ellis become more important.
- Crusader States: Crusader states like Acre and Ellis became reliant on connections to core regions like Venice for ceramic distribution (Figure 9).
- Regional Trade: Smaller, often overlooked sites played a crucial role in facilitating regional trade.

## Methodological Considerations:

- The interpretations are shaped by uneven archaeological research and data preservation challenges.
- Network models represent connections between artifacts, not traders, thus not capturing the full complexity of human agency.
- Focusing on pottery distribution provides tangible evidence of changing trade patterns.
- Theoretical Framework:
  - The study integrates world-system theory to understand the evolving relationships between core, periphery, and semi-periphery regions.

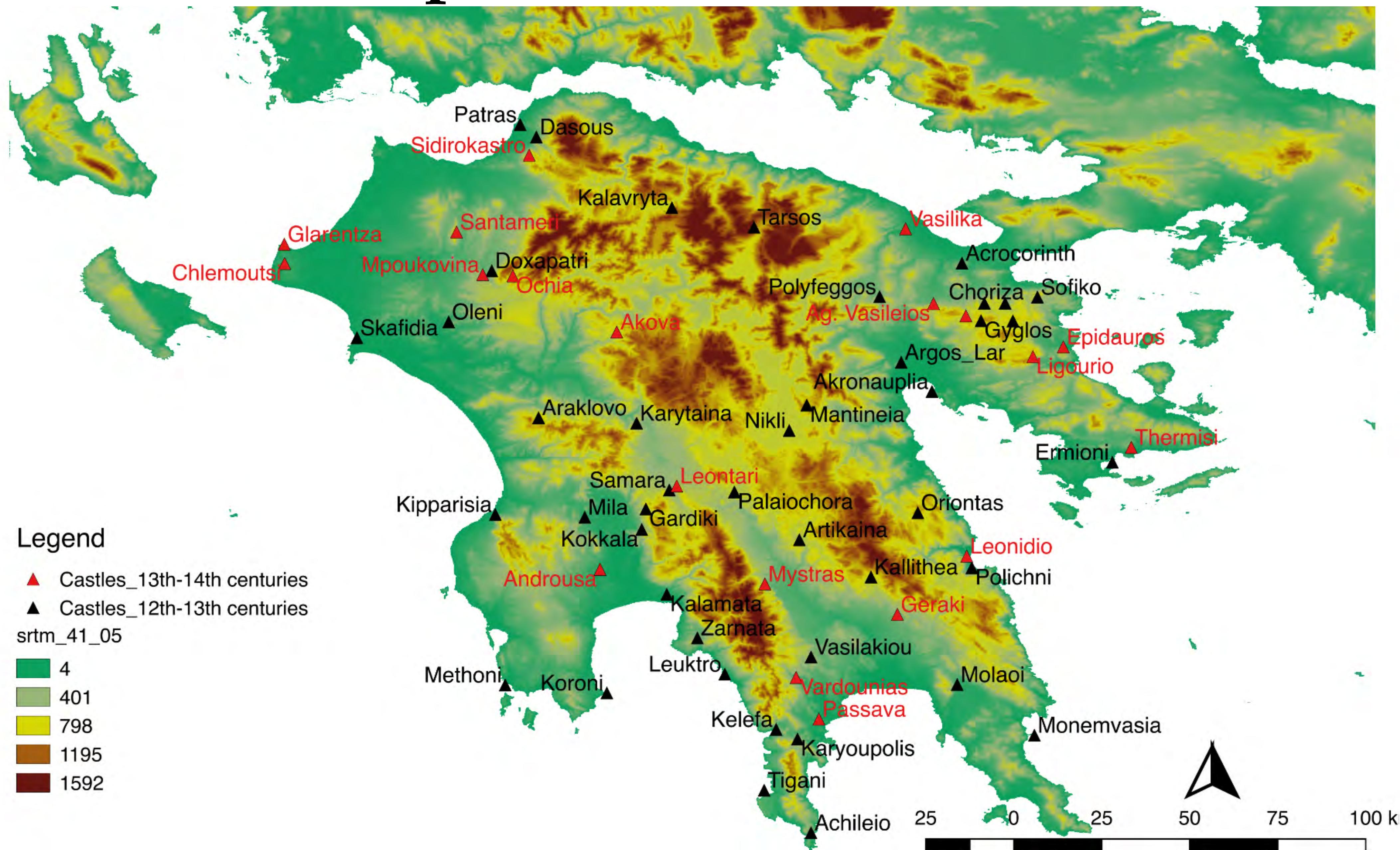
## Conclusion:

- This interdisciplinary approach highlights the interconnectedness of trade, politics, and material culture in shaping the Medieval Eastern Mediterranean.

## Future Research:

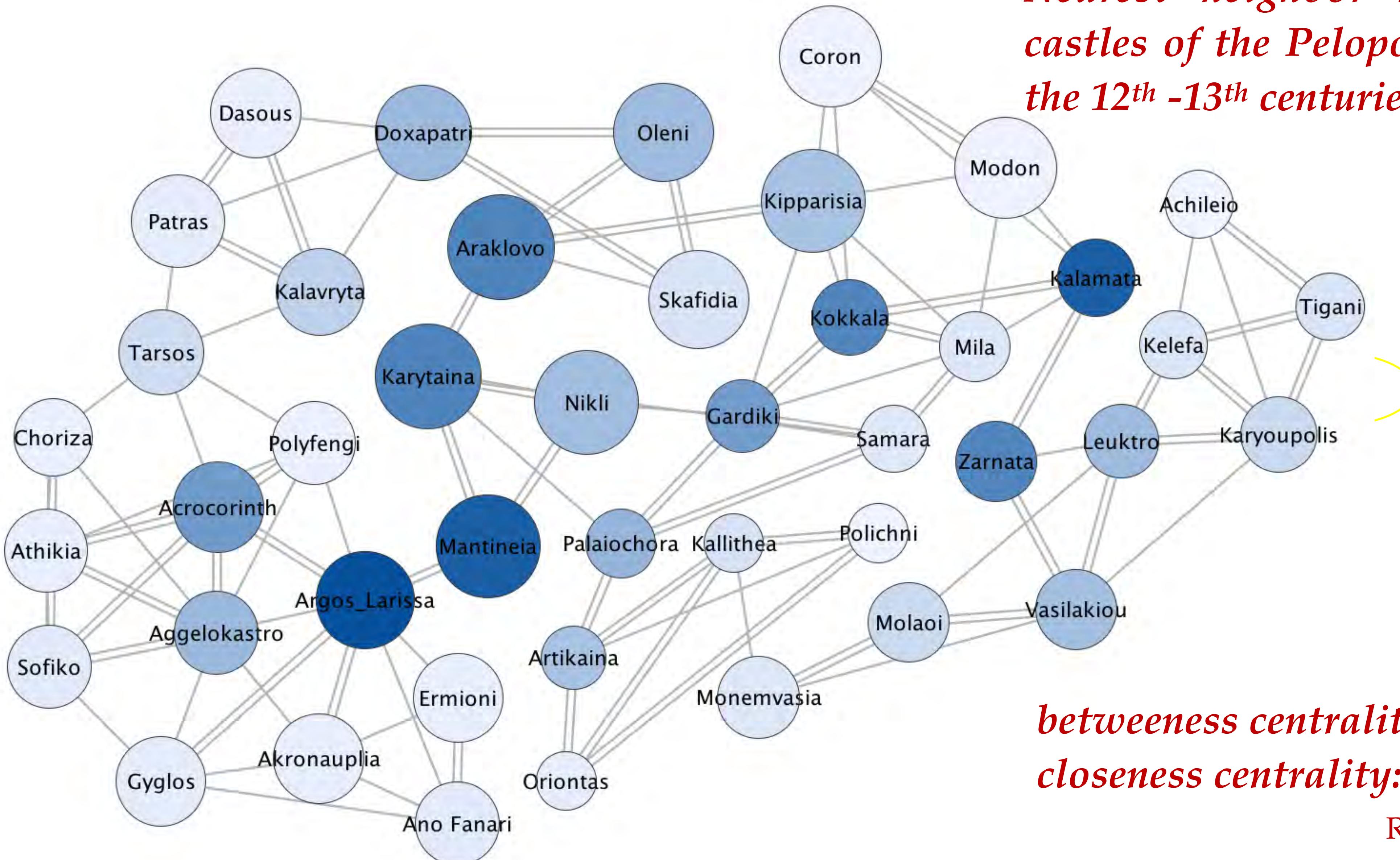
- Future research could incorporate additional datasets, such as coin distributions or textual evidence, to further refine our understanding of trade dynamics and directional flows.

# Spatial Networks



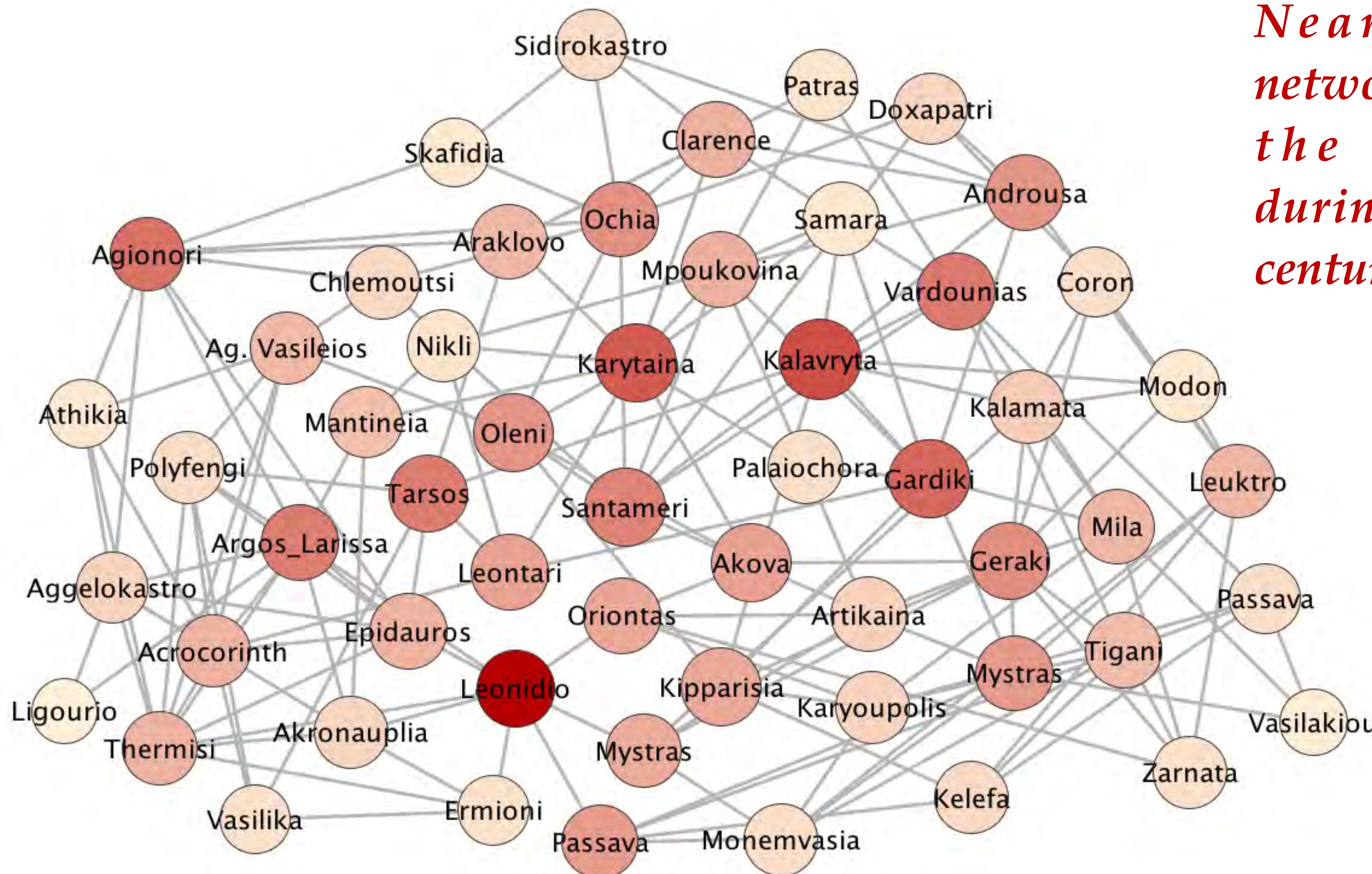
# Spatial Networks: model of Interaction and exchange based on the location of the castles

*Nearest neighbor networks of castles of the Peloponnese during the 12<sup>th</sup> -13<sup>th</sup> centuries*



*betweeness centrality: colour  
closeness centrality: size*

# Spatial Networks: model of Interaction and exchange based on the location of the castles

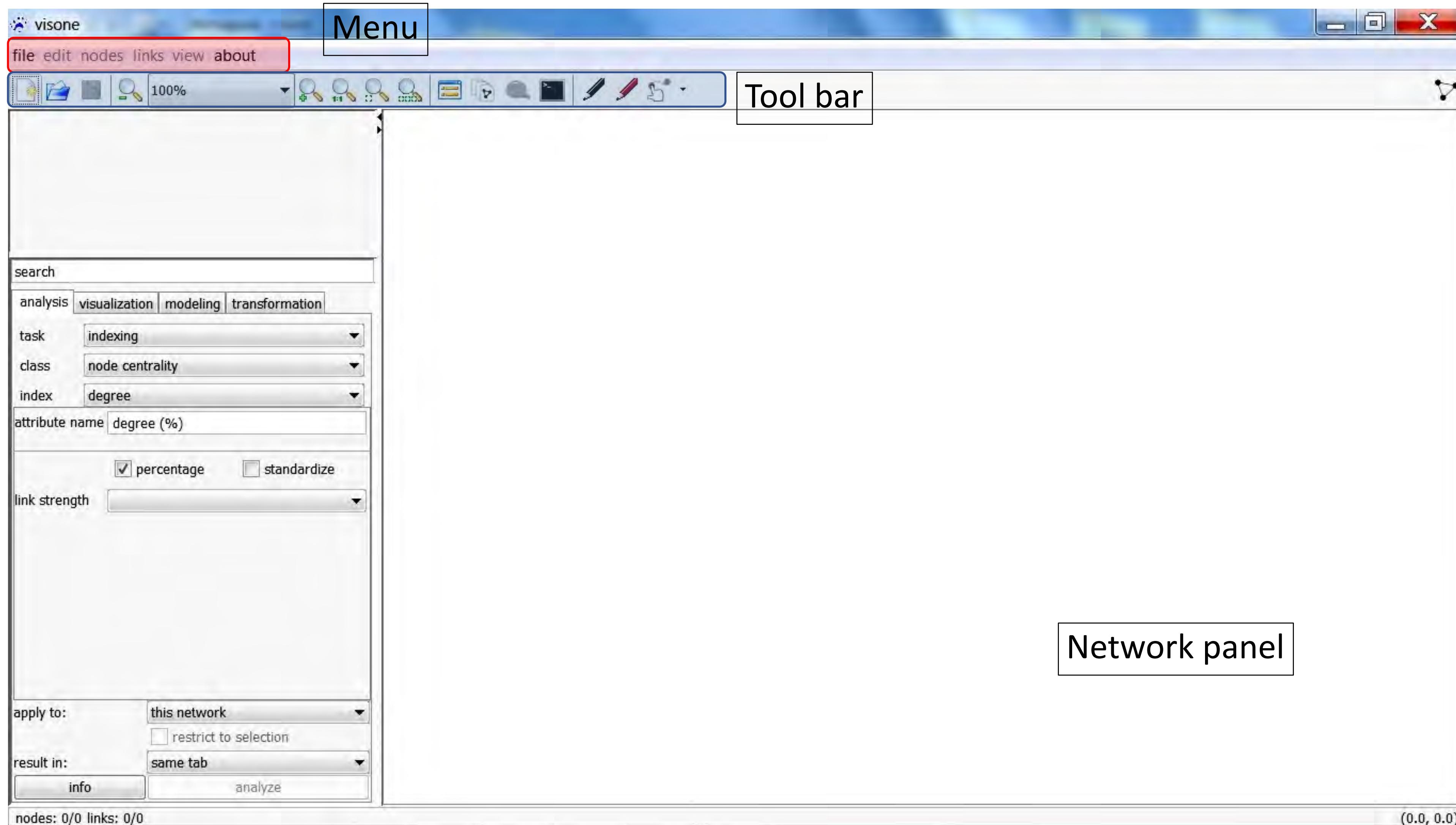


*Nearest neighbor networks of castles of the Peloponnesian during the 13<sup>th</sup>-14<sup>th</sup> centuries*

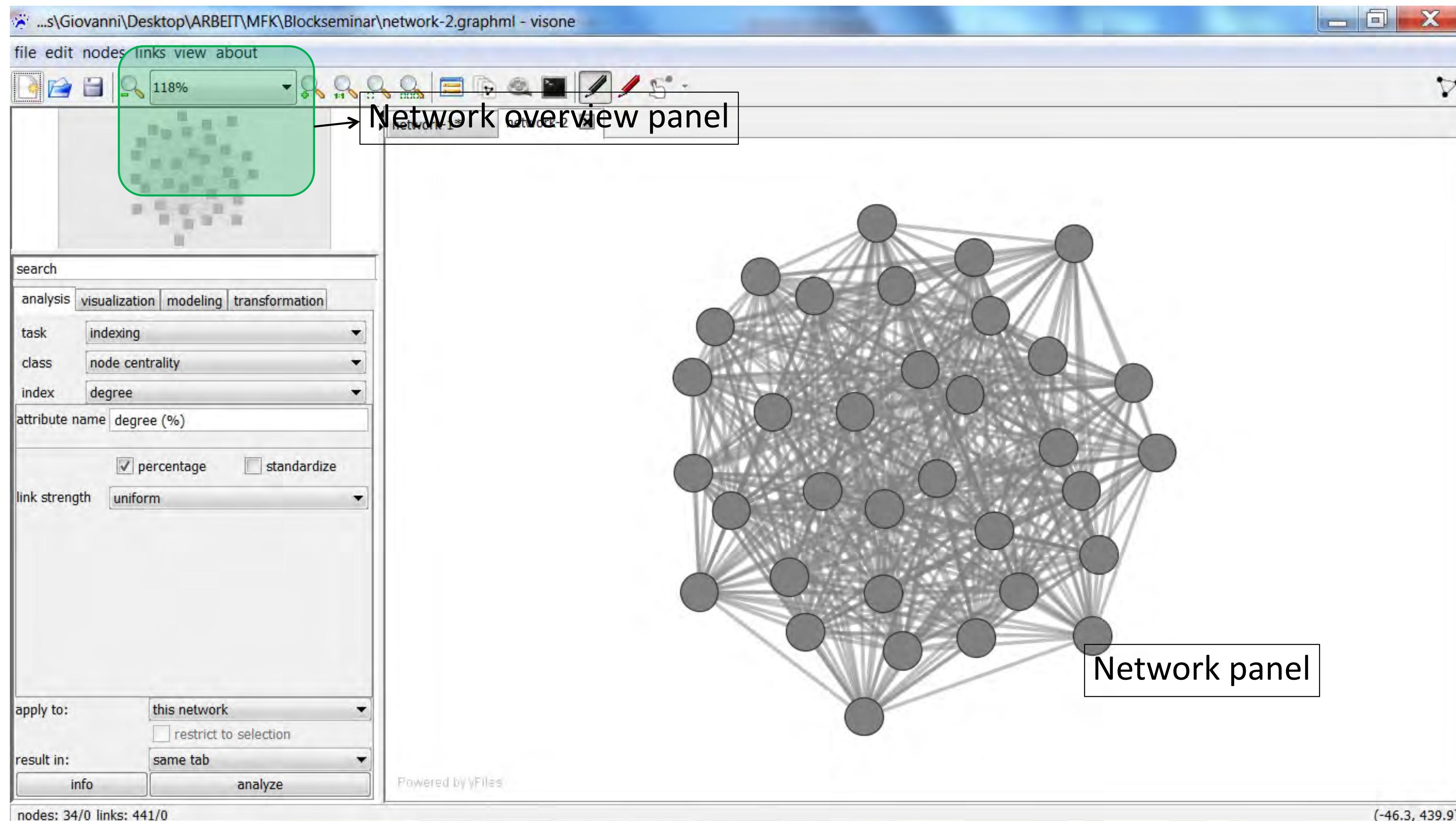
*betweeness  
centrality: colour  
closeness  
centrality: size*

