人工智慧財務金融應用

AI in Financial Application

社會網絡分析財務金融應用
(Social Network Analysis for Finance Application)

1081AIFA09
EMBA, IMTKU (M2457) (8413) (Fall 2019)
Fri 12,13,14 (19:20-22:10) (D301)

Min-Yuh Day
戴敏育
Associate Professor
副教授
Dept. of Information Management, Tamkang University
淡江大學 資訊管理學系
http://mail. tku.edu.tw/myday/

2019-12-27

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
1	2019/09/13	中秋節 (Mid-Autumn Festival) 放假一天 (Day off)
2	2019/09/20	人工智慧財務金融應用課程介紹 (Course Orientation for AI in Financial Application)
3	2019/09/27	人工智慧投資分析與機器人理財顧問 (Artificial Intelligence for Investment Analysis and Robo-Advisors)
4	2019/10/04	金融科技對話式商務與智慧型交談機器人 (Conversational Commerce and Intelligent Chatbots for Fintech)
5	2019/10/11	國慶日補假 (Bridge Holiday for National Day, Extra Day Off)
6	2019/10/18	財務金融事件研究法 (Event Studies in Finance)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
7	2019/10/25	人工智慧財務金融應用個案研究 I (Case Study on AI in Financial Application I)
8	2019/11/01	Python AI智慧金融分析基礎 (Foundations of AI in Finance Big Data Analytics with Python)
9	2019/11/08	Python Pandas 量化投資分析 (Quantitative Investing with Pandas in Python)
10	2019/11/15	期中報告 (Midterm Project Report)
11	2019/11/22	Python Scikit-Learn 機器學習財務金融應用 (Machine Learning in Finance Application with Scikit-Learn In Python)
12	2019/11/29	TensorFlow 深度學習財務金融應用I (Deep Learning for Finance Application with TensorFlow I)

課程大綱 (Syllabus)

週次 (Week)	日期 (Date)	內容 (Subject/Topics)
13	2019/12/06	人工智慧財務金融應用個案研究 II (Case Study on AI in Financial Application II)
14	2019/12/13	TensorFlow 深度學習財務金融應用II (Deep Learning for Finance Application with TensorFlow II)
15	2019/12/20	TensorFlow 深度學習財務金融應用III (Deep Learning for Finance Application with TensorFlow III)
16	2019/12/27	社會網絡分析財務金融應用 (Social Network Analysis for Finance Application)
17	2020/01/03	期末報告 I (Final Project Presentation I)
18	2020/01/10	期末報告 II (Final Project Presentation II)

Social Network Analysis (SNA)

Outline

- Social Computing and Social Network Analysis (SNA)
- Social Network Analysis with Gephi
- Applications of SNA

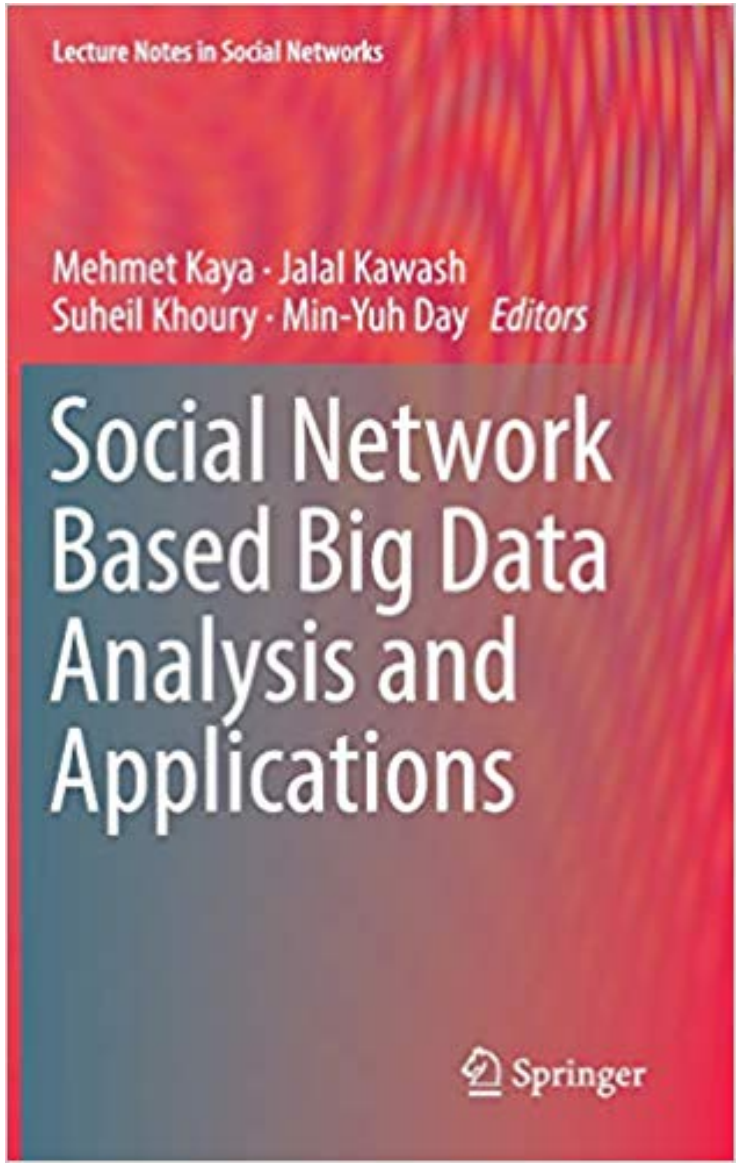
Social Computing

Social Network Analysis (SNA)

Social Computing

- Social Network Analysis
- Link mining
- Community Detection
- Social Recommendation

Mehmet Kaya, Jalal Kawash, Suheil Khoury, Min-Yuh Day (2018), **Social Network Based Big Data Analysis and Applications**, Springer

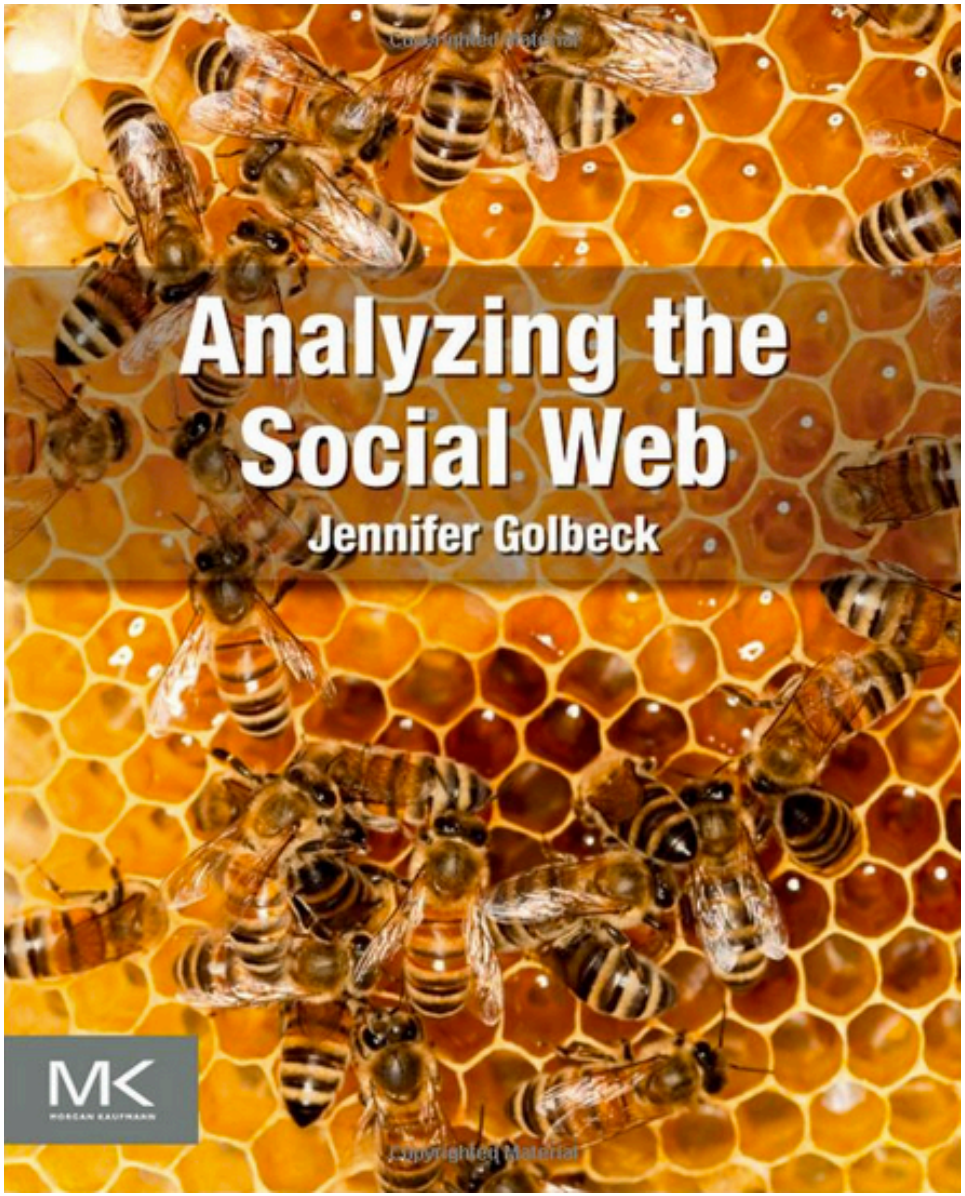


Source: https://www.amazon.com/Network-Analysis-Applications-Lecture-Networks/dp/3319781952

Business Insights with Social Analytics

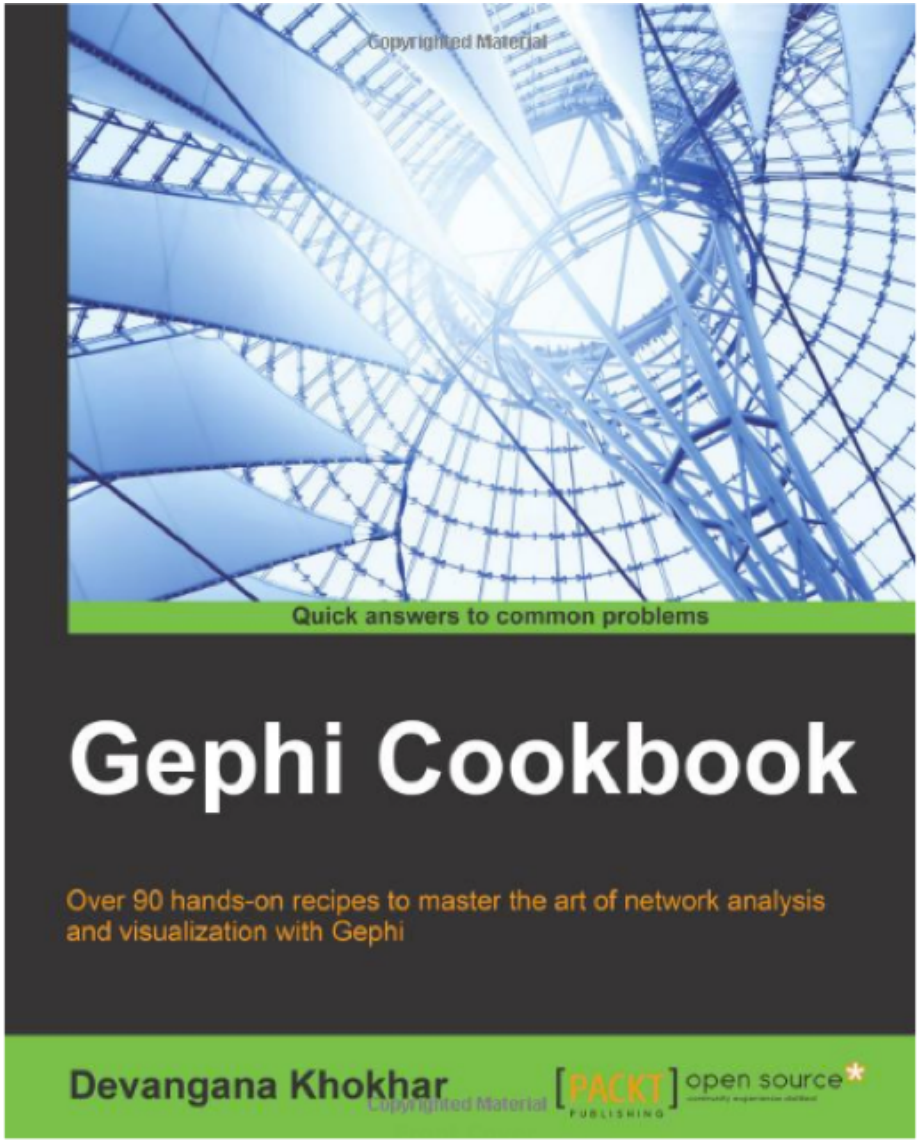
Analyzing the Social Web:
Social Network Analysis

Jennifer Golbeck (2013), **Analyzing the Social Web**, Morgan Kaufmann



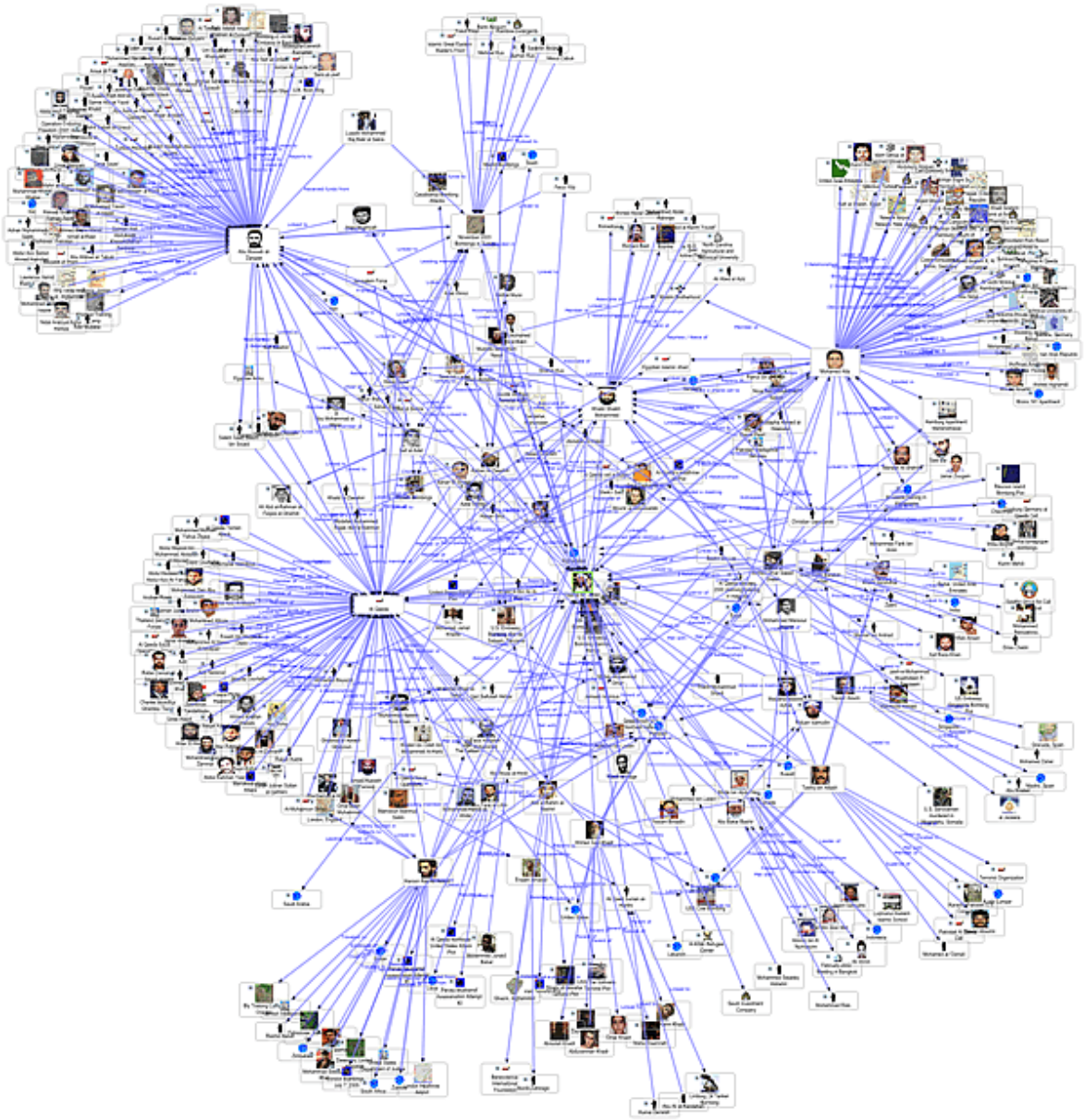
Source: http://www.amazon.com/Analyzing-Social-Web-Jennifer-Golbeck/dp/0124055311