# **Visone Interface: Where is what**

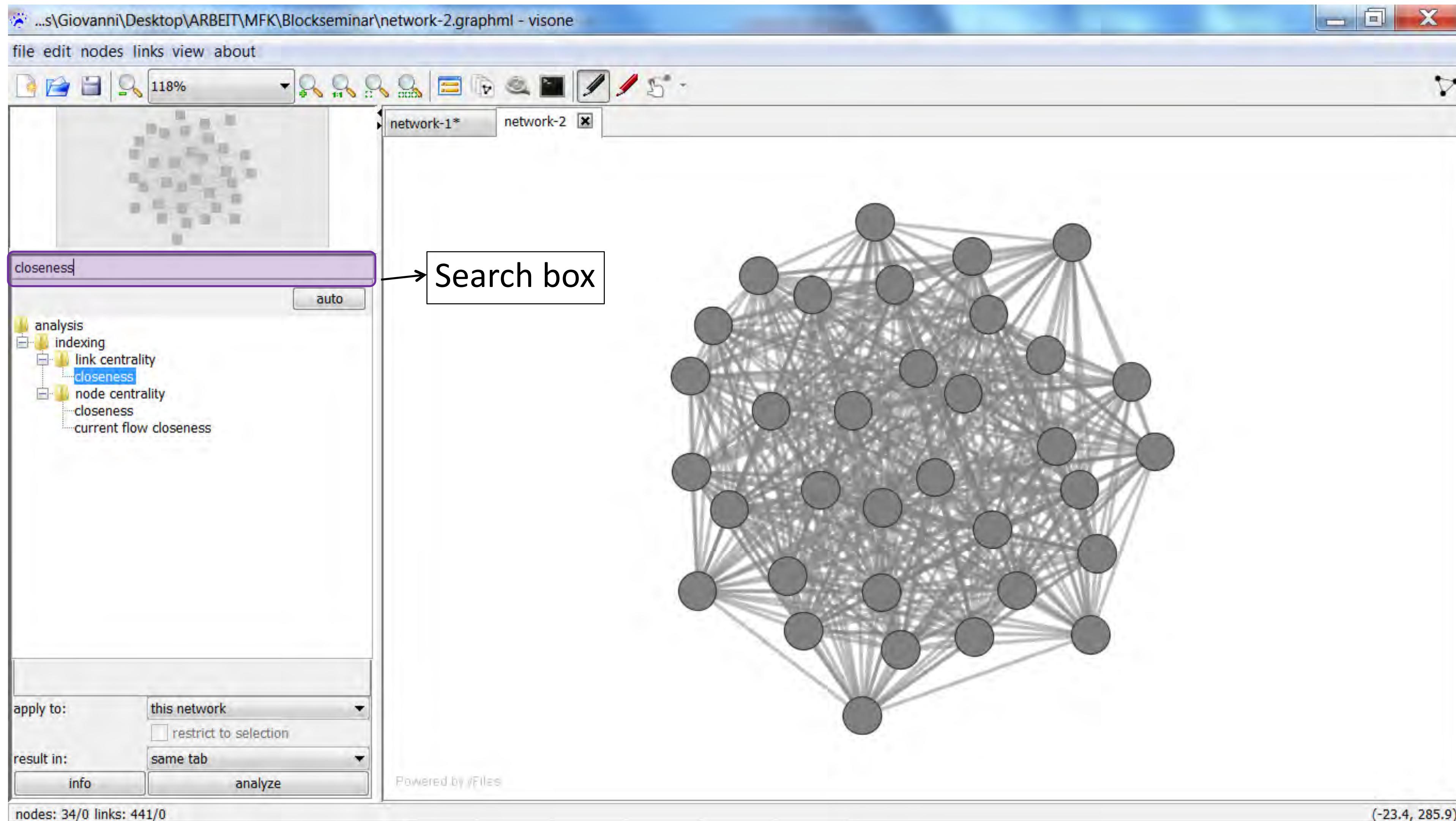
# General Overview: Menu- Tool bar and Network panel



# General Overview: Network overview panel



# General Overview: Search Box



# General Overview: Tabs, Tab panel, Control panel

...s\Giovanni\Desktop\ARBEIT\MFK\Blockseminar\network-2.graphml - visone

file edit nodes links view about

118%

network-1\* network-2

**TABS**

analysis visualization modeling transformation

task grouping

class clustering

measure girvan newman clustering (GNC)

to attribute

attribute name girvan newman clustering (GNC)

create group nodes

group node name group name

complete hierarchy

edge order attribute

attribute name GNC-edge order

apply to: this network  restrict to selection

result in: same tab

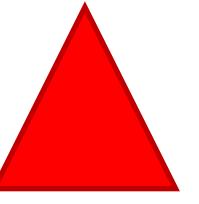
info analyze

Powered by jFiles

nodes: 34/1 links: 441/0 (-165.6, 243.6)

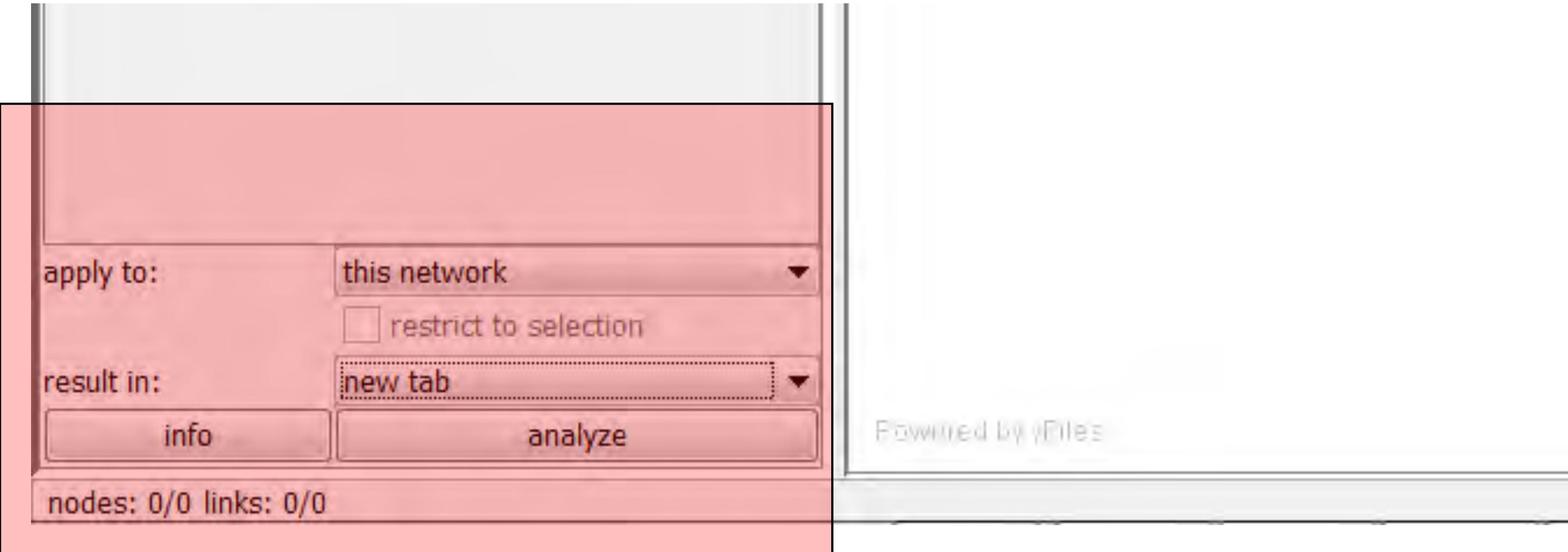
The screenshot displays the visone software interface for network analysis. At the top, the title bar shows the file path "...s\Giovanni\Desktop\ARBEIT\MFK\Blockseminar\network-2.graphml - visone". Below the title bar is a menu bar with options: file, edit, nodes, links, view, and about. A toolbar follows, containing icons for file operations like open, save, and print, as well as zoom controls and search functions. The main workspace is divided into two tabs: "network-1\*" and "network-2". The "network-2" tab is active, showing a complex network graph with numerous nodes (represented by gray circles) and edges (represented by thin gray lines). To the left of the graph is a "Tab panel" containing several tabs: "analysis" (which is selected and highlighted in yellow), "visualization", "modeling", and "transformation". Below these tabs are various configuration options: "task" set to "grouping", "class" set to "clustering", and "measure" set to "girvan newman clustering (GNC)". Other settings include "to attribute" checked, "attribute name" "girvan newman clustering (GNC)", "create group nodes" checked, "group node name" "group name", "complete hierarchy" unchecked, "edge order attribute" checked, and "attribute name" "GNC-edge order". At the bottom of the panel are "apply to:" dropdowns set to "this network" and "restrict to selection" unchecked, and "result in:" dropdown set to "same tab". Buttons for "info" and "analyze" are also present. The status bar at the bottom provides network statistics: "nodes: 34/1 links: 441/0" and coordinates "(-165.6, 243.6)".

## Attention

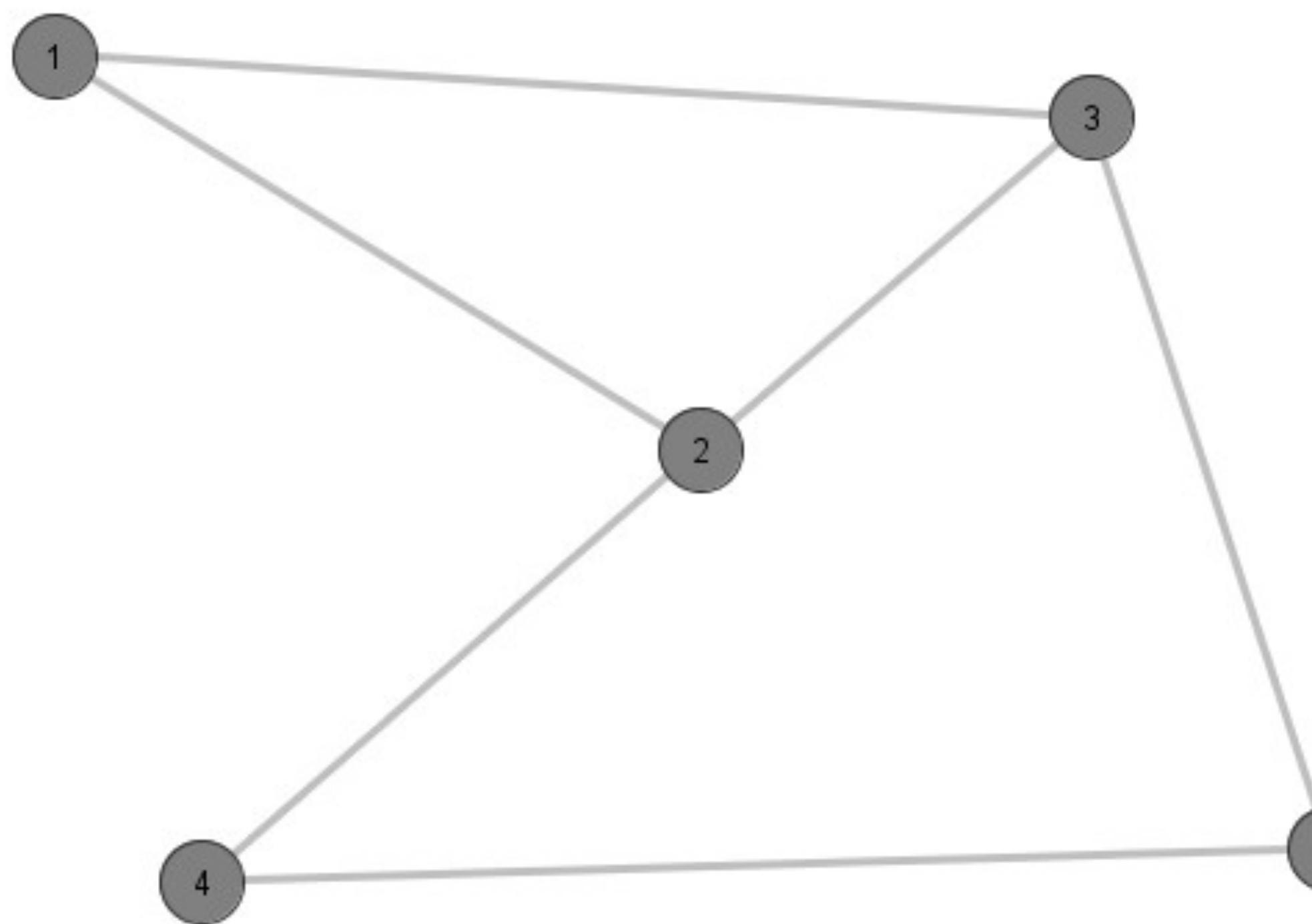


### Visone does not have an UNDO-REDO function

If you do not want to start everything a new if you do something wrong, it would be better to save intermediate phases of your work and /or save change in a new tab, instead to overwrite the active network



## How to format data



ADIACENCY LIST (directed)

```
1, 2, 3  
2, 1, 3, 4  
3, 1, 2, 5  
4, 2, 5  
5, 3, 4
```

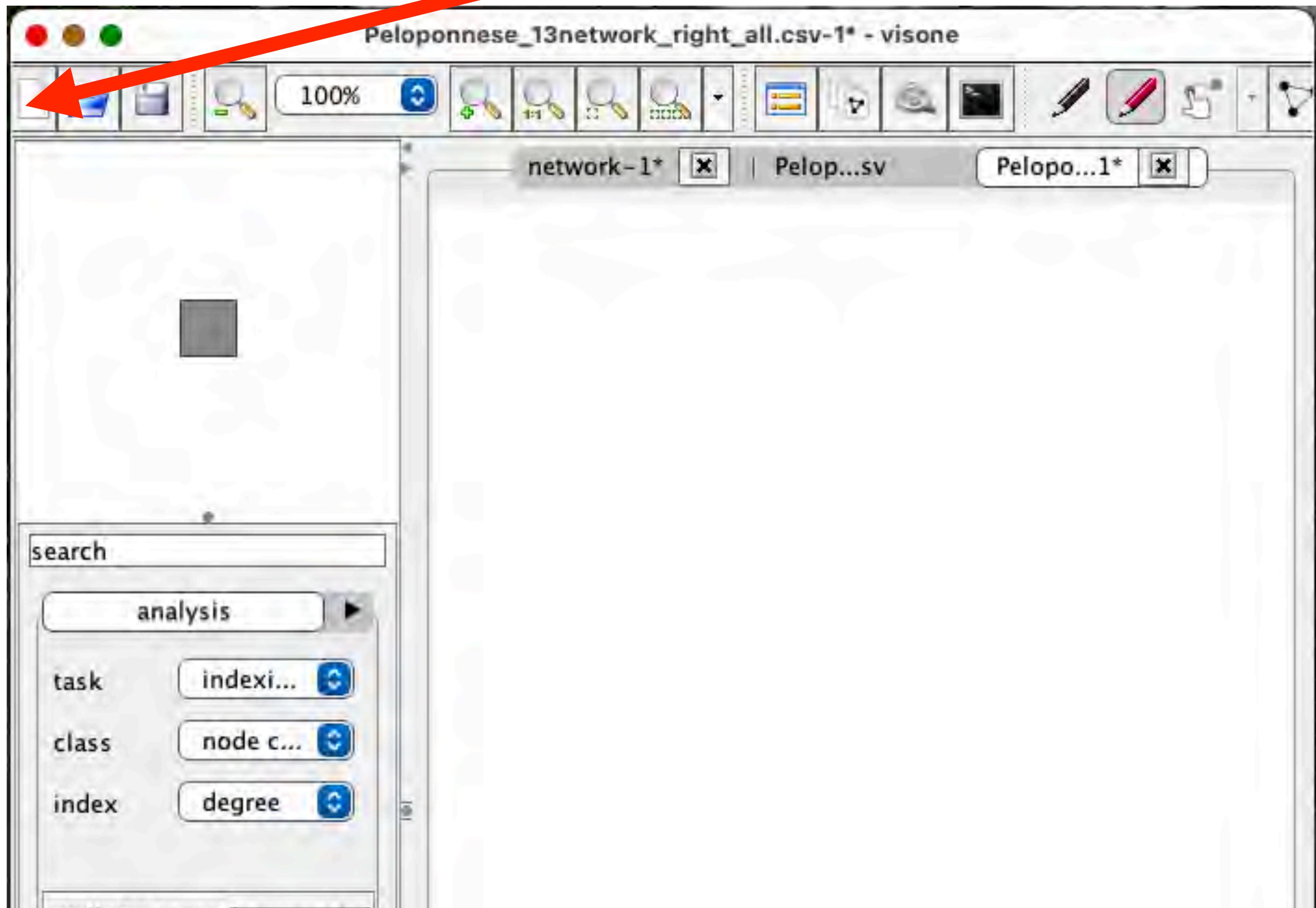
ADIACENCY MATRIX

1 , 2 , 3 , 4 , 5
1 , 0 , 1 , 1 , 0 , 0
2 , 1 , 0 , 1 , 1 , 0
3 , 1 , 1 , 0 , 0 , 1
4 , 0 , 1 , 0 , 0 , 1
5 , 0 , 0 , 1 , 1 , 0