Devangana Khokhar (2015), Gephi Cookbook, Packt Publishing



Source: http://www.amazon.com/Gephi-Cookbook-Devangana-Khokhar/dp/1783987405

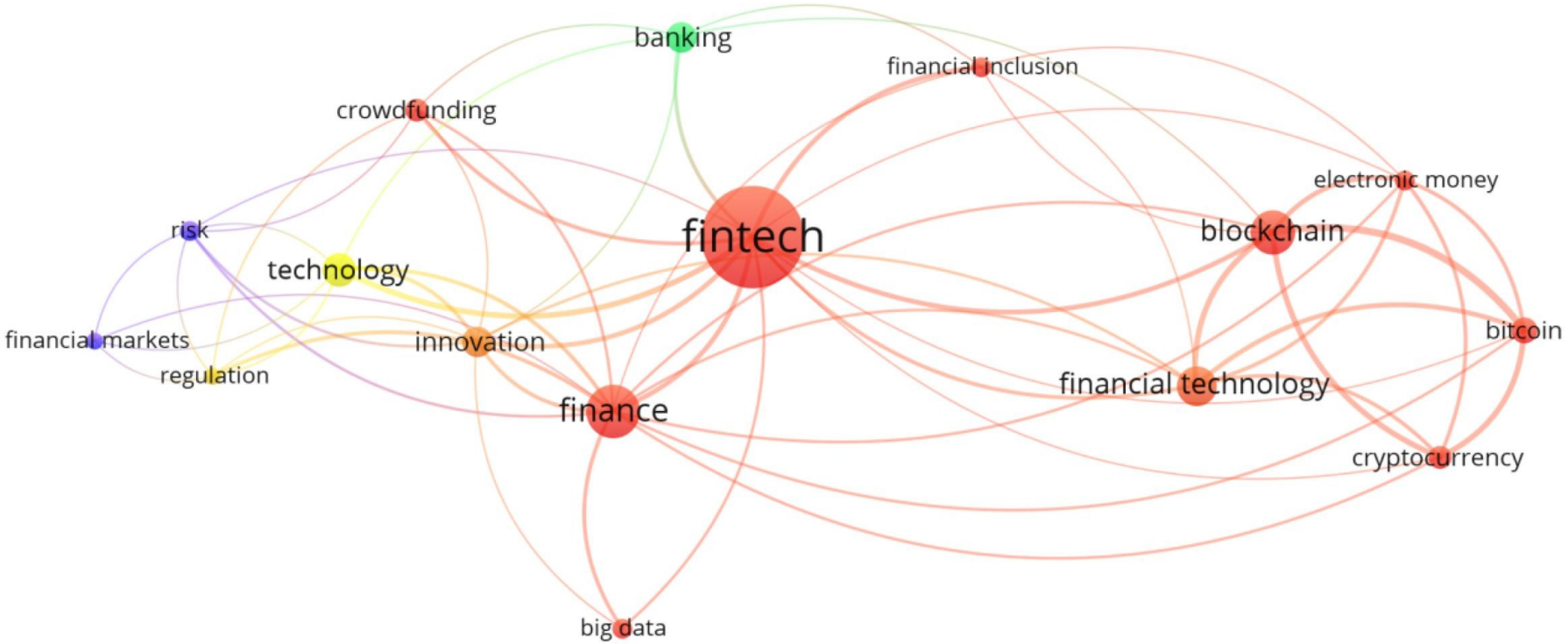
Social Network Analysis



Source: http://www.fmsasg.com/SocialNetworkAnalysis/

SNA in Fintech Research

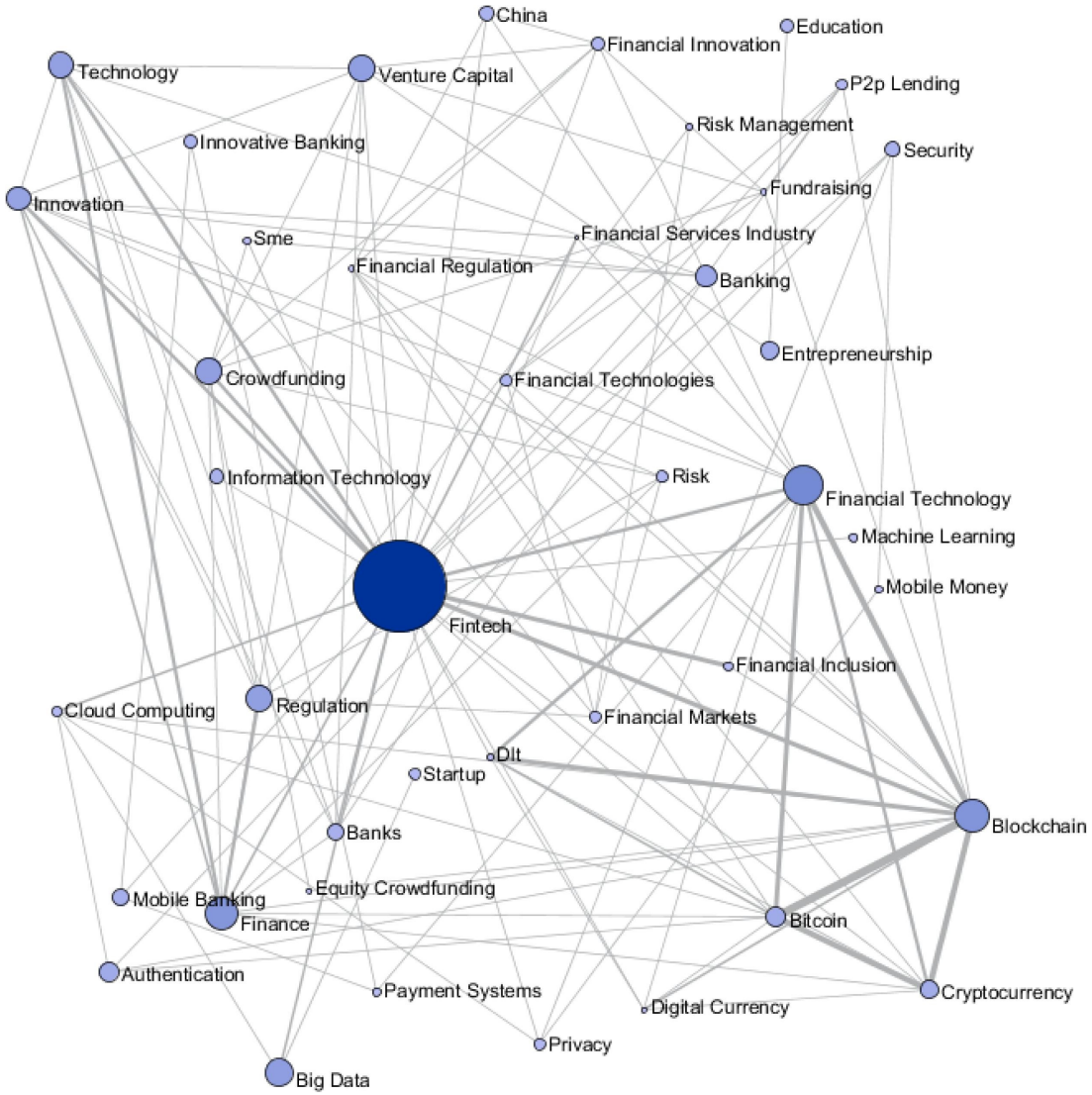
VOSviewer – Network Visualization of the Occurrences of Keywords



Source: Eduardo Z. Milian, Mauro de M. Spinola, and Marly M. de Carvalho (2019).
"Fintechs: A literature review and research agenda." Electronic Commerce Research and Applications, 34, 100833.

SNA in Fintech Research

Sci2 Tool – Keyword Co-occurrence Network



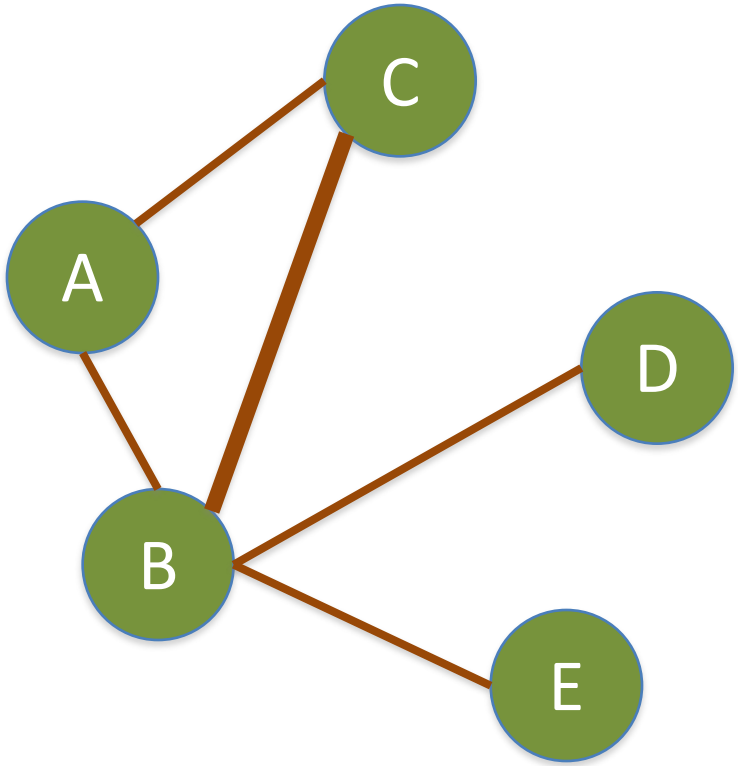
Source: Eduardo Z. Milian, Mauro de M. Spinola, and Marly M. de Carvalho (2019). "Fintechs: A literature review and research agenda." Electronic Commerce Research and Applications, 34, 100833.

Social Network Analysis

- A **social network** is a social structure of people, related (directly or indirectly) to each other through a common relation or interest
- **Social network analysis (SNA)** is the study of social networks to understand their structure and behavior

Graph Theory

Graph



Graph

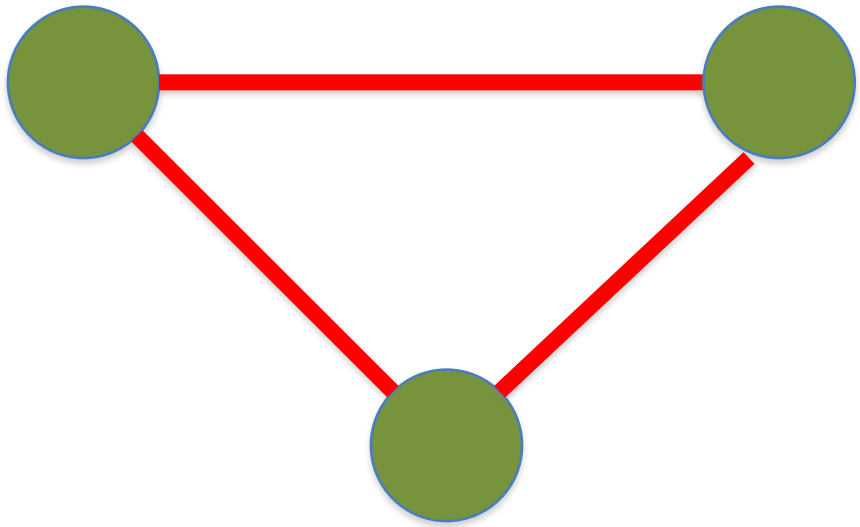
g = (V, E)

Vertex (Node)

Vertices (Nodes)