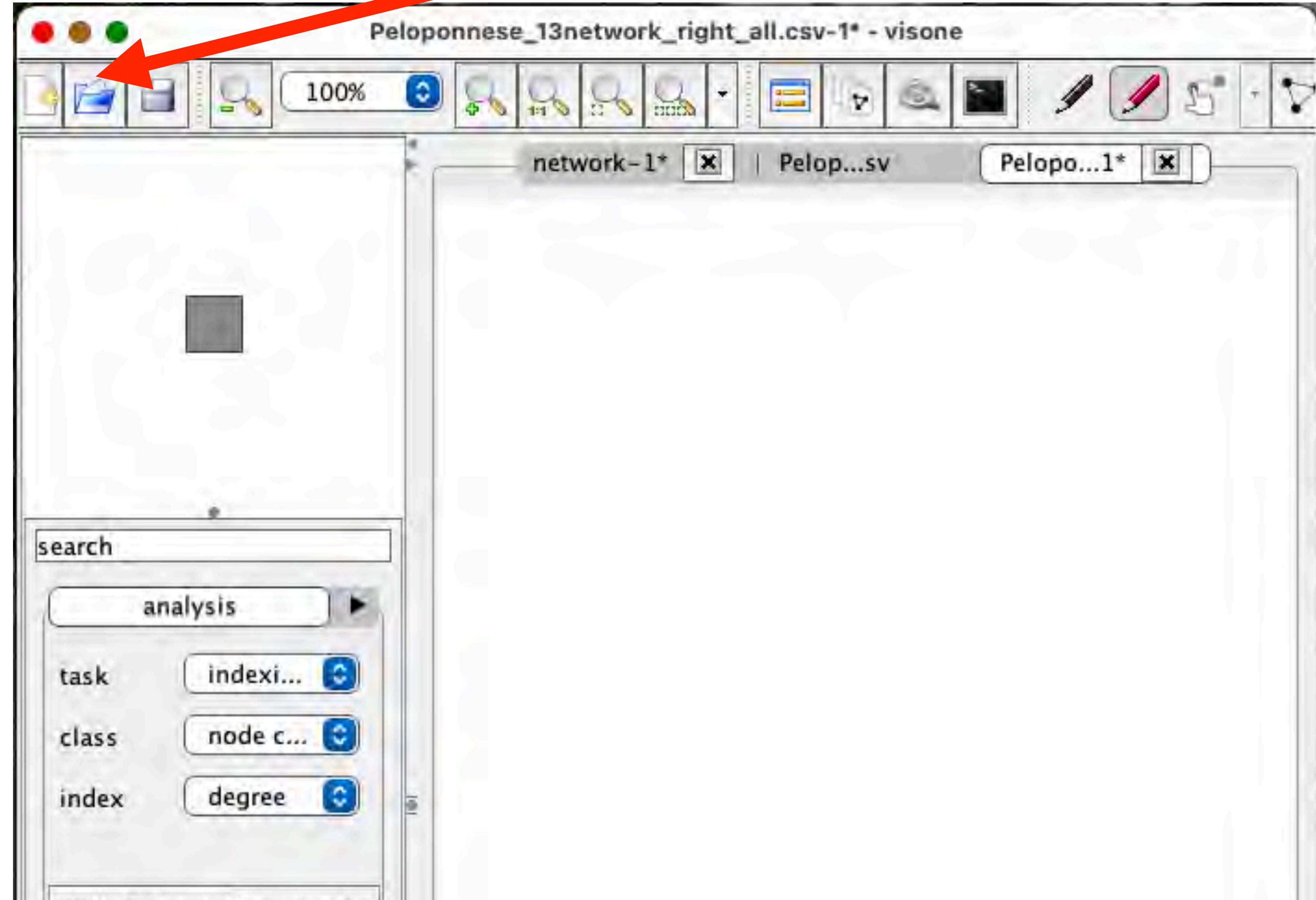
ADIACENCY LIST (undirected)

```
1, 2, 3  
2, 4  
3, 5  
4, 5
```

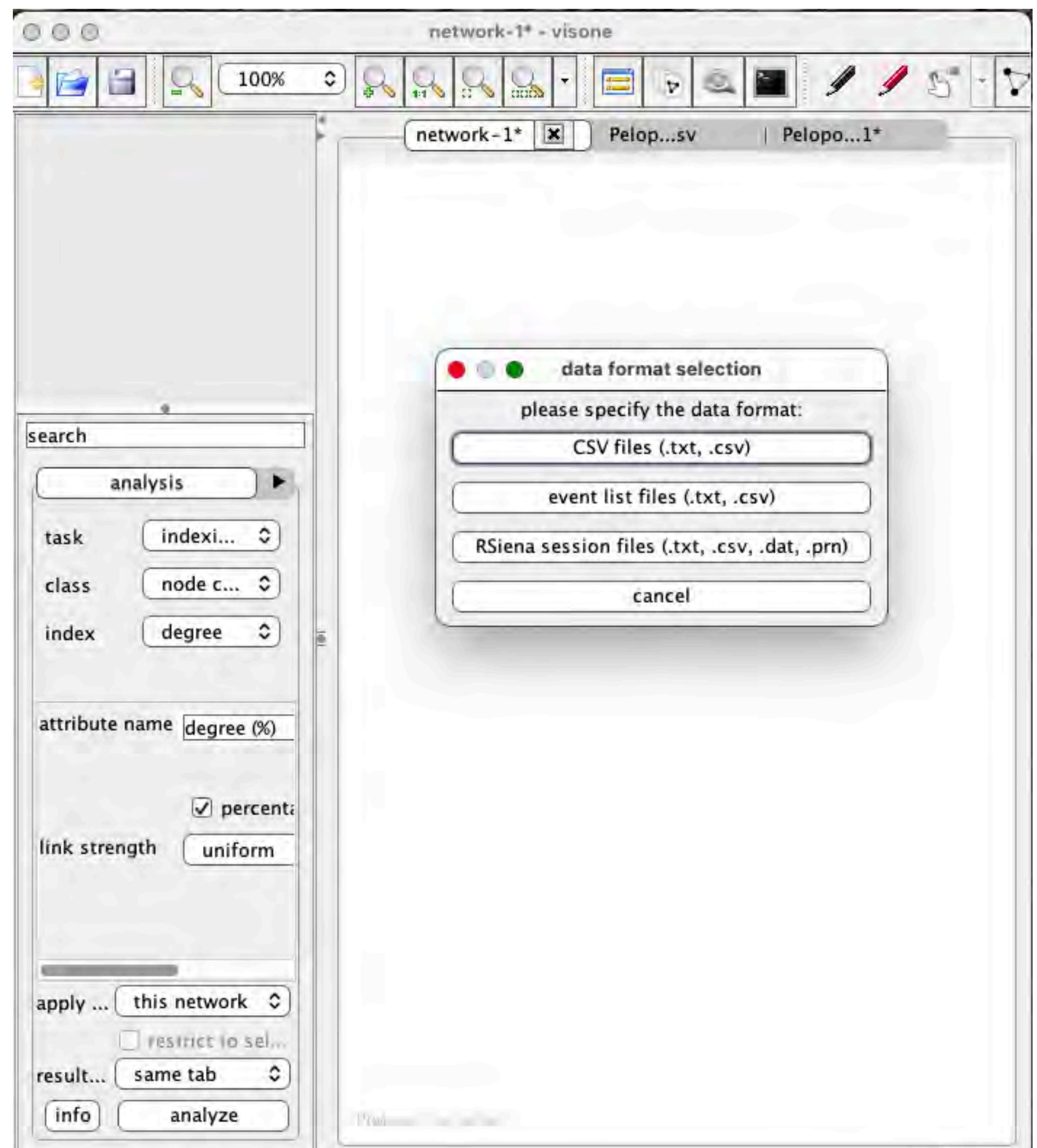
- Create a new network in the panel:

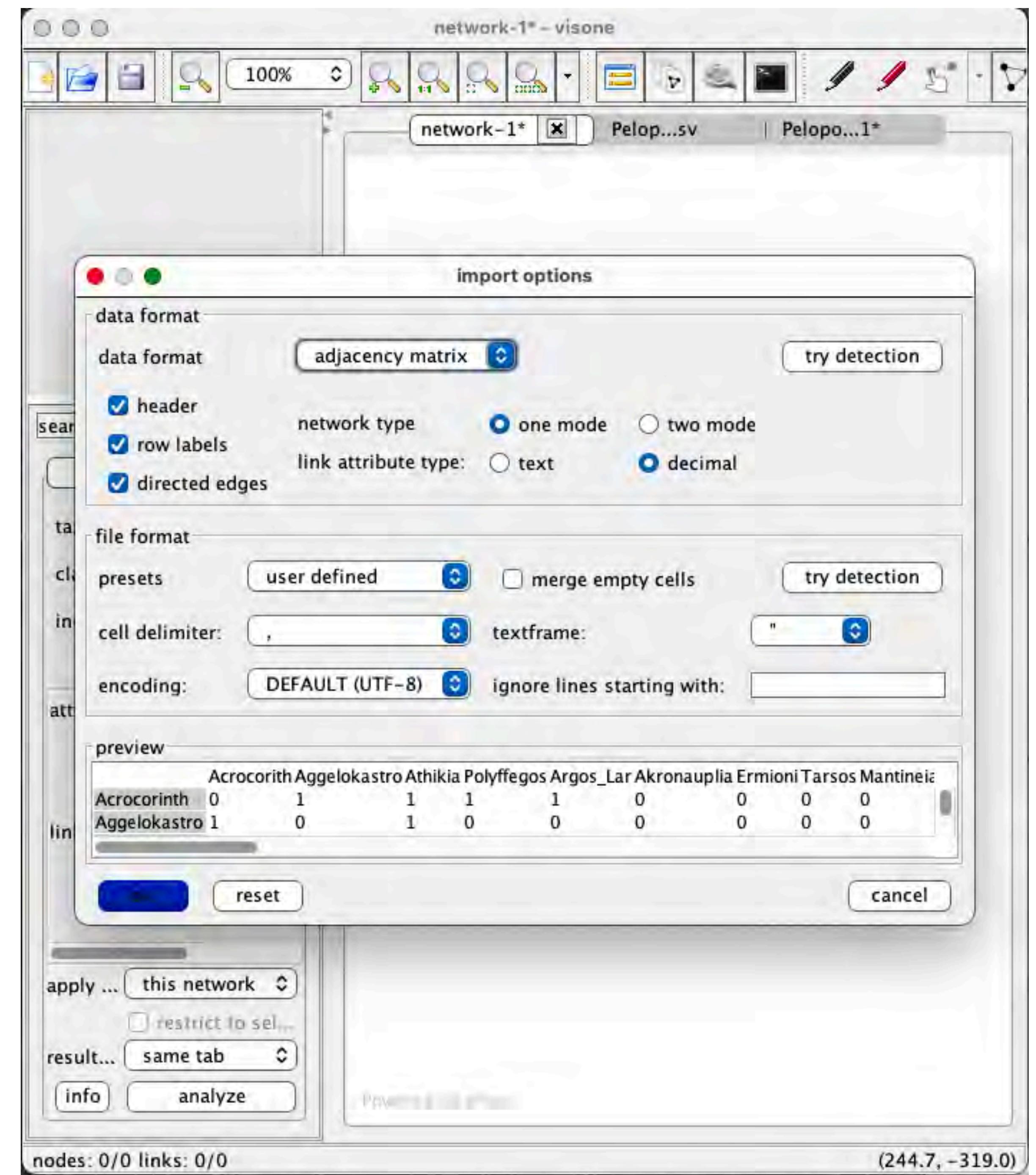


Open the file  
Peloponnes\_13network

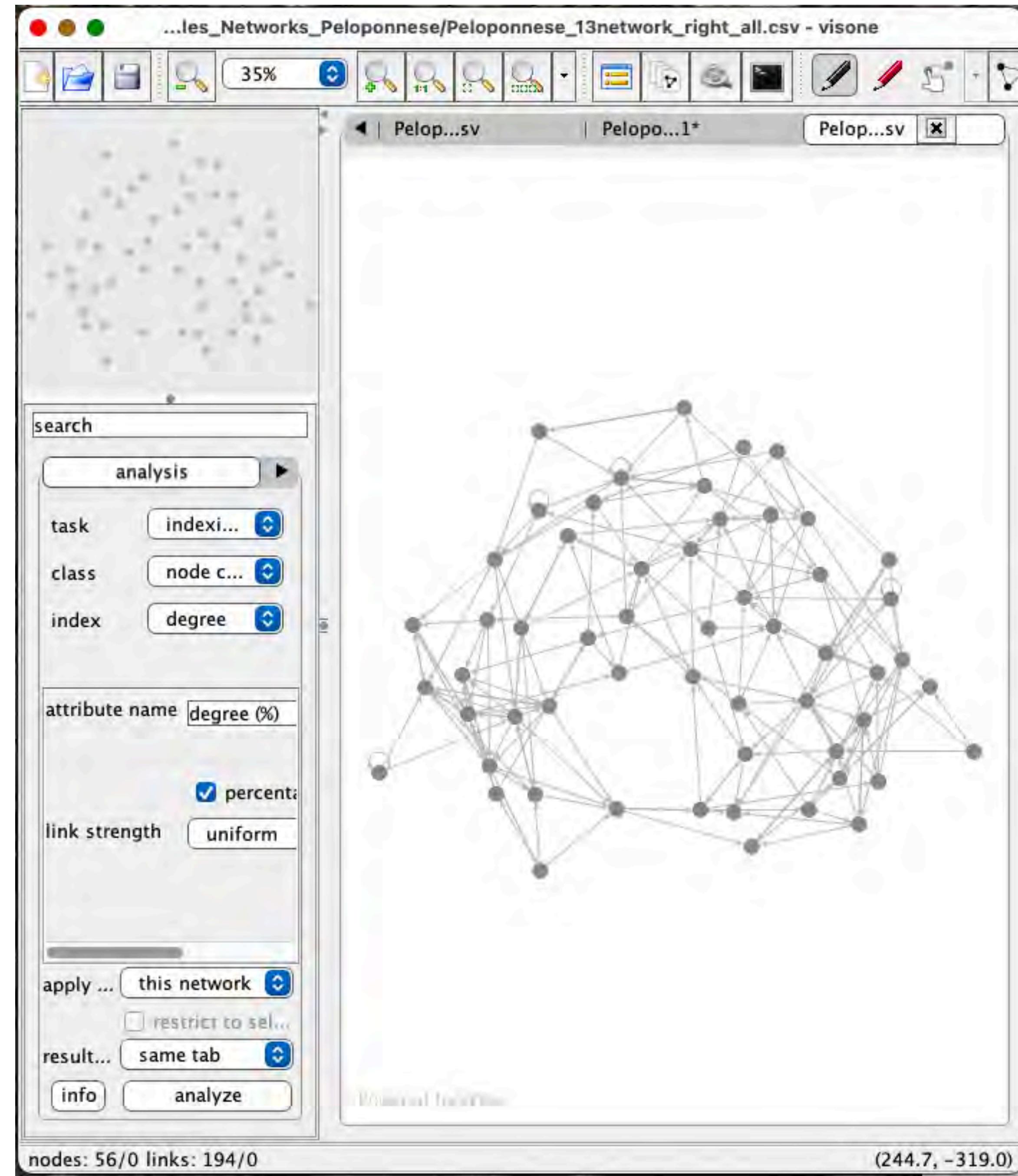


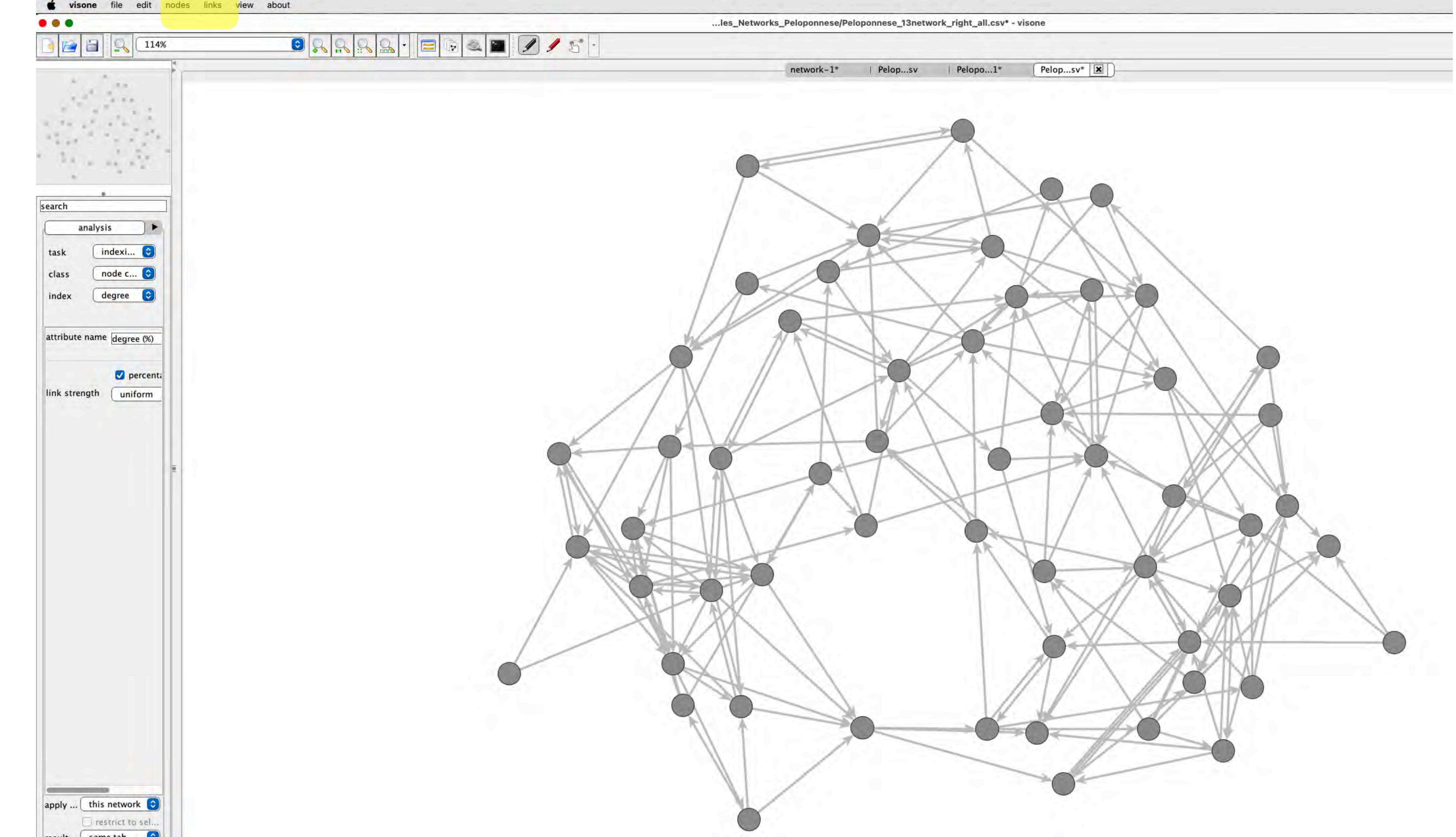
- Choose, CSV files.
- Your database should always be CSV files. It can be created in excel or numbers and the save as/export to csv