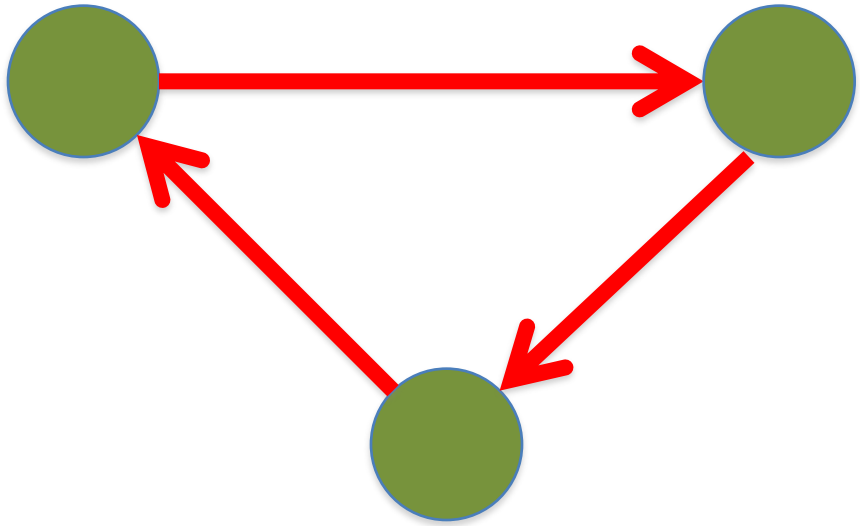
Edge

Edges

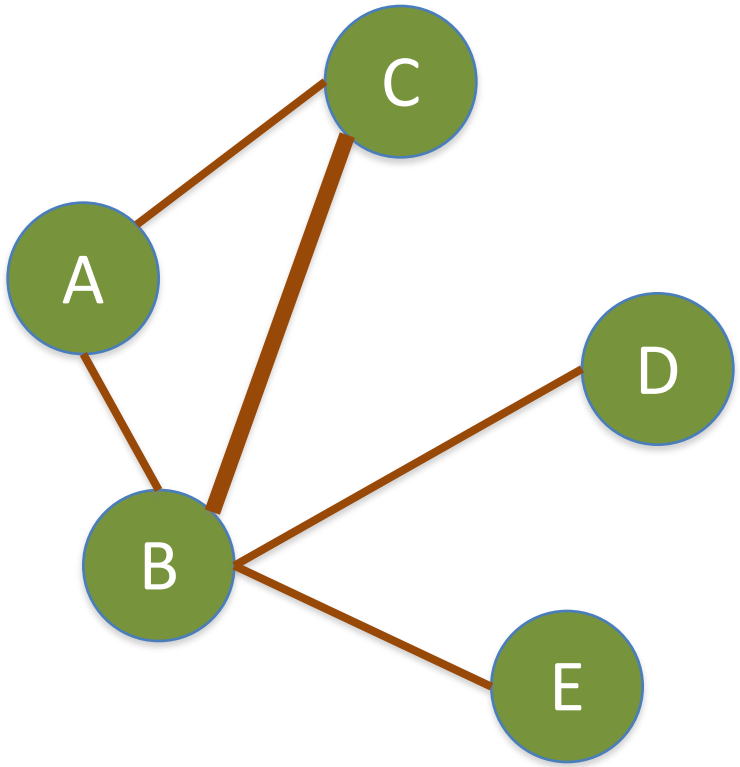


Arc

Arcs

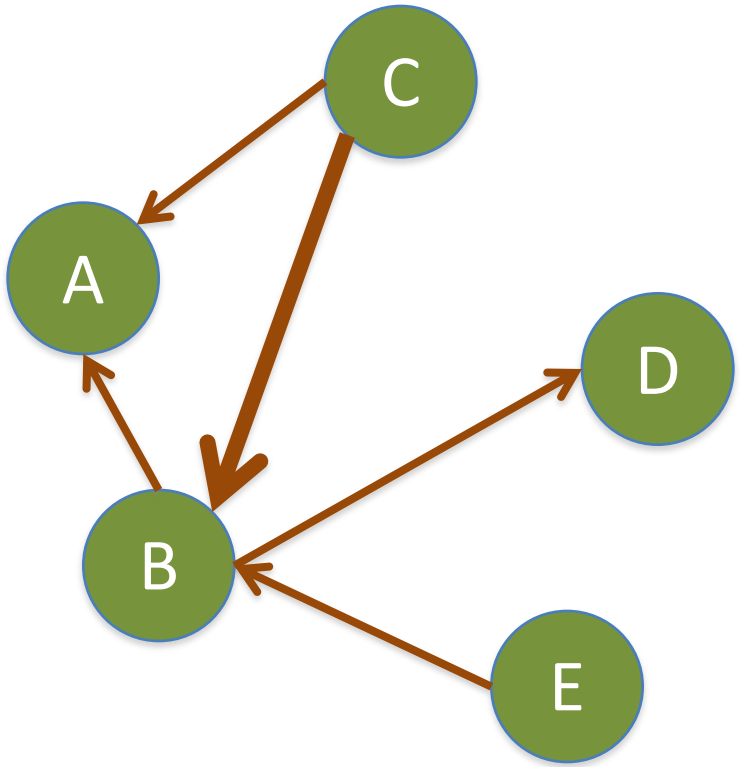


Undirected Graph



Source: https://www.youtube.com/watch?v=89mxOdwPfxA

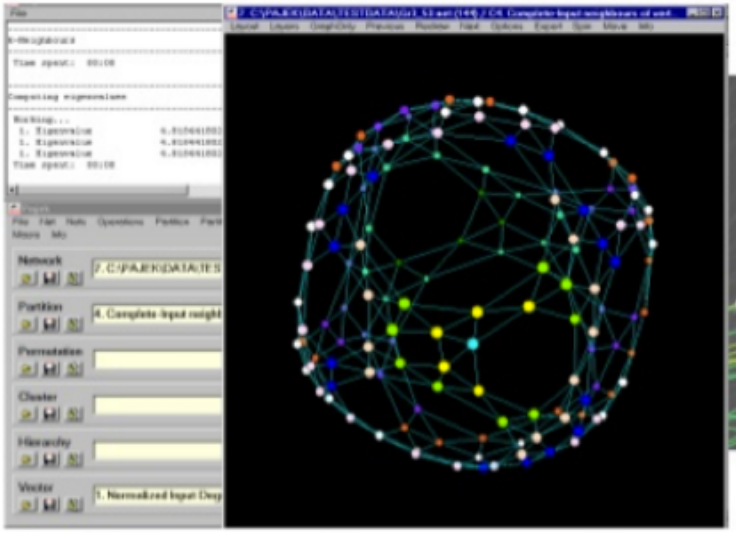
Directed Graph

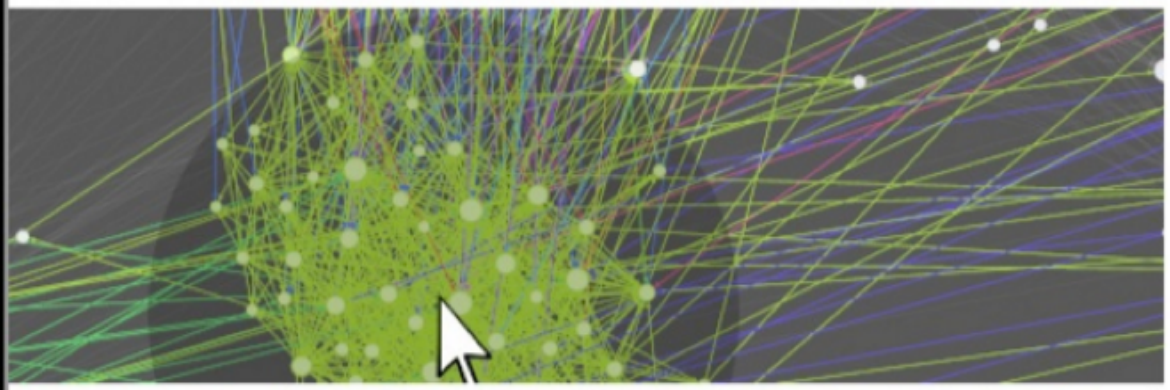


Source: https://www.youtube.com/watch?v=89mxOdwPfxA

Measurements of Social Network Analysis

Exploratory Network Analysis





1 see the network

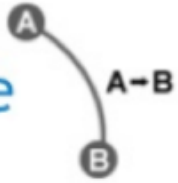
1st graph viz tool: Pajek (1996)
Vladimir Batagelj, Andrej Mrvar

2 interact in real time

Gephi prototype (2008)
group, filter, compute metrics...

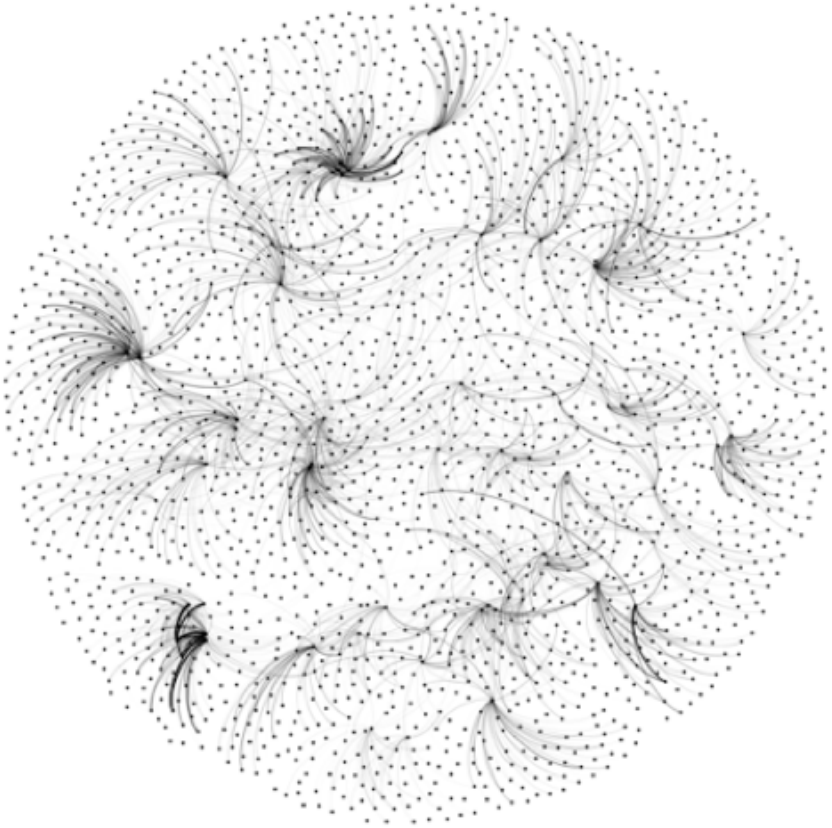
3 build a visual language

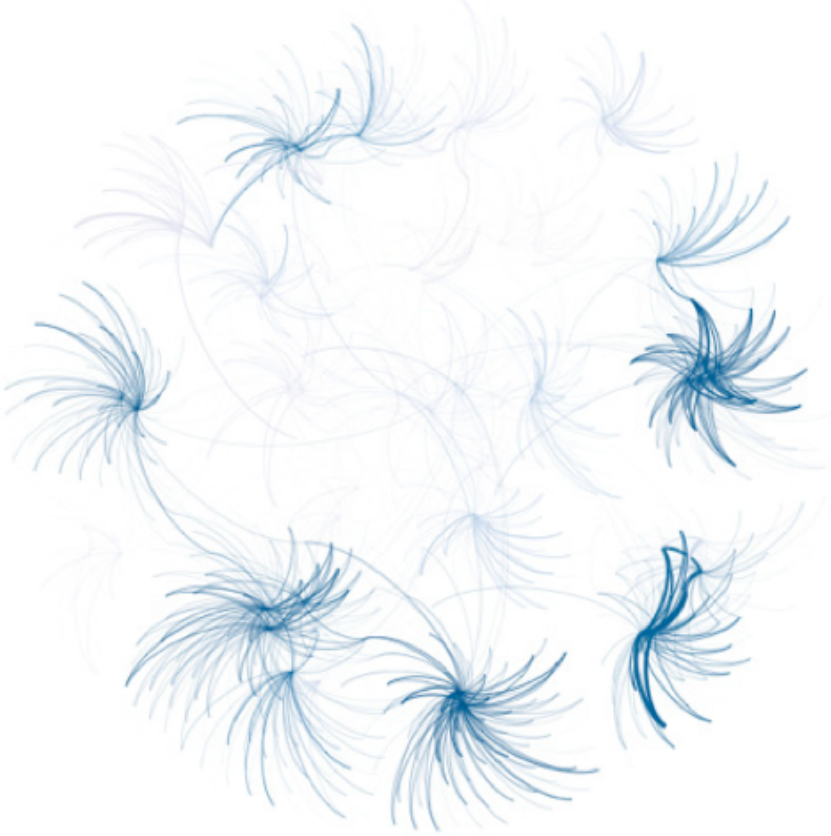
size by rank, color by partition,
label, curved edges, thickness...



Source: http://sebastien.pro/gephi-icwsm-tutorial.pdf

Looking for a “Simple Small Truth”? What Data Visualization Should Do?





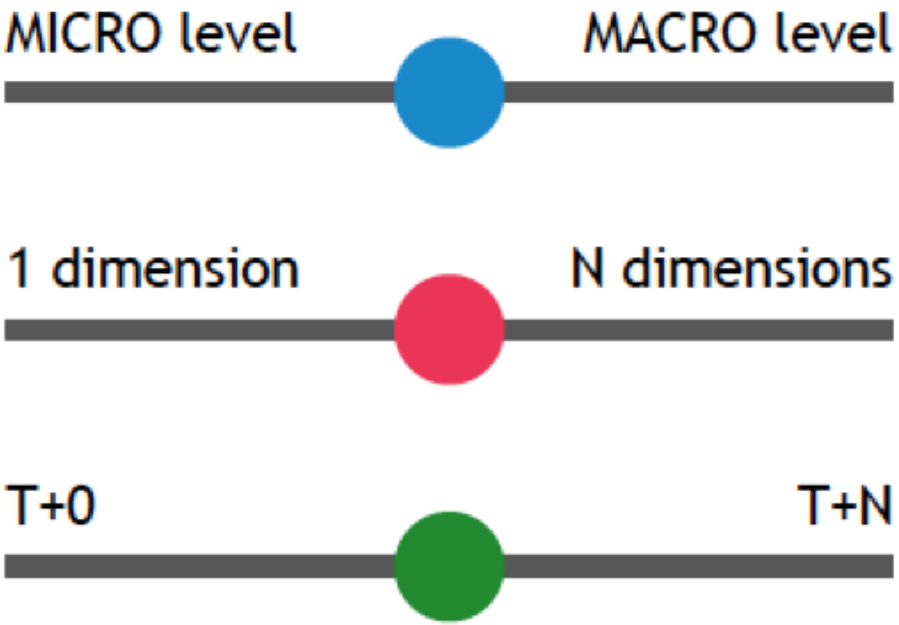
1. Make complex things **simple**
2. Extract **small** information from large data
3. Present **truth**, do not deceive

Source: http://sebastien.pro/gephi-icwsm-tutorial.pdf

Measurements

Looking for Orderness in Data

Make varying 3 cursors simultaneously to extract meaningful patterns



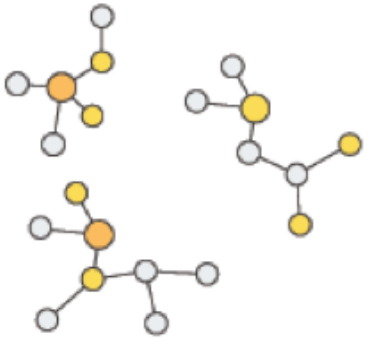
at different levels

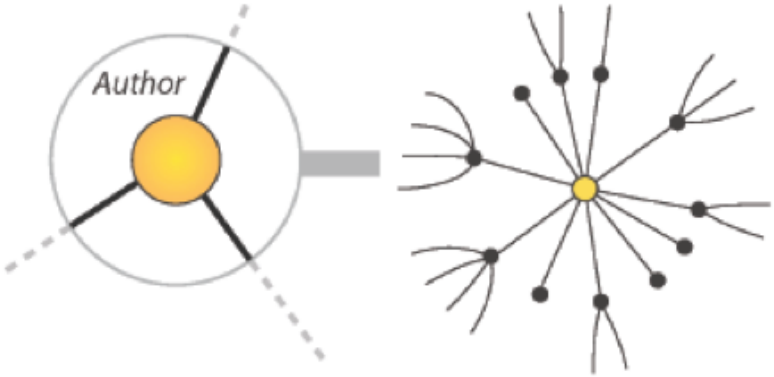
on multiple dimensions

at time scale

Source: http://sebastien.pro/gephi-icwsm-tutorial.pdf

“Zoom” cursor on Quantitative Data





Global
- connectivity
- density
- centralization

Local
- communities
- bridges between communities
- local centers vs periphery

Individual
- centrality
- distances
- neighborhood
- location
- local authority vs hub

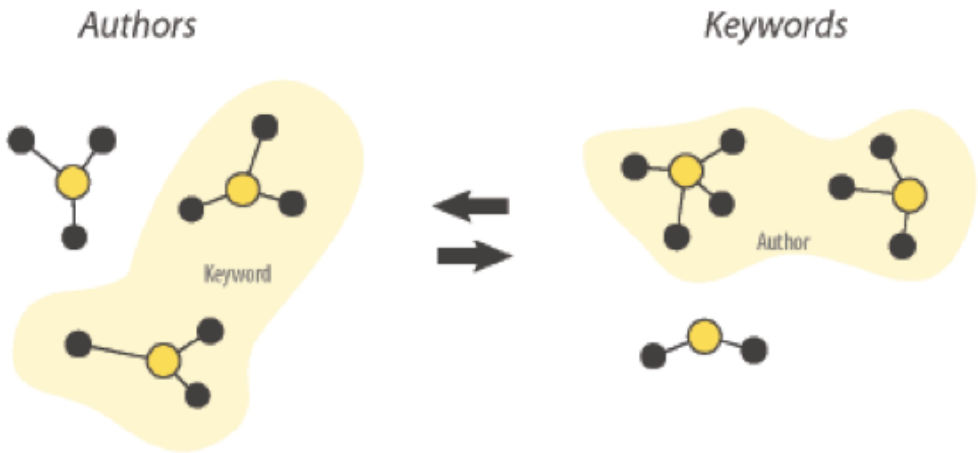
Source: http://sebastien.pro/gephi-icwsm-tutorial.pdf

“Crossing” cursor on Quantitative Data

Social
- who with whom
- communities
- brokerage
- influence and power
- homophily

Semantic
- topics
- thematic clusters

Geographic
- spatial phenomena



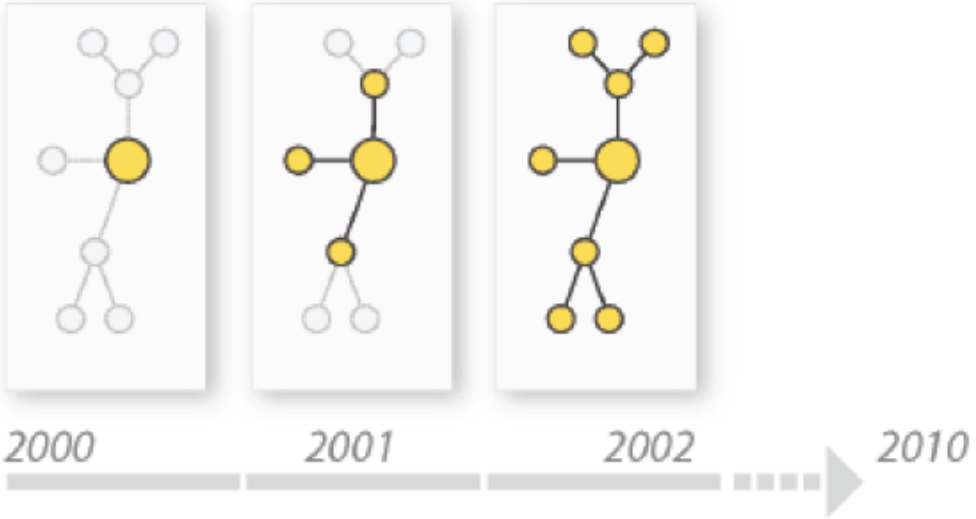
Source: http://sebastien.pro/gephi-icwsm-tutorial.pdf