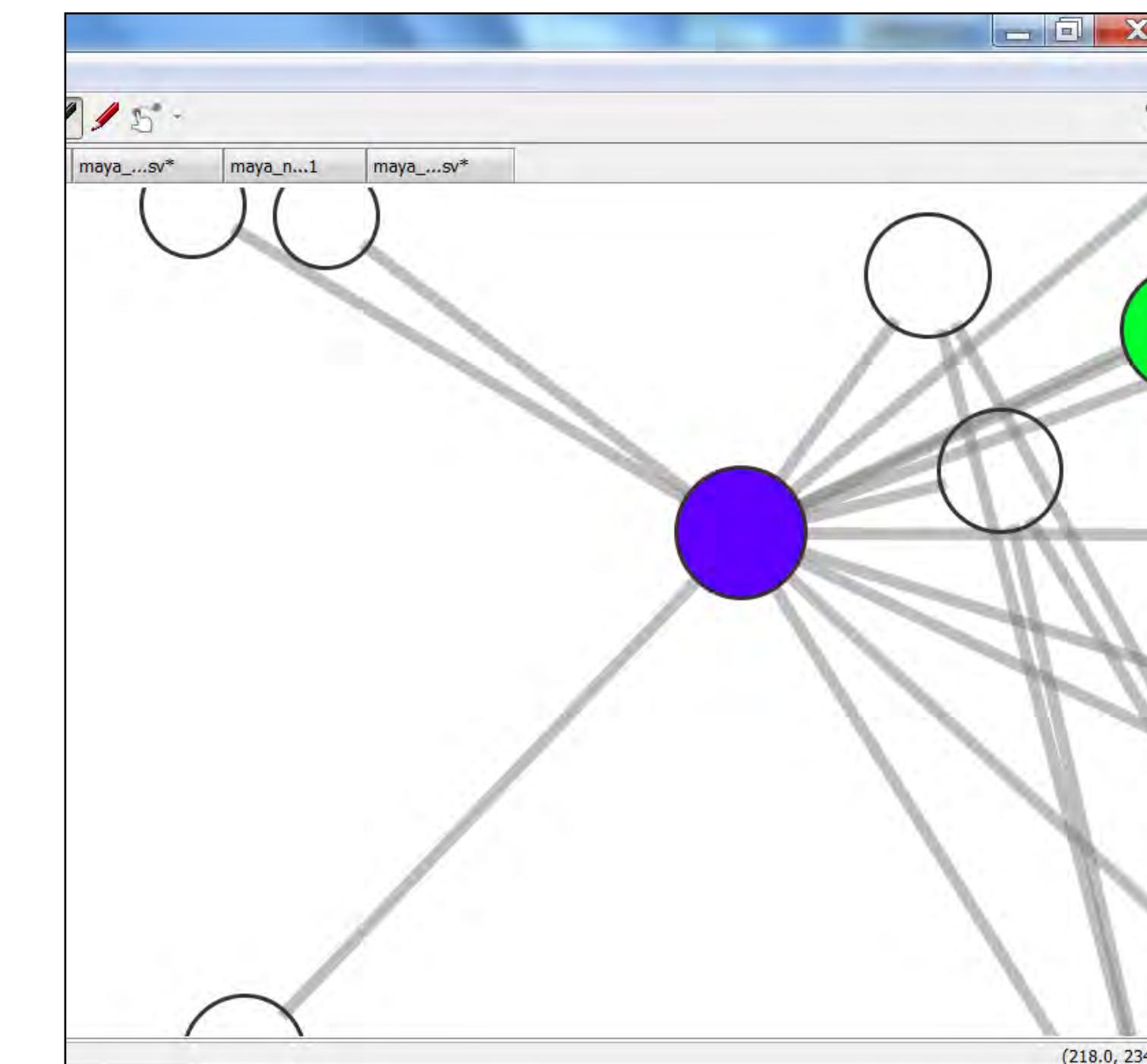
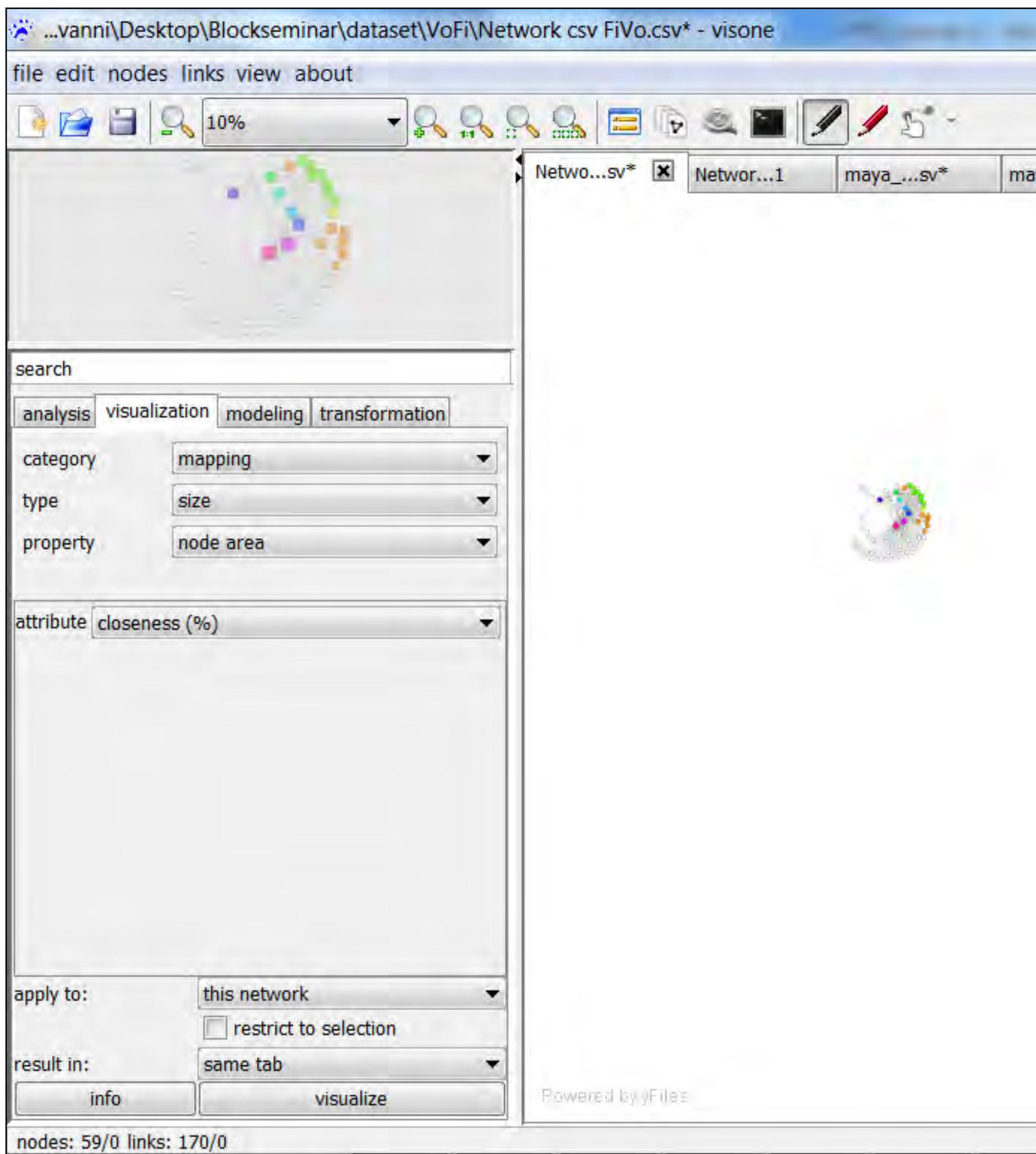


- The result, save it as png, tiff, jpeg

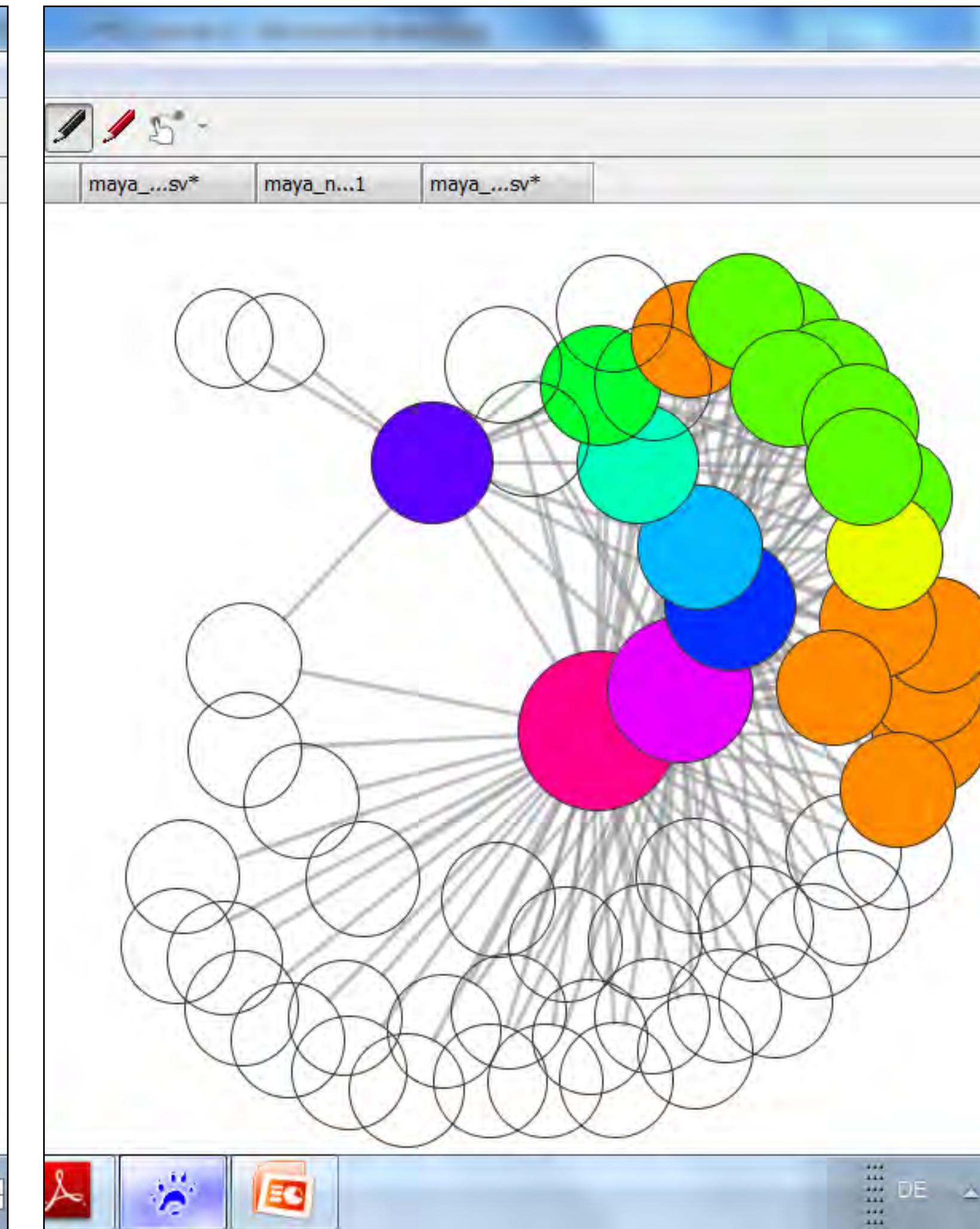
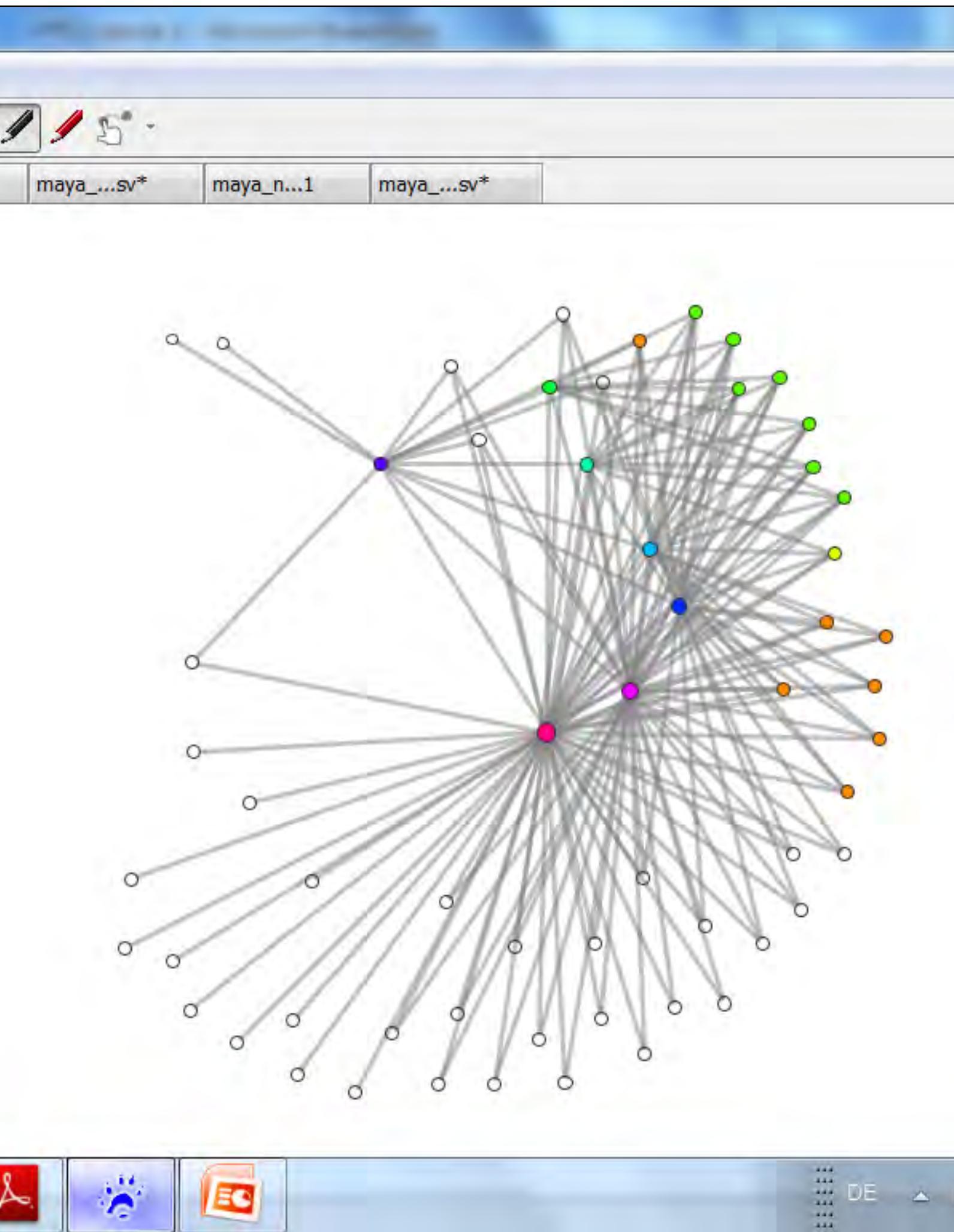




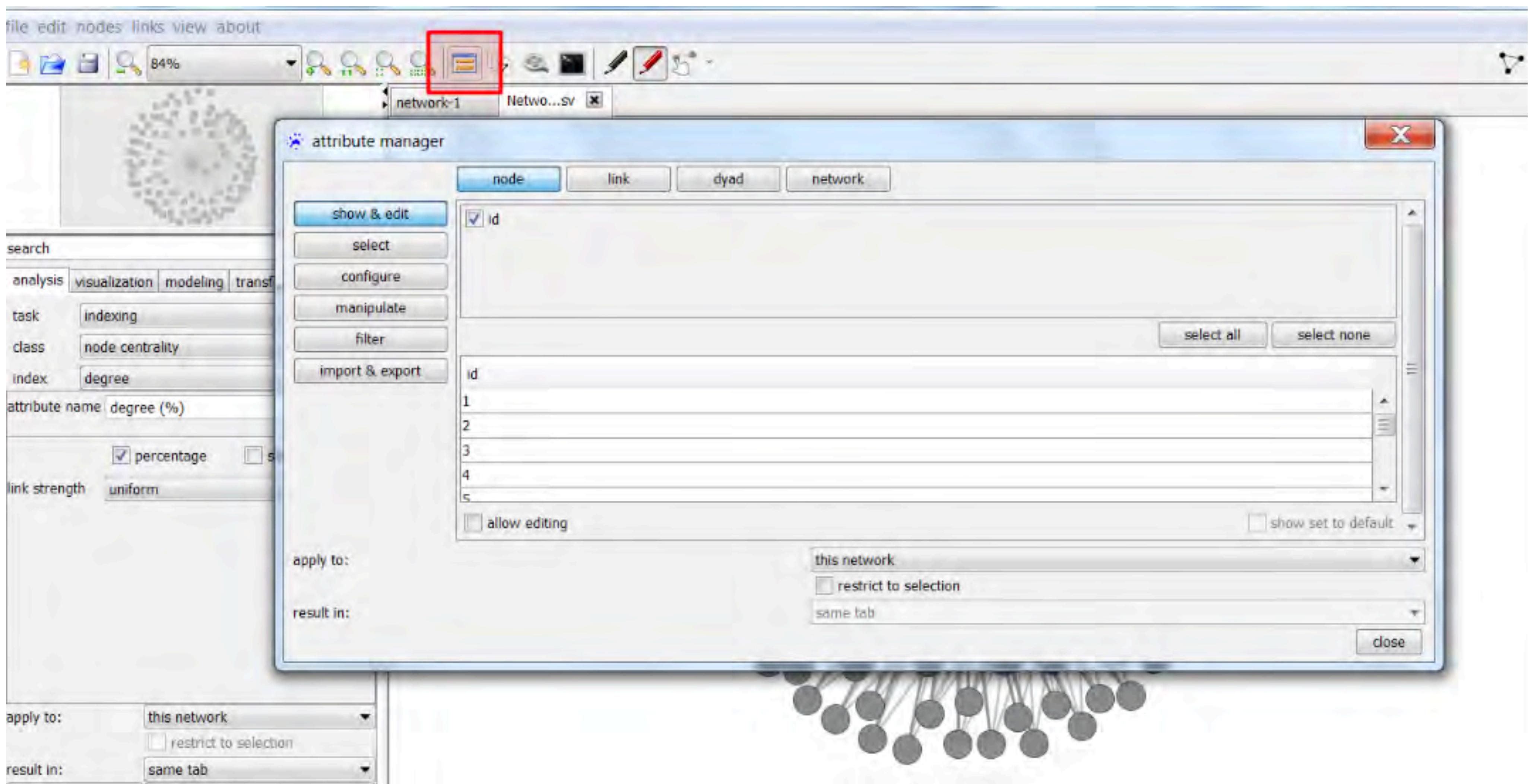
If you click with the mouse in the network panel and scroll the wheel, you can change the size of the all network....