“Timeline” cursor on Temporal Data

Evolution of social ties

Evolution of communities

Evolution of topics



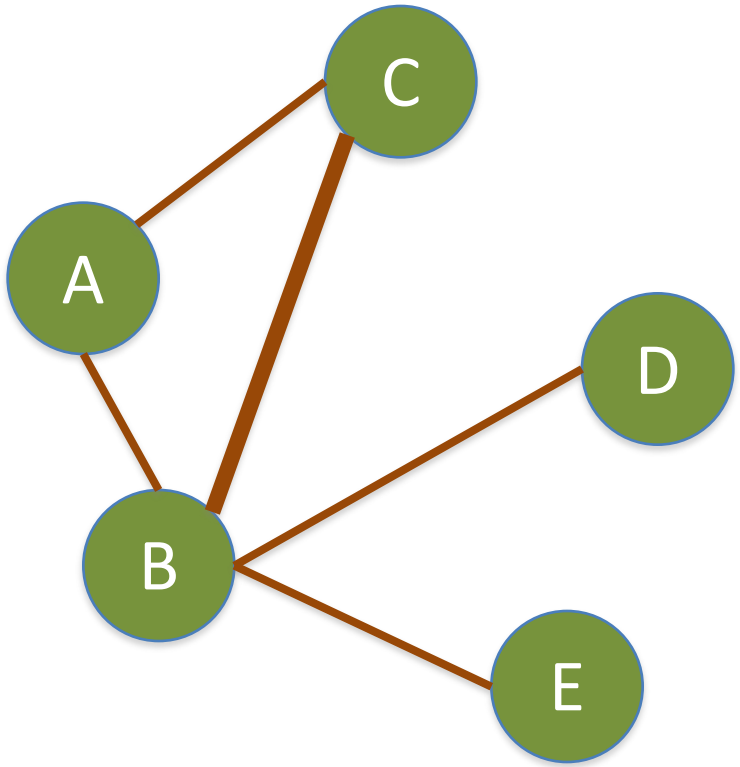
Source: http://sebastien.pro/gephi-icwsm-tutorial.pdf

SNA Guideline

# nodes	
1 - 100	lists + edges in bonus, focus on qualitative data
100 - 1,000	How attributes explain the structure? • easy to read, "obvious" patterns • focus on entities (in context) • metrics are tools to describe the graph (centrality, bridging...) • links help to build and interpret categories of entities challenge: mix attribute crossing and connectivity
1,000 - 50,000	How the structure explains attributes? • hard to read, problem of "**hidden signals**": track patterns with various layouts and filtering • focus on structures • metrics are tools to build the graph (cosine similarity...) • categories help to understand the structure challenge: pattern recognition
> 50,000	require high computational power

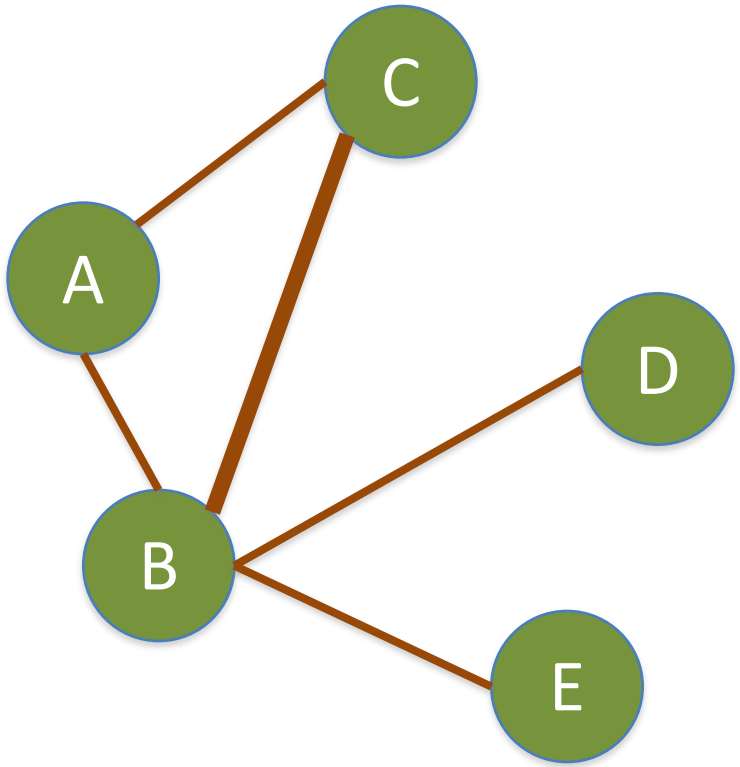
Source: http://sebastien.pro/gephi-icwsm-tutorial.pdf

Degree



Source: https://www.youtube.com/watch?v=89mxOdwPfxA

Degree



A: 2

B: 4

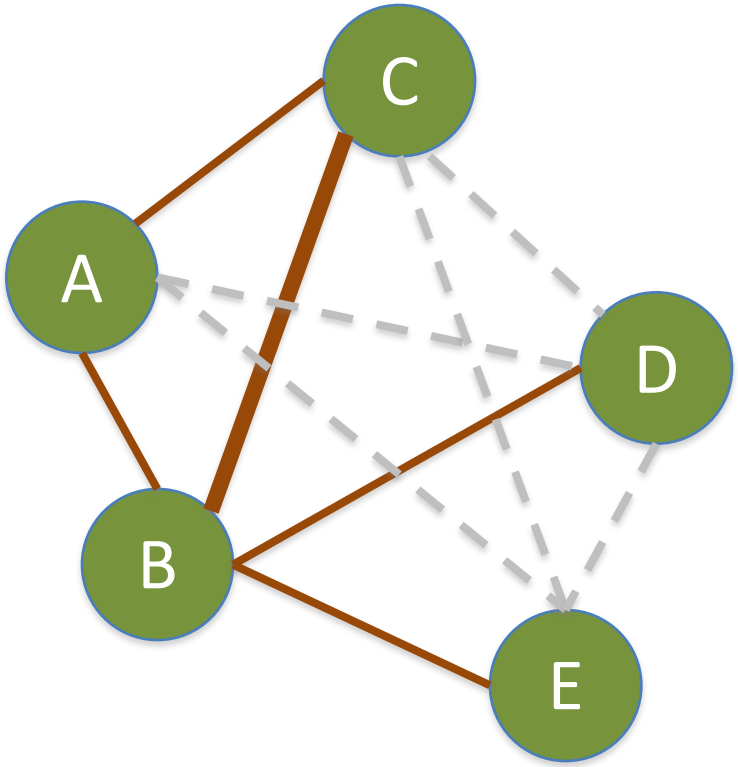
C: 2

D:1

E: 1

Source: https://www.youtube.com/watch?v=89mxOdwPfxA

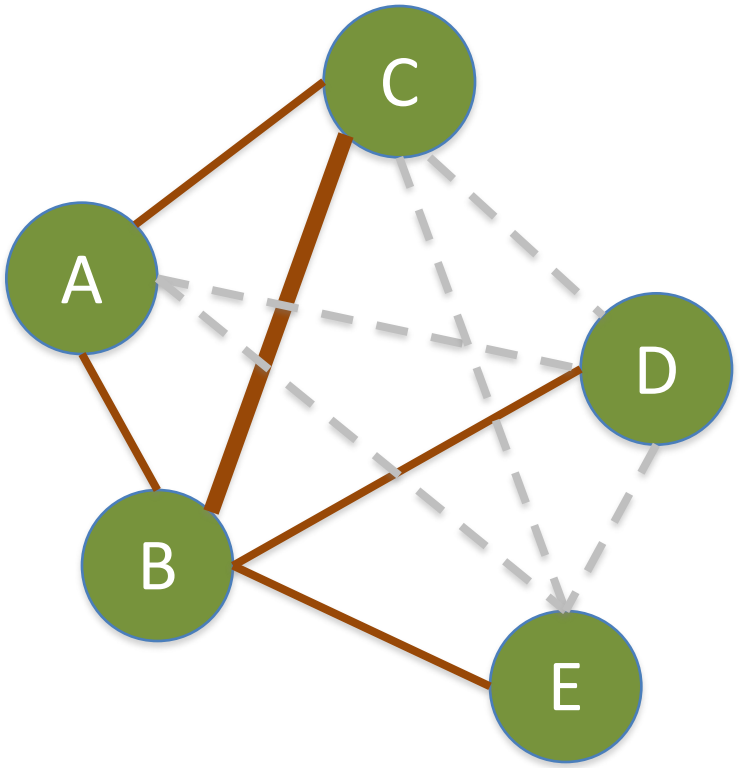
Density



Source: https://www.youtube.com/watch?v=89mxOdwPfxA

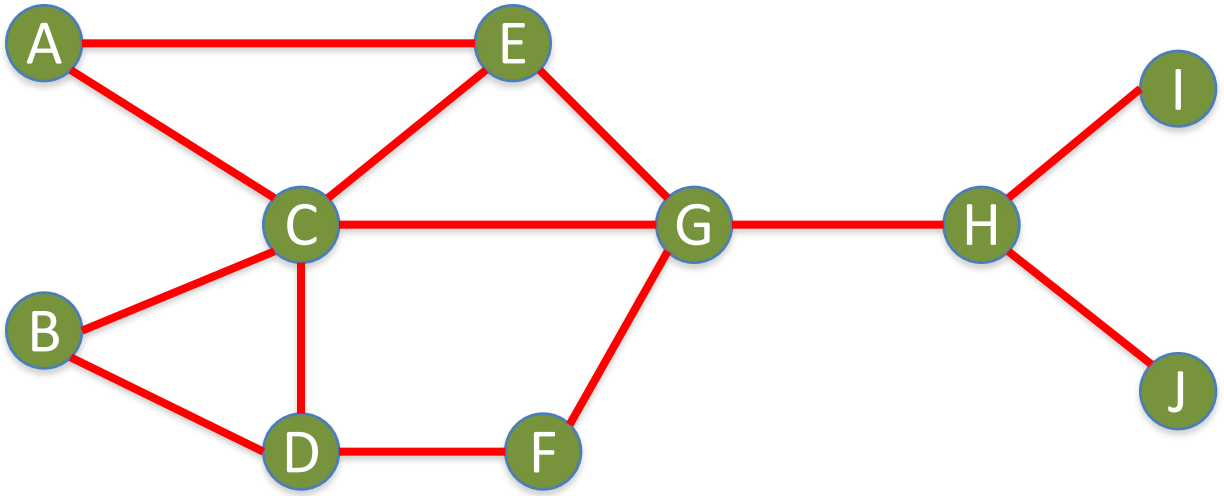
Density

Edges (Links): 5
Total Possible Edges: 10
Density: 5/10 = 0.5



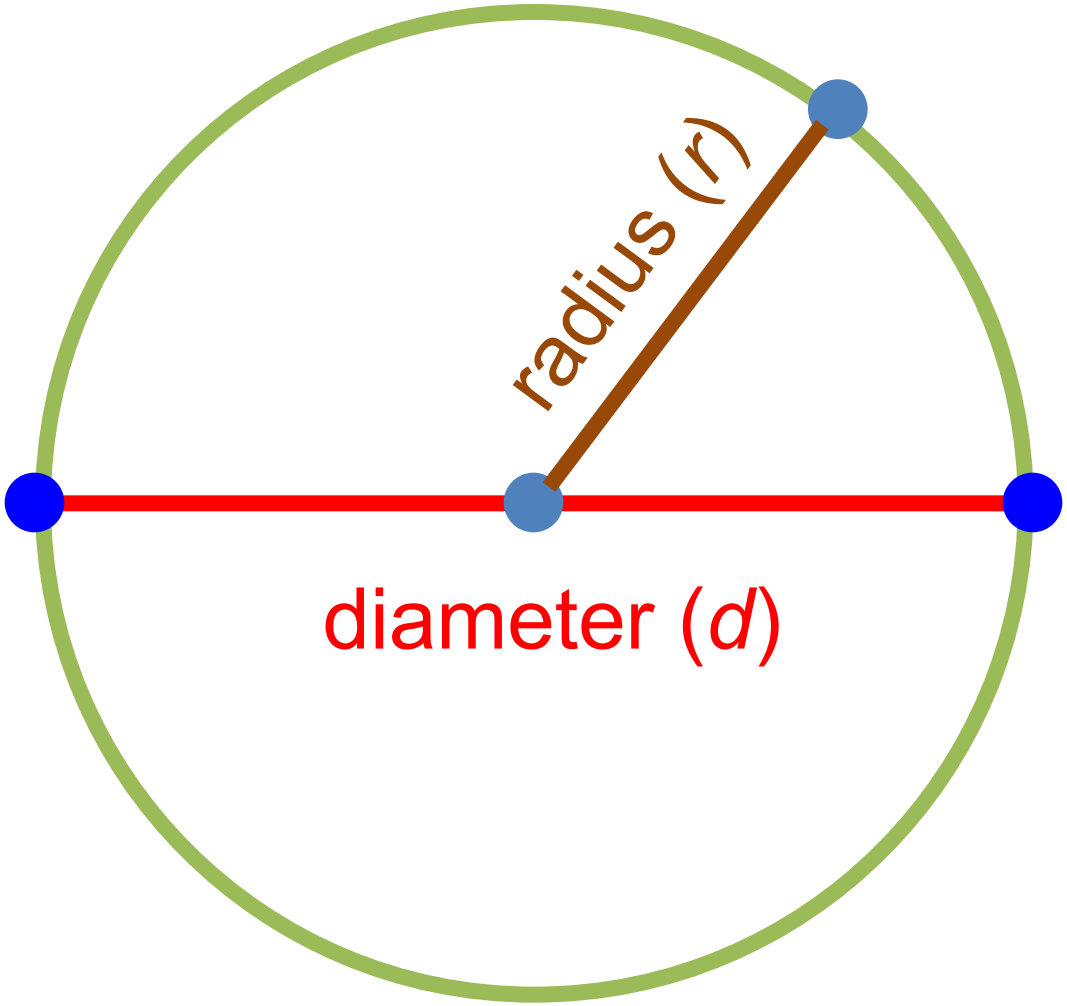
Source: https://www.youtube.com/watch?v=89mxOdwPfxA

Density

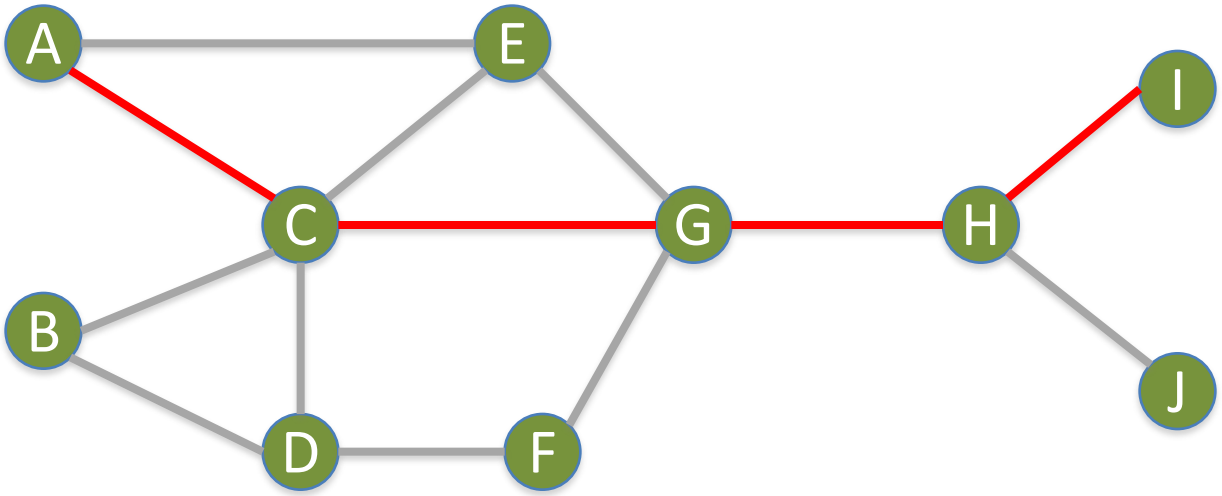


Nodes (n): 10
Edges (Links): 13
Total Possible Edges: (n * (n-1)) / 2 = (10 * 9) / 2 = 45
Density: 13/45 = 0.29

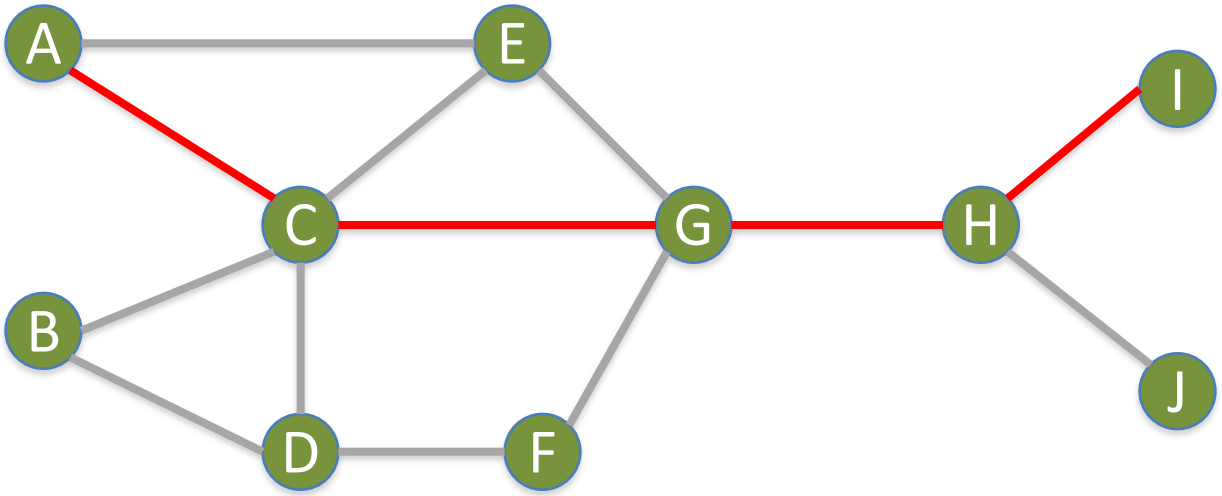
Diameter



Diameter

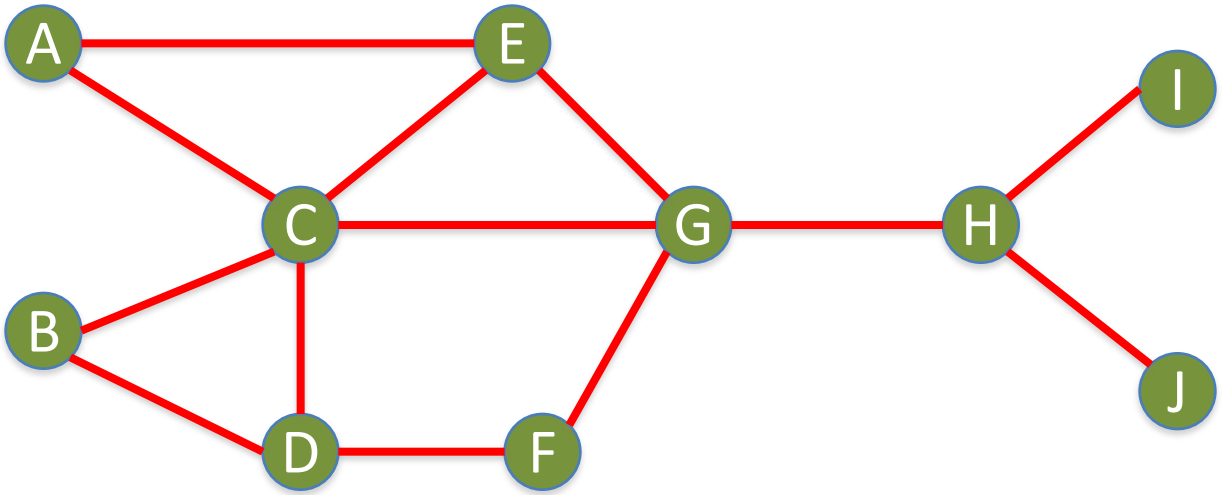


Diameter
Geodesic Path (Shortest Path)



A→ I : Diameter = 4

Which Node is Most Important?