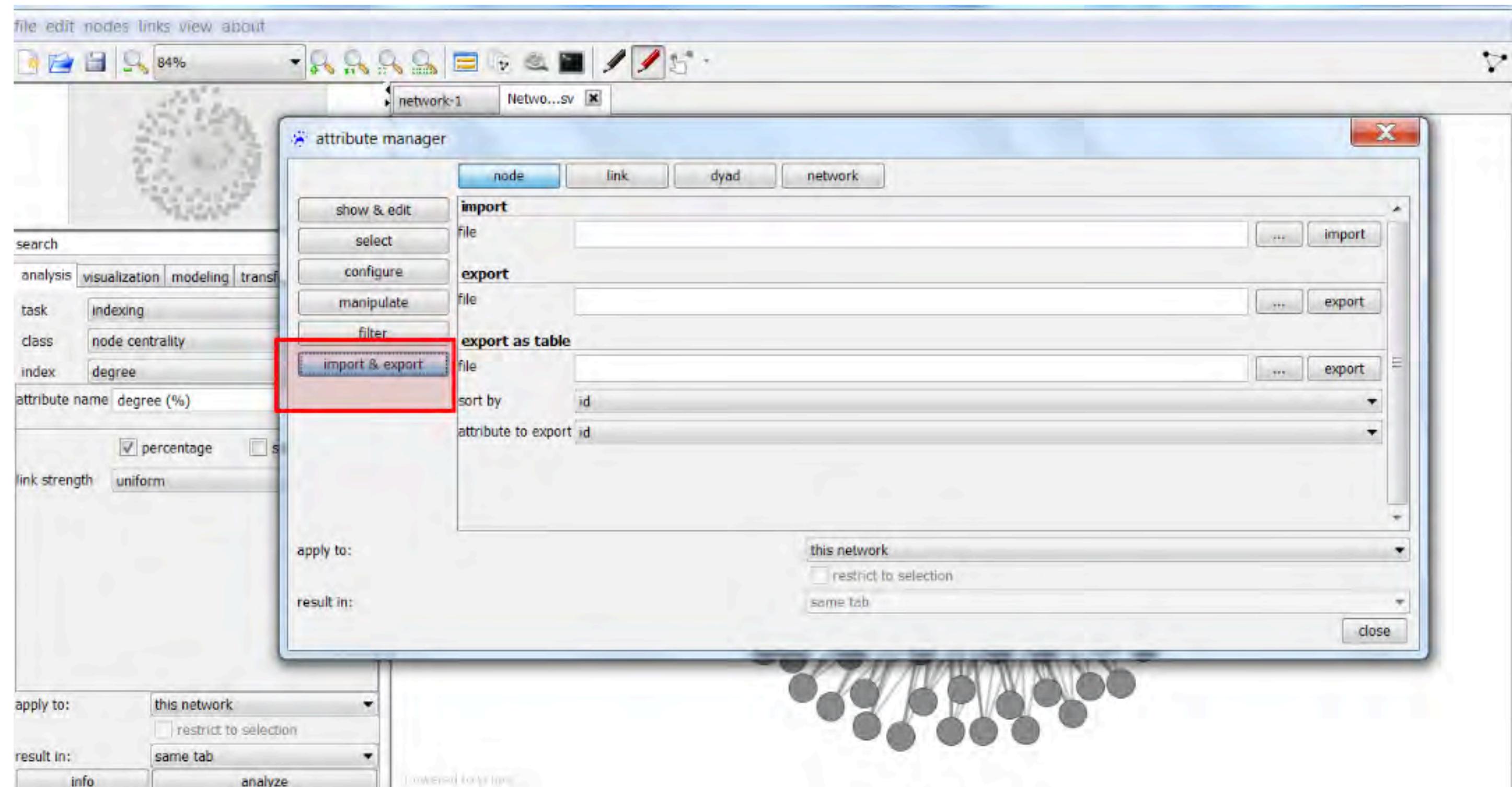
If you click with the mouse in the network panel and scroll the wheel, and at the same time you press Ctrl, you can change the size of the nodes.  
Select nodes and or edges with Ctrl +CLICK on it



# Attribute Manager



# Import attributes



### load options

#### joining attributes

network attribute: **id** file attribute: **Site ID**

header

#### file format

presets **user defined**  merge empty cells **try detection**

cell delimiter: **,** textframe: **"**

encoding: **DEFAULT (UTF-8)**  ignore lines starting with:

#### preview

Site ID	locus	urban	rural	castle	coordinate E	coordinate N	UTM lon	UTM lat
type	integer	text	text	text	text	text	decimal	decimal
2	Ag. Vasileios		x	22 47.868	37 47.230	22.79791	37.787828	
3	Agionori		x	22 52.818	37 45.389	22.8805379	37.7566067	
6	Epidauros		x	23 07.52	37 40.655	23.129267	37.677487	
13	Thermisi		x	23 18.159	37 25.339	23.30283755	37.42099327	
17	Ligourio		x			23.05164617	37.6525733	
22	Vasilika		x			22.726571	37.978898	
26	Tsipiana		x			22.47481	37.609519	
28	Leonidio		x			22.882711	37.143438	
31	Leontari		x			22.14232019	37.32254985	
35	Akova		x			21.989158	37.71533	
59	Aa. Eleni		x			22.870833	37.510967	

reset

cancel

## **Little reminder: Centrality measures**

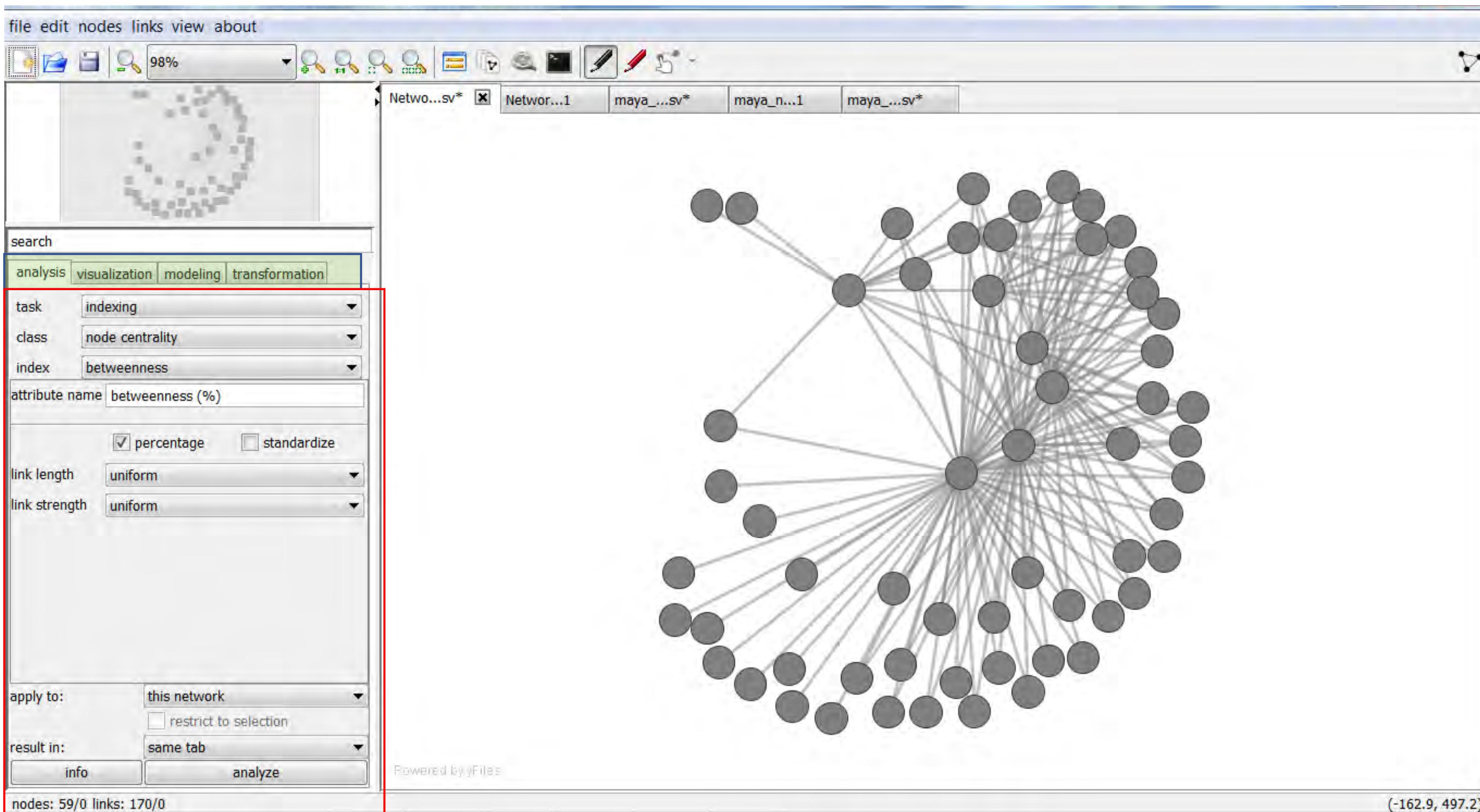
### **Betweenness**

The Betweenness of a node is defined as the number of times a node acts as a bridge on the shortest path between two other nodes. Thus, nodes with high betweenness can be regarded as important waypoints on the connections between other nodes, but also as bottlenecks in the network.

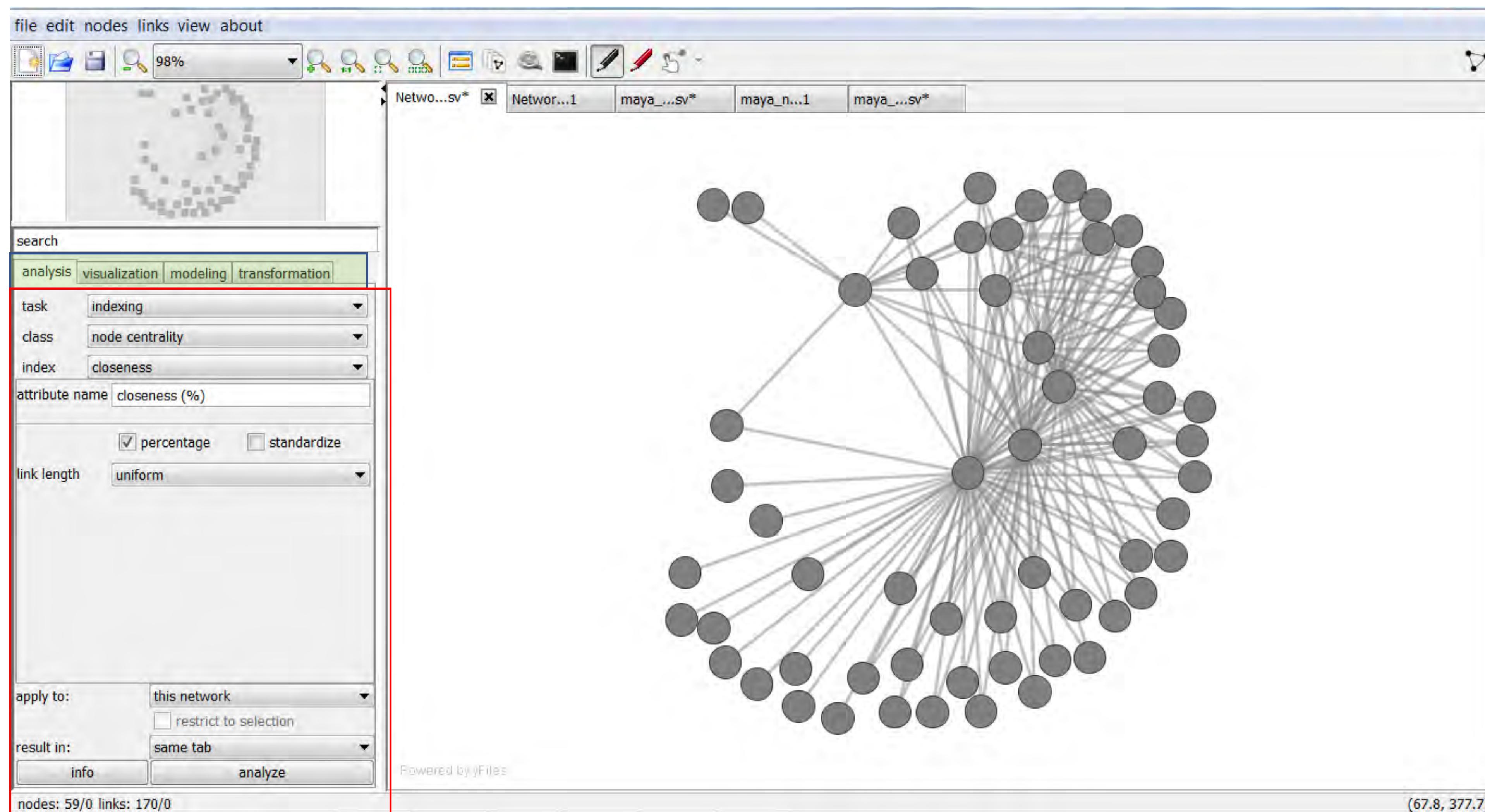
### **Closeness**

The Closeness of a node is the distance of the node to all other nodes in the network. Nodes with a high closeness can reach all other nodes of the network in fewer steps than nodes with a low closeness.

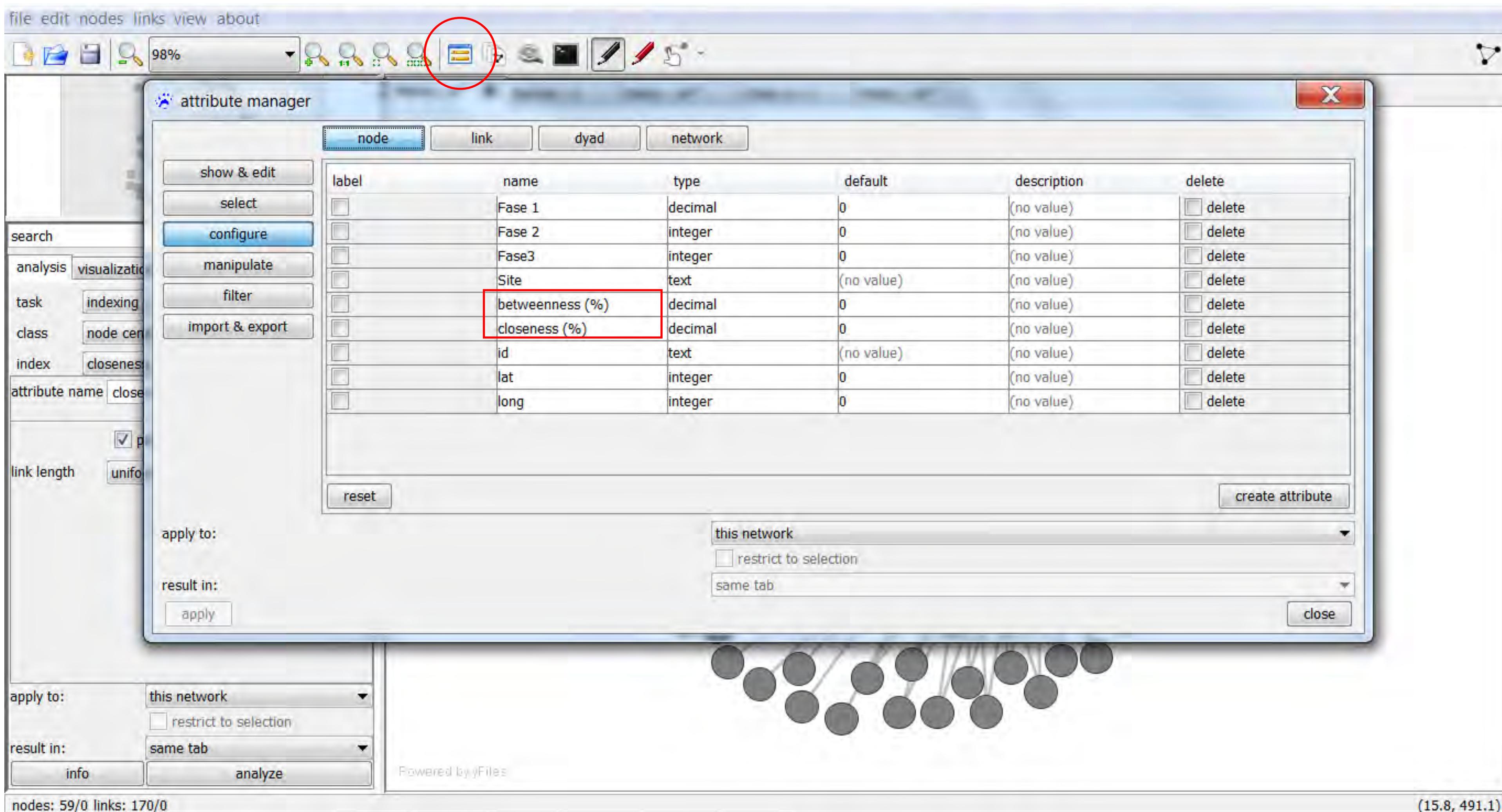
# Analysis: betweennes



# Analysis: closeness

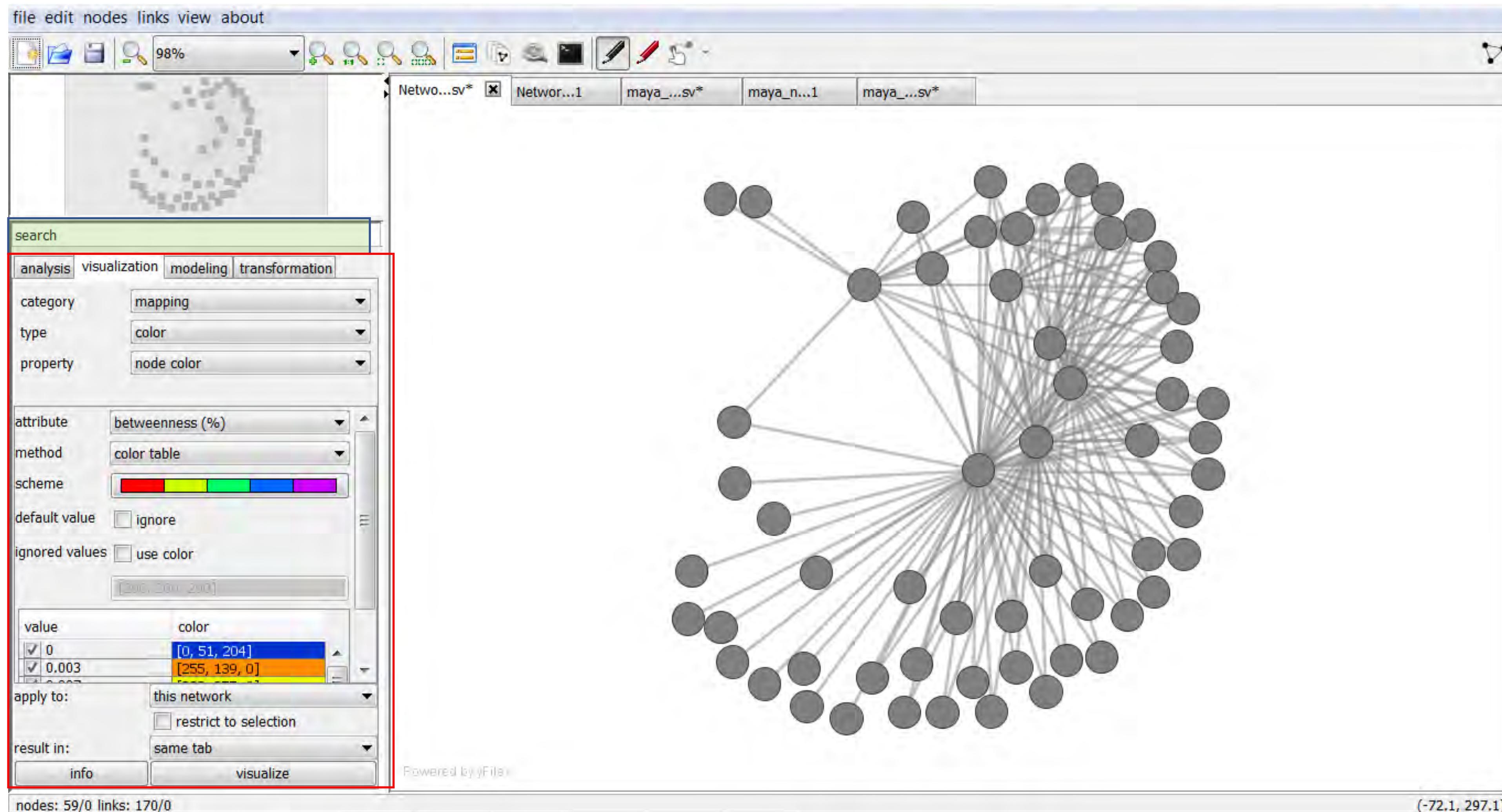


## Betweenness and closeness are now in the configure tab of the node in the attribute manager



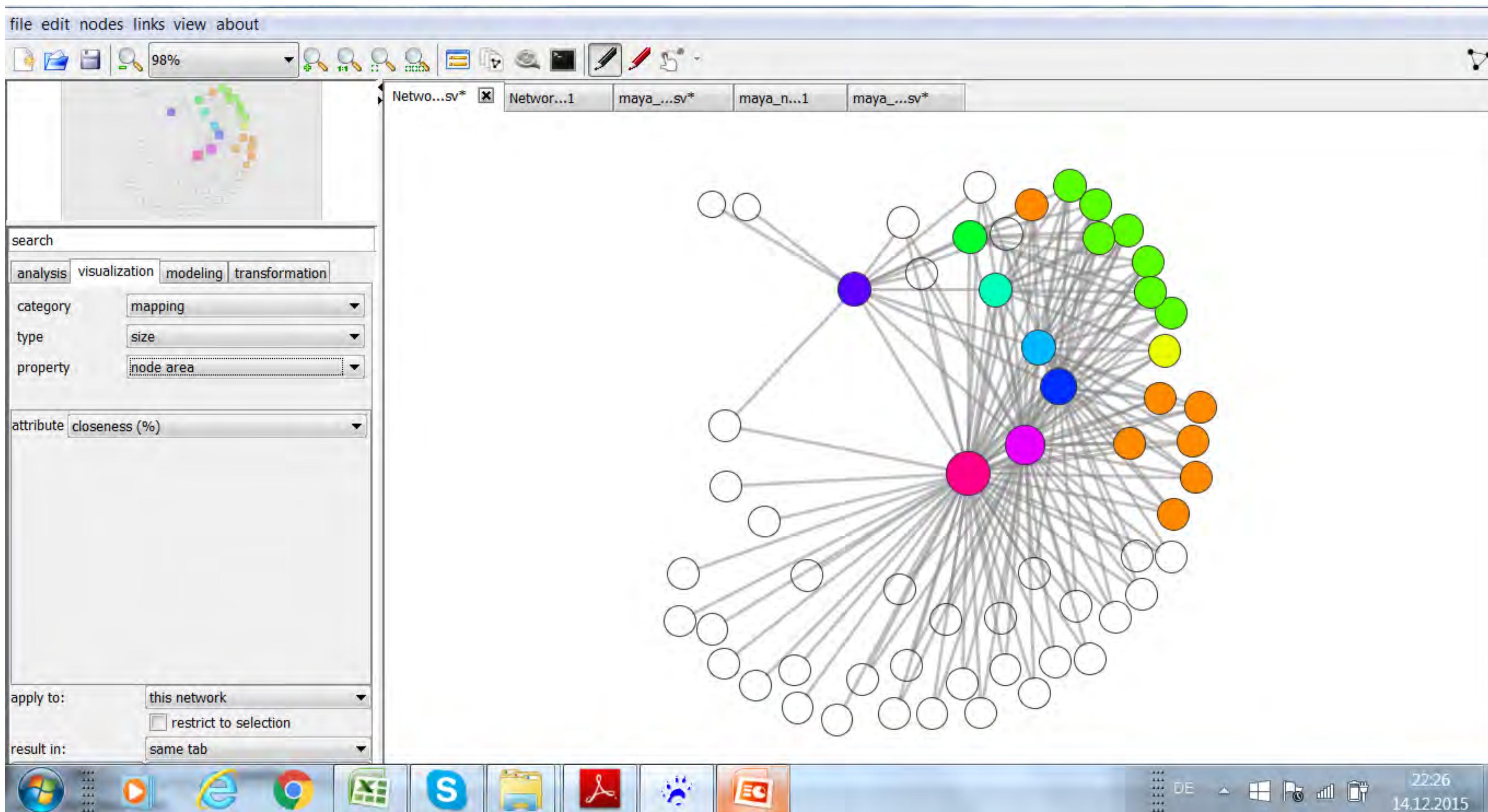
# How to visualize centrality measures

Visualization tab. Category: mapping. Type: color. Property: node color; attribute: betweenness; method: color table/interpolation...

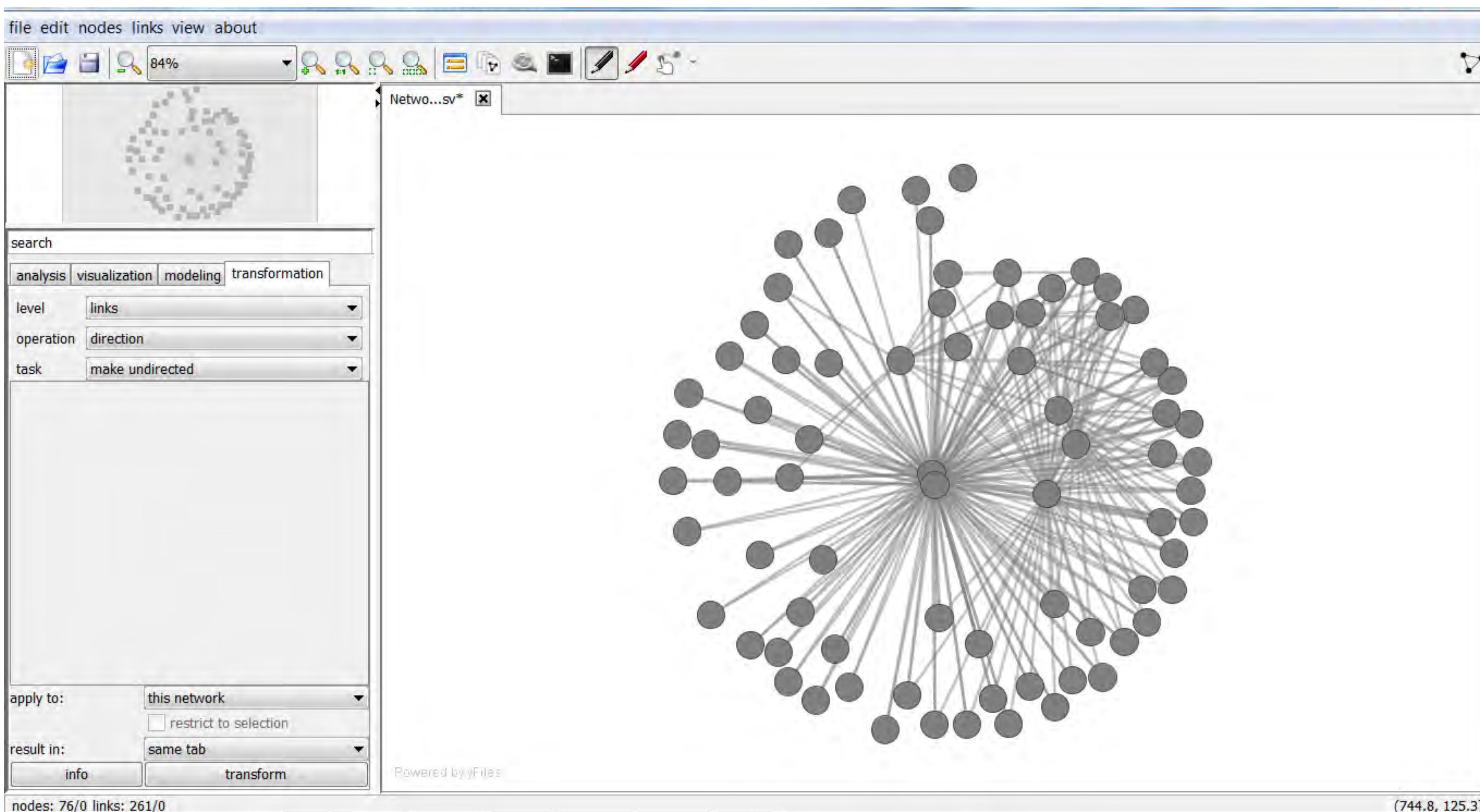


# Visualize

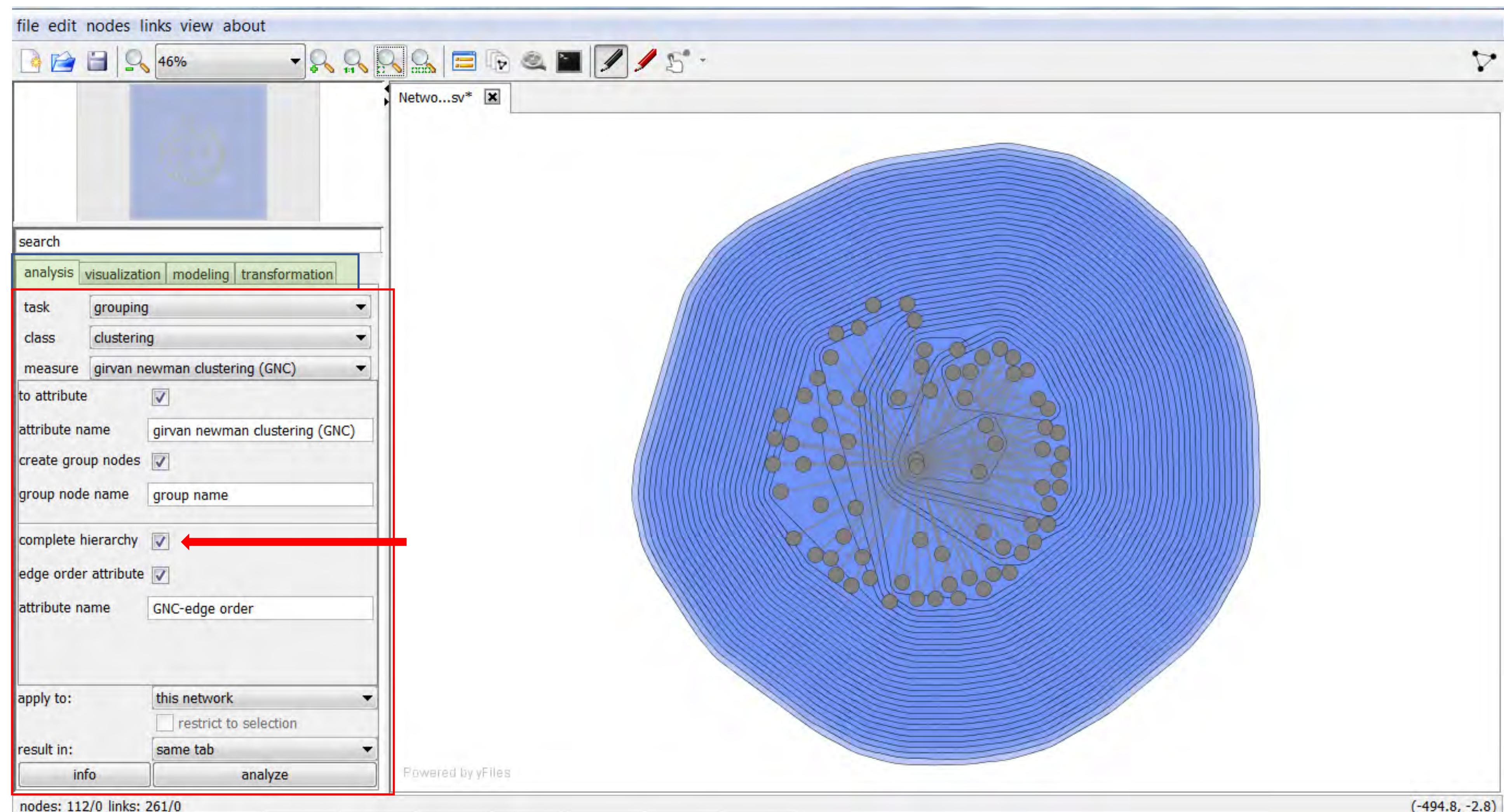
Visualization tab. Category: mapping. Type: size Property: node area; attribute: closeness



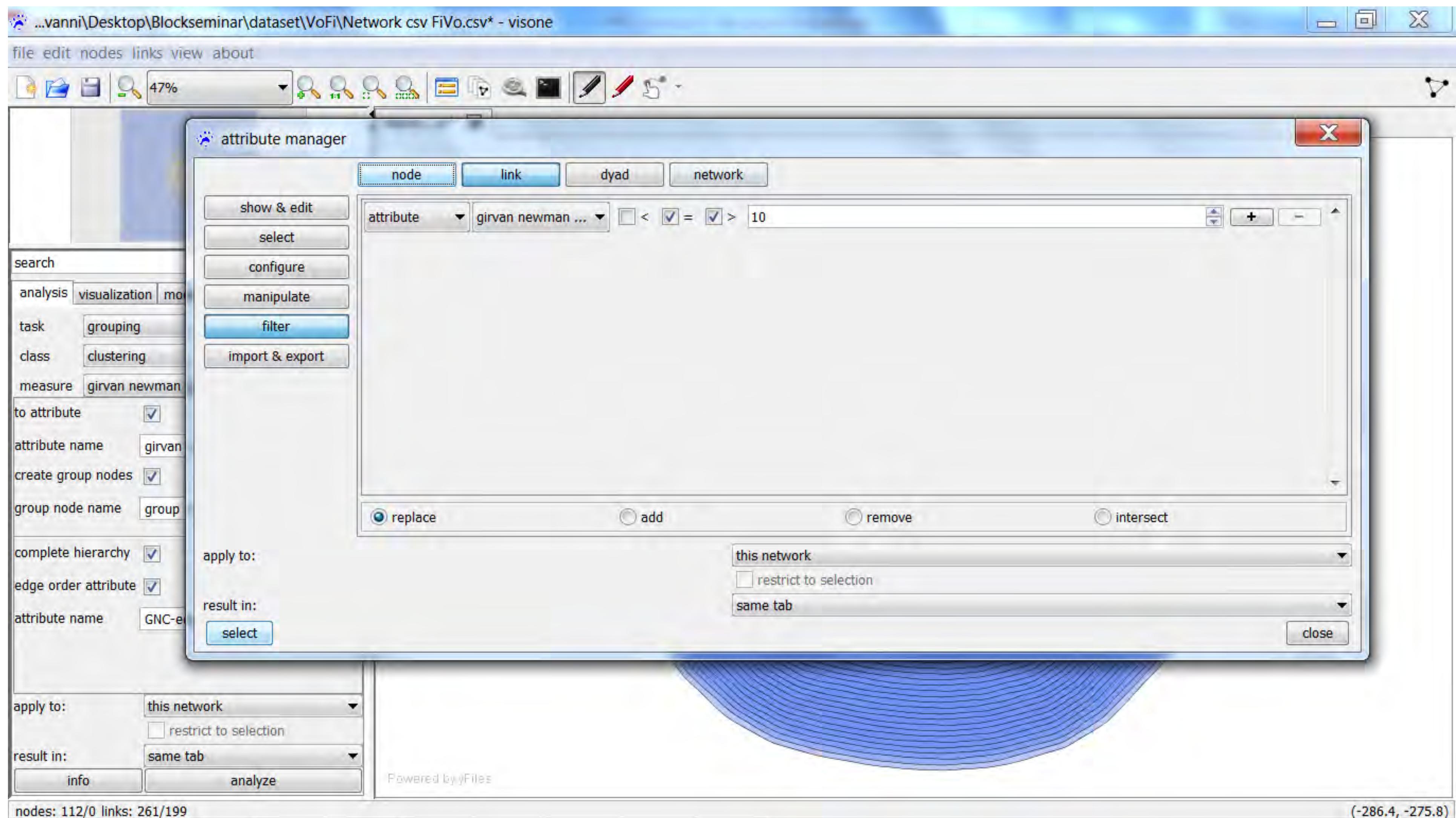
Visone use an algorithm of hyerarchical clusterization  
The Girvan-Newman Clustering algorithm (GNC),  
which is adaptded just for presence/absence of link



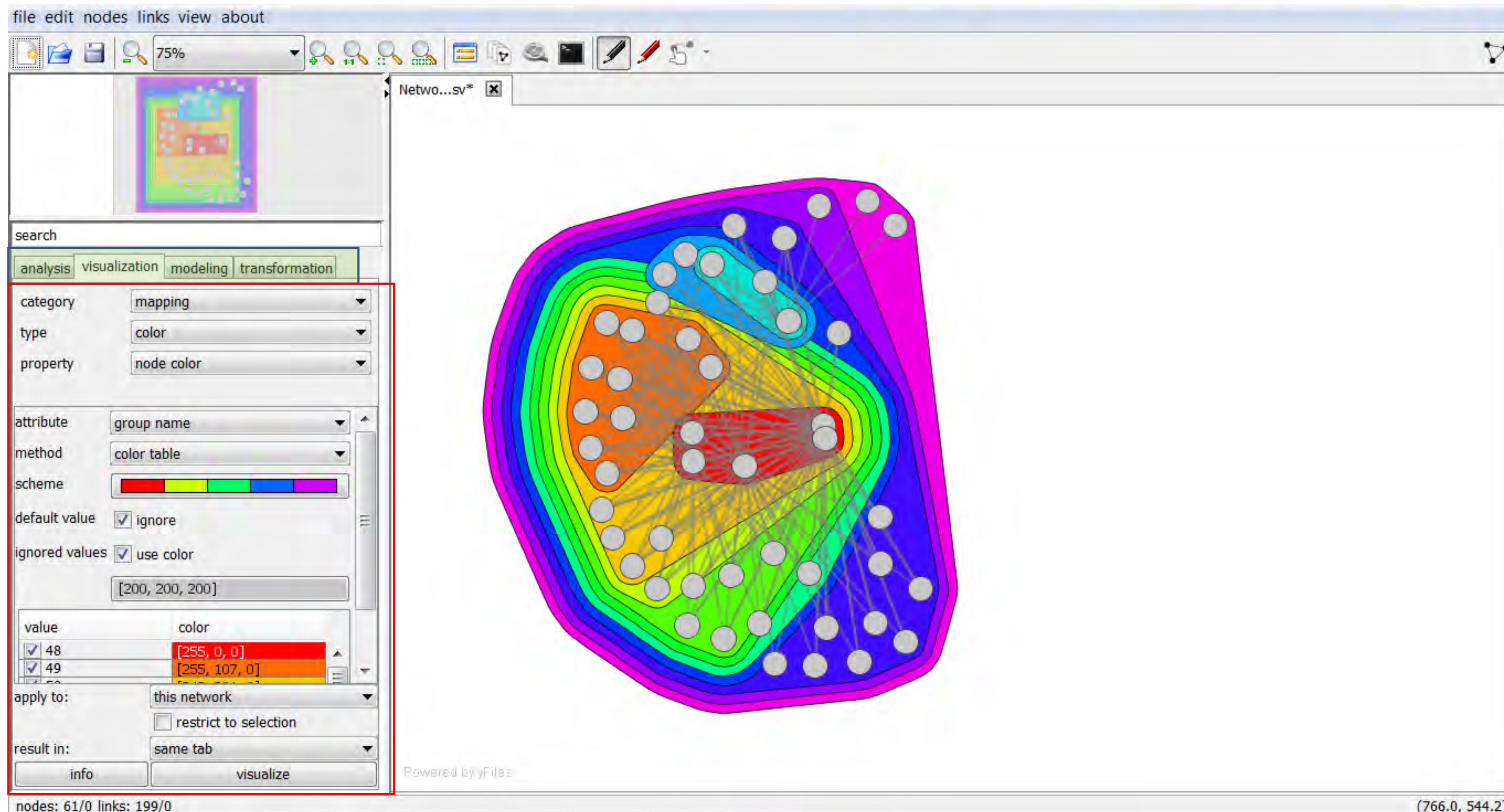
# Analyse



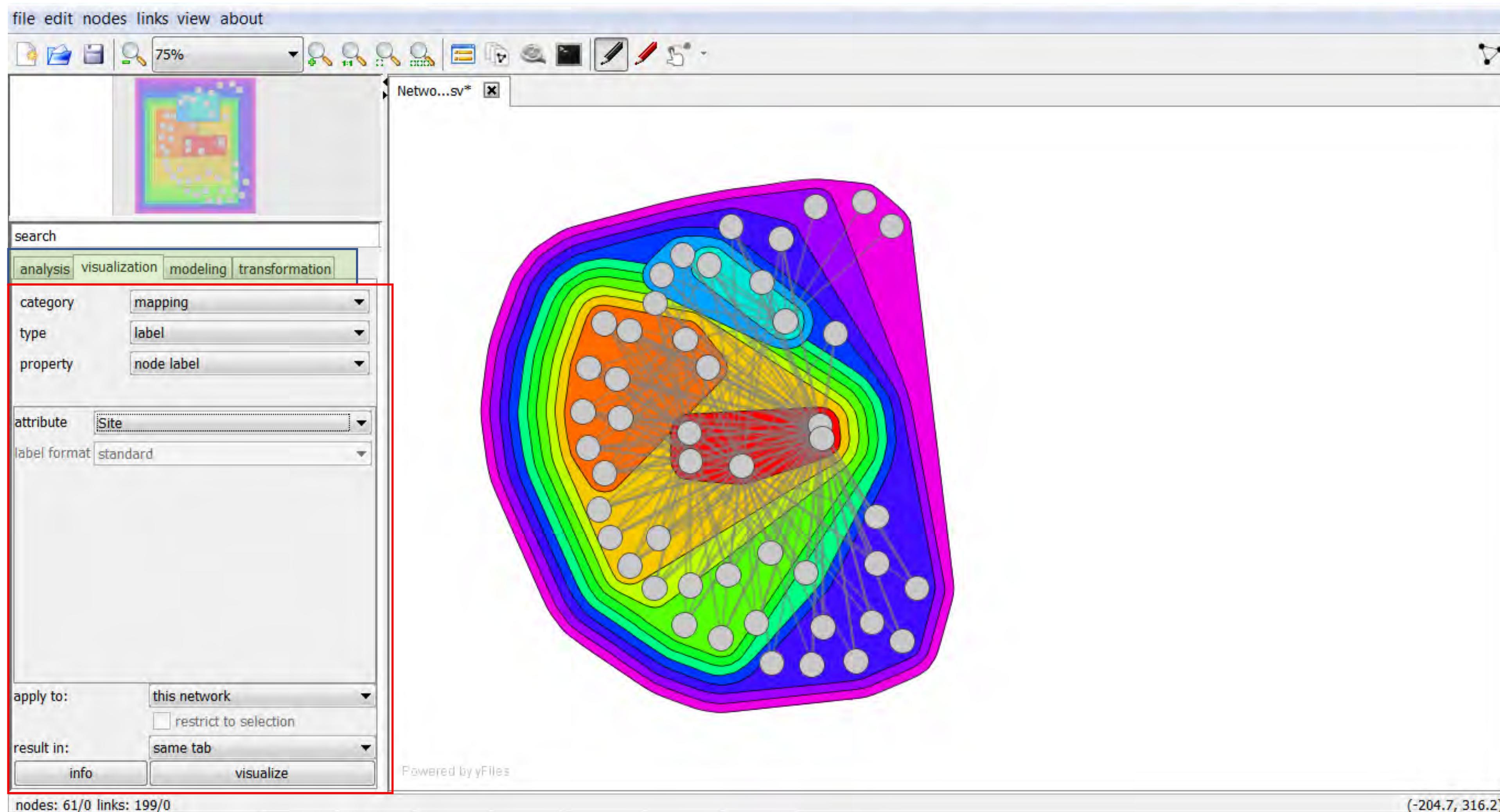
# Filter the groups



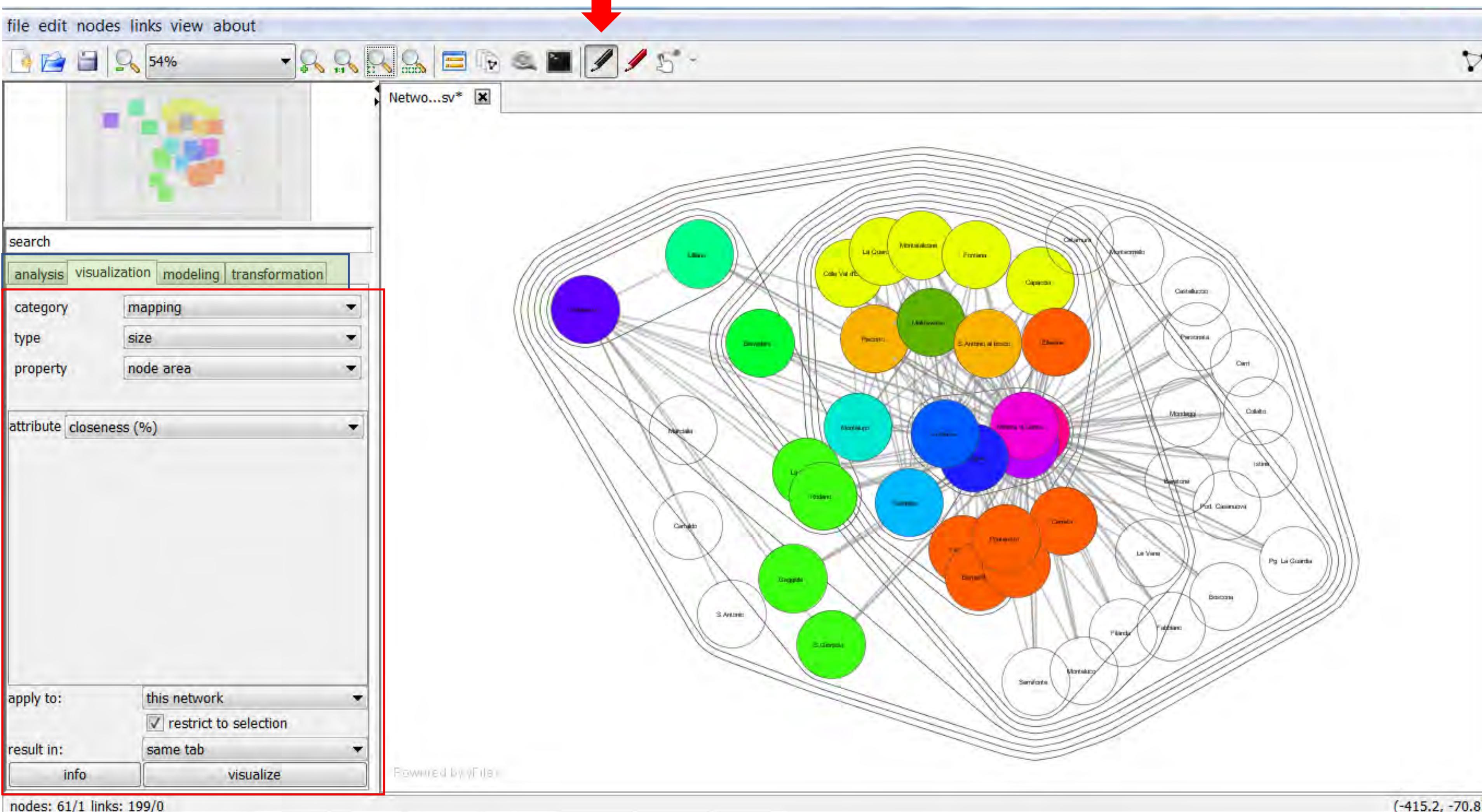
# Visualization Tab to color the groups



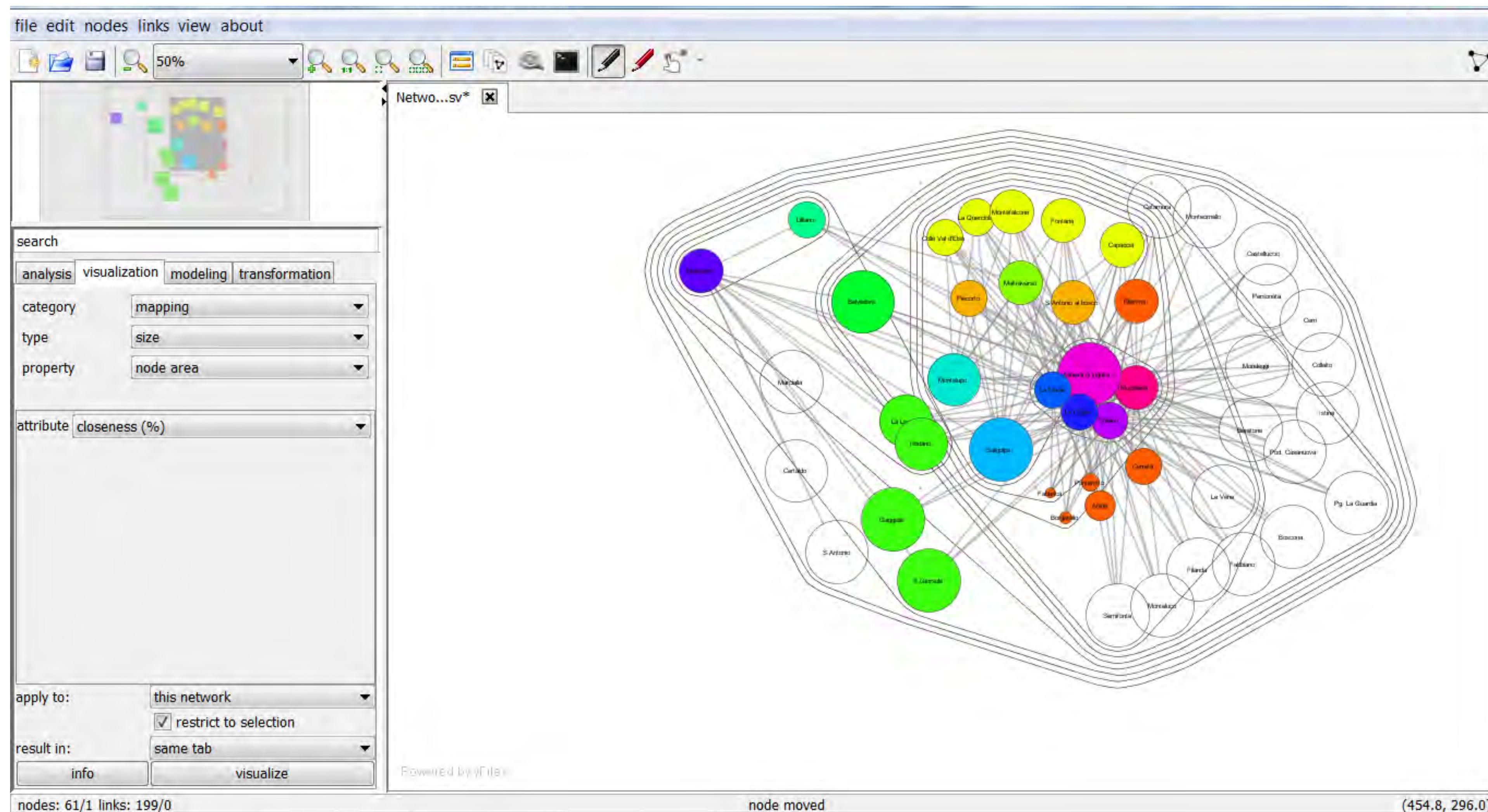
# Visualization Tab to label the node with the site name



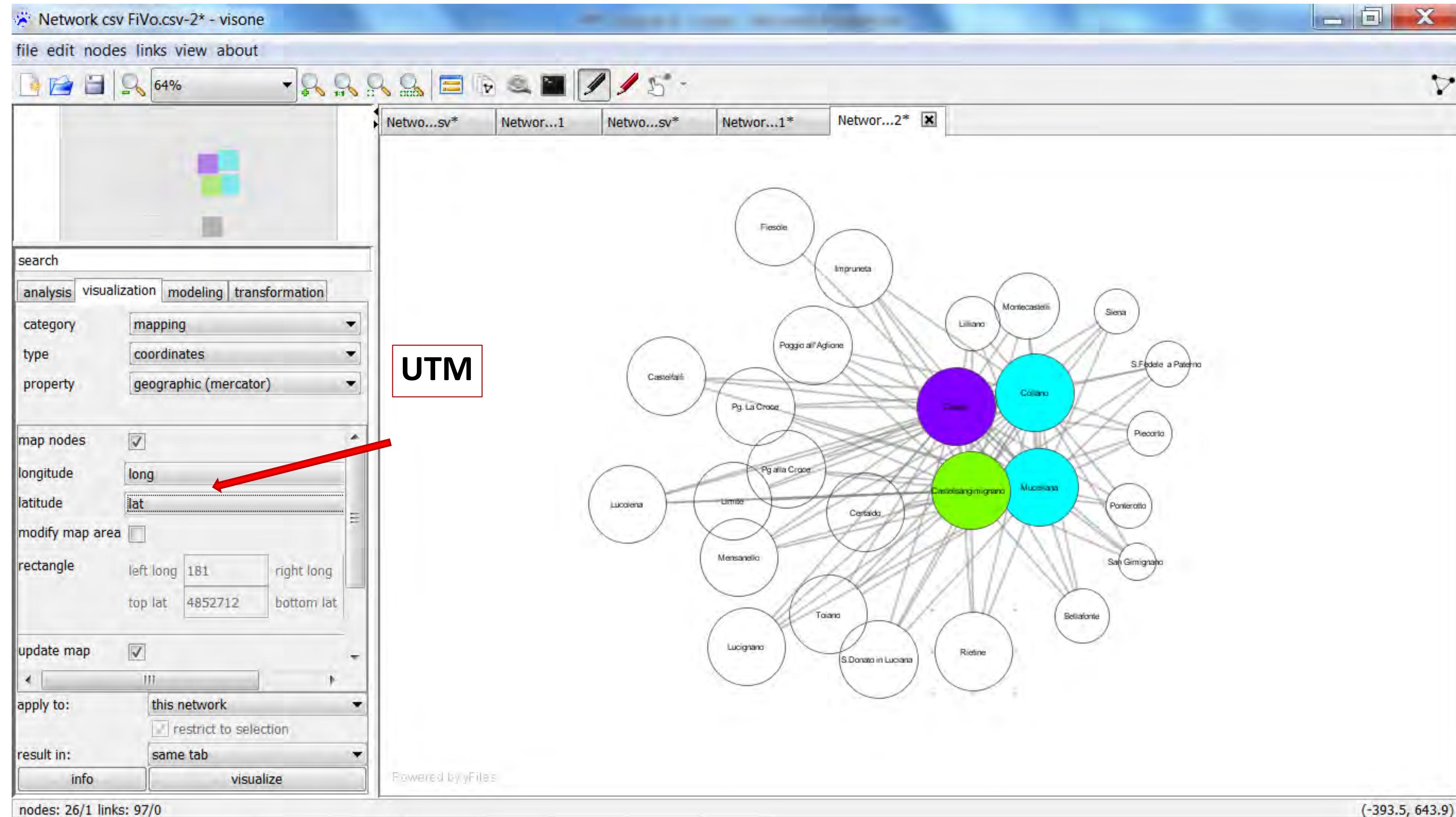
**Visualization Tab, Mapping size/colour node to apply closeness and betweenness instead group color. And analysis mode + move nodes for a better visualization**



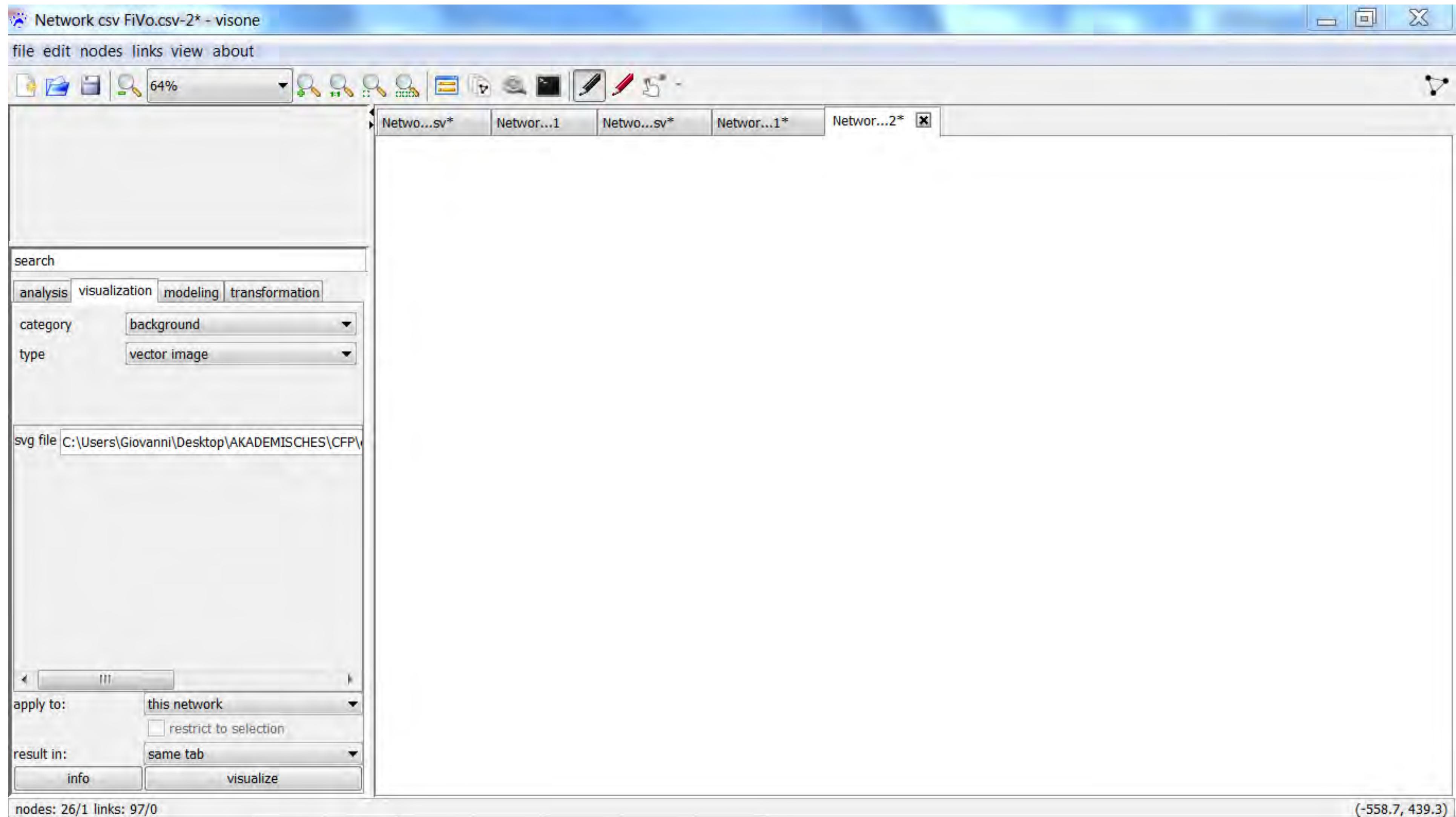
To reduce single node, click on it and then **ctrl + scroll down** (also pluriselection)



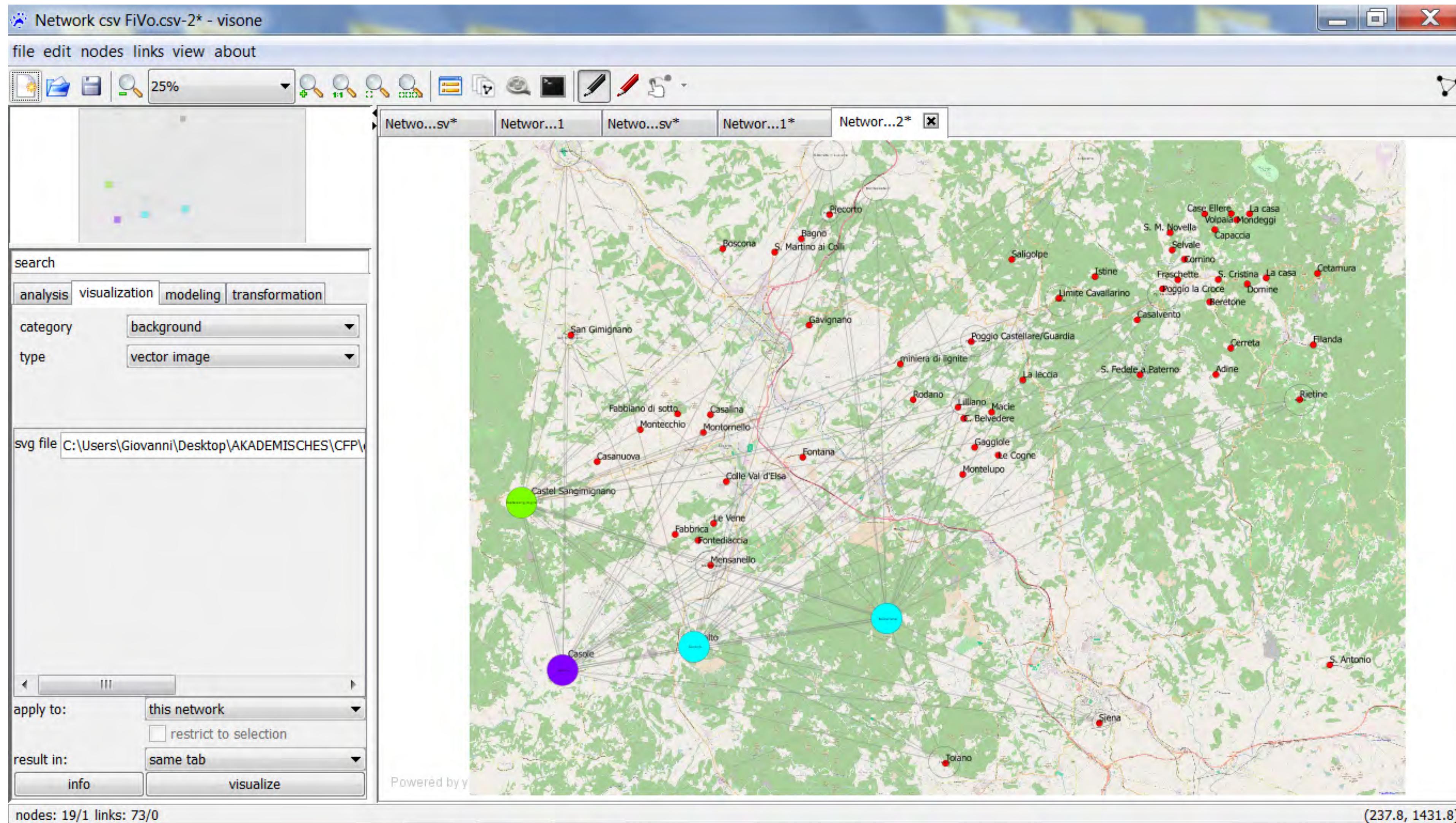
# Apply geographic coordinates



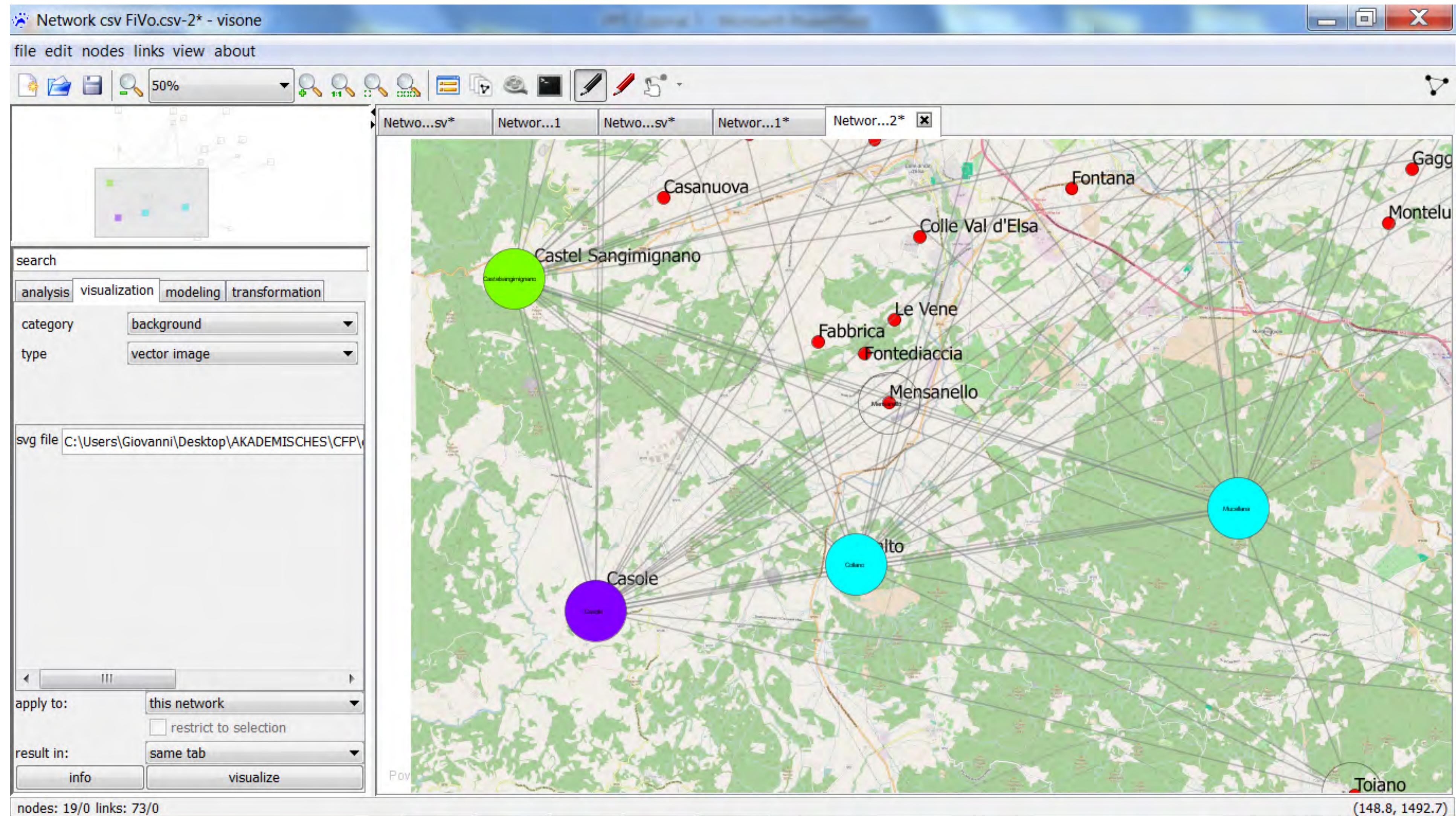
## Or Apply Svg vector image (e.g. from Q-GIS) as background



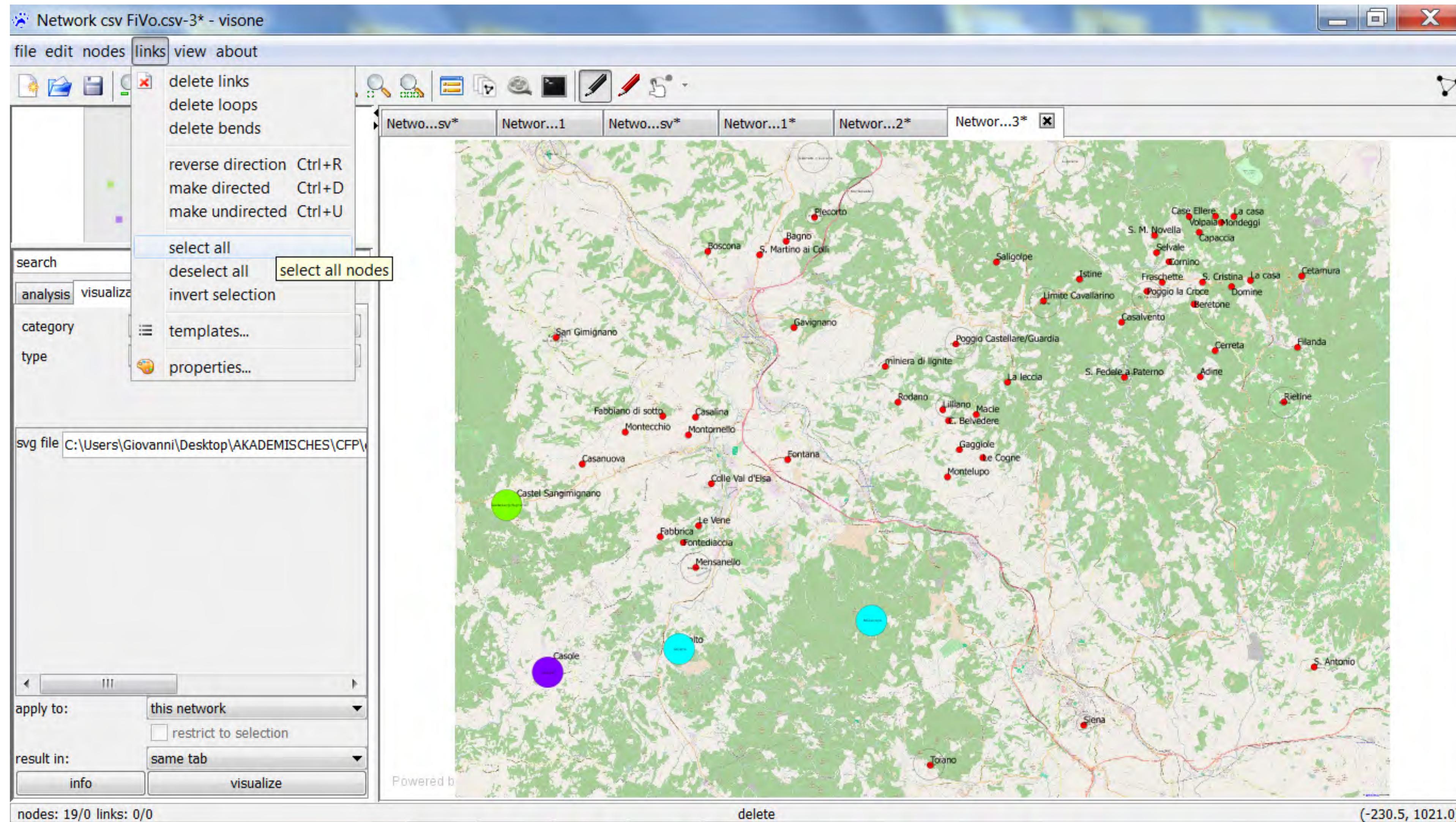
# Manual positioning



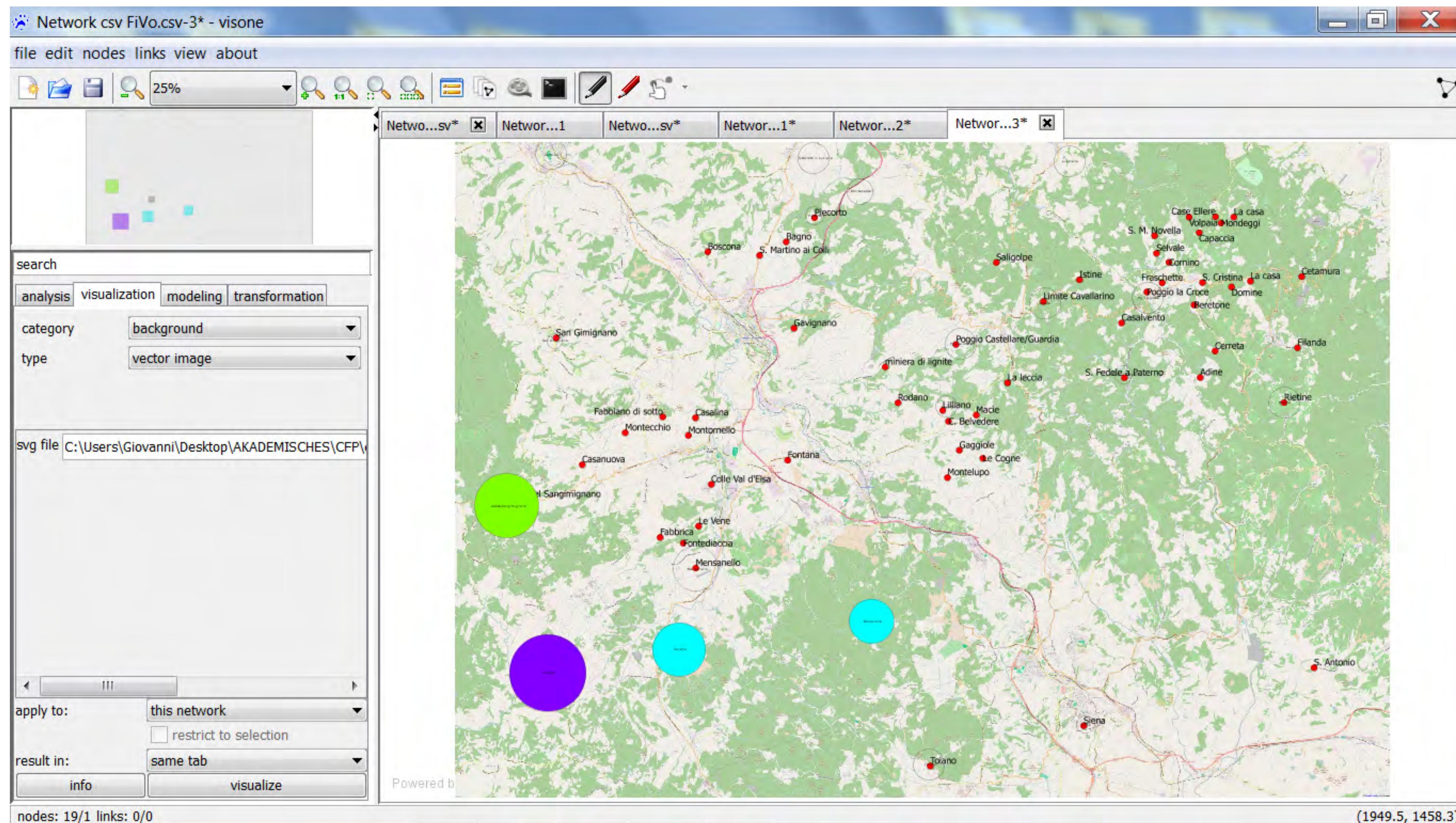
# Visualize a part in detail



# Select and delete all links



# Visualize it better (ctrl + scroll)



# NETWORK ANALYSIS IN ARCHAEOLOGY THEORY, PRACTICE, AND APPLICATIONS

Thank you!!!!

Mycenae

Gordion

Pompeii

Uruk

Knossos

Troy

Uruk

Amarna

Chichen Itza