Centrality

- Important or prominent actors are those that are linked or involved with other actors extensively.
- A person with extensive contacts (links) or communications with many other people in the organization is considered more important than a person with relatively fewer contacts.
- The links can also be called **ties**.
  A central actor is one involved in many ties.

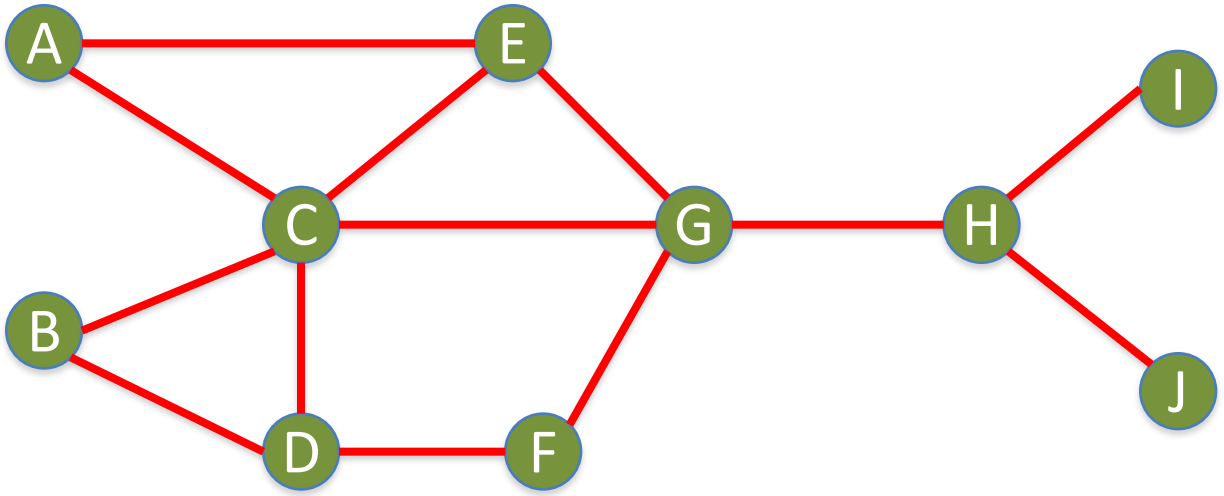
Source: Bing Liu (2011) , "Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data"

Social Network Analysis (SNA)

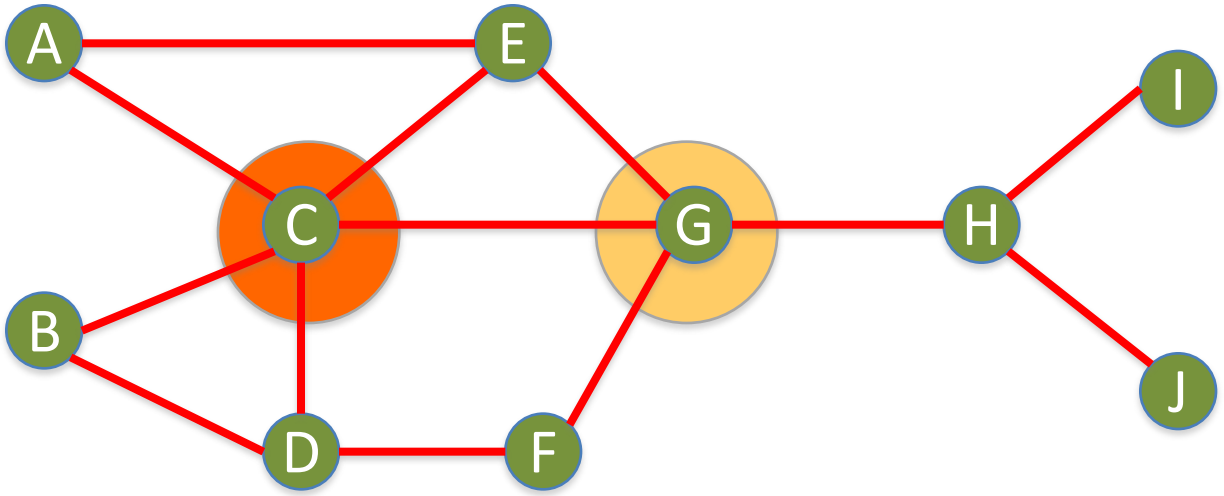
- Degree Centrality
- Betweenness Centrality
- Closeness Centrality

Degree Centrality

Social Network Analysis: Degree Centrality



Social Network Analysis: Degree Centrality



Node	Score	Standardized Score
A	2	2/10 = 0.2
B	2	2/10 = 0.2
C	**5**	**5/10 = 0.5**
D	3	3/10 = 0.3
E	3	3/10 = 0.3
F	2	2/10 = 0.2
G	**4**	**4/10 = 0.4**
H	3	3/10 = 0.3
I	1	1/10 = 0.1
J	1	1/10 = 0.1

Betweenness Centrality

Betweenness centrality:

Connectivity

Number of shortest paths going through the actor

Betweenness Centrality

$$C_B(i) = \sum_{j<k} g_{ik}(i) / g_{jk}$$

Where g_{jk} = the number of shortest paths connecting jk
$g_{jk}(i)$ = the number that actor i is on.

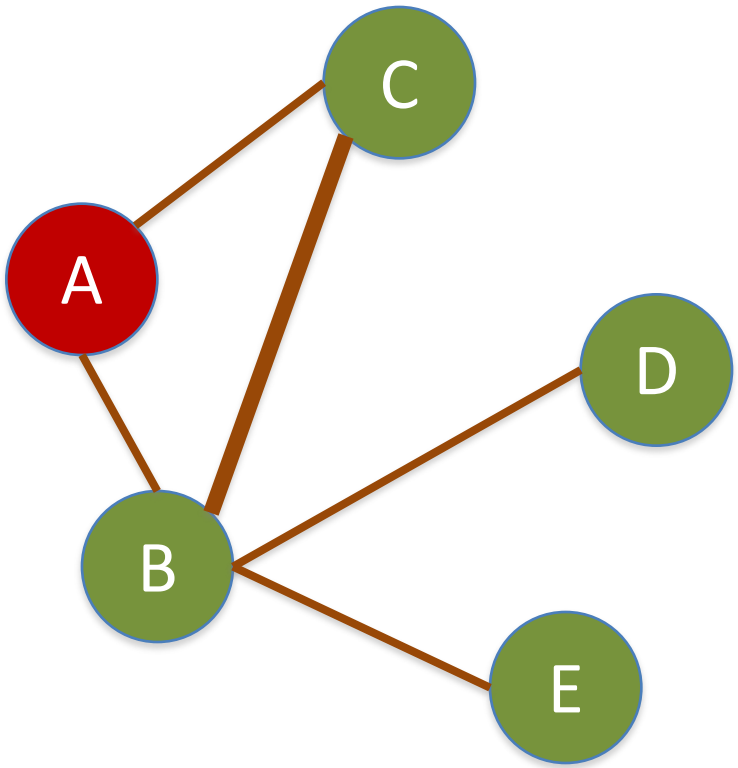
Normalized Betweenness Centrality

$$C'_B(i) = C_B(i) / [(n-1)(n-2)/2]$$

Number of pairs of vertices excluding the vertex itself

Source: https://www.youtube.com/watch?v=RXohUeNCJiU

Betweenness Centrality

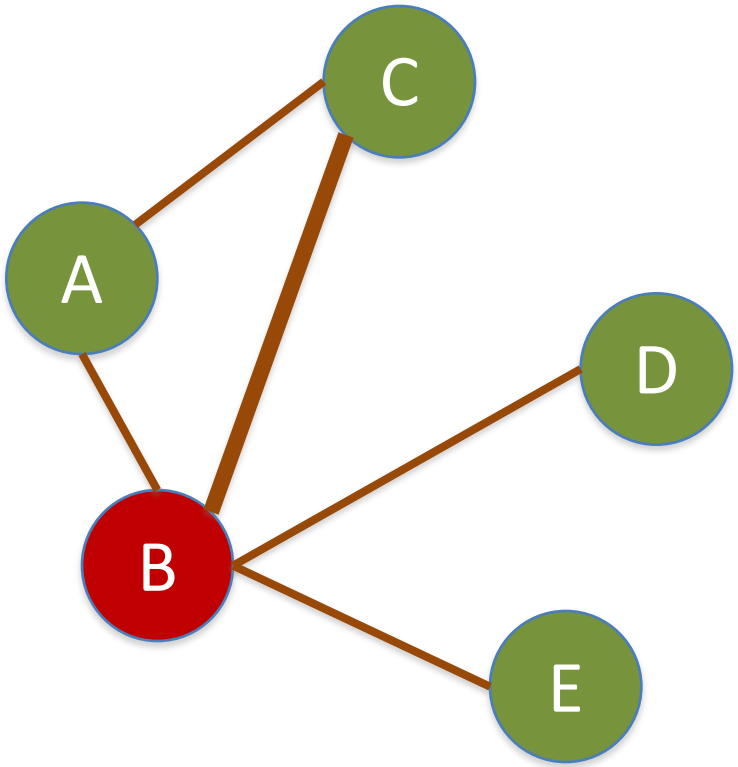


A:
B→C: 0/1 = 0
B→D: 0/1 = 0
B→E: 0/1 = 0
C→D: 0/1 = 0
C→E: 0/1 = 0
D→E: 0/1 = 0

Total: 0

A: Betweenness Centrality = 0

Betweenness Centrality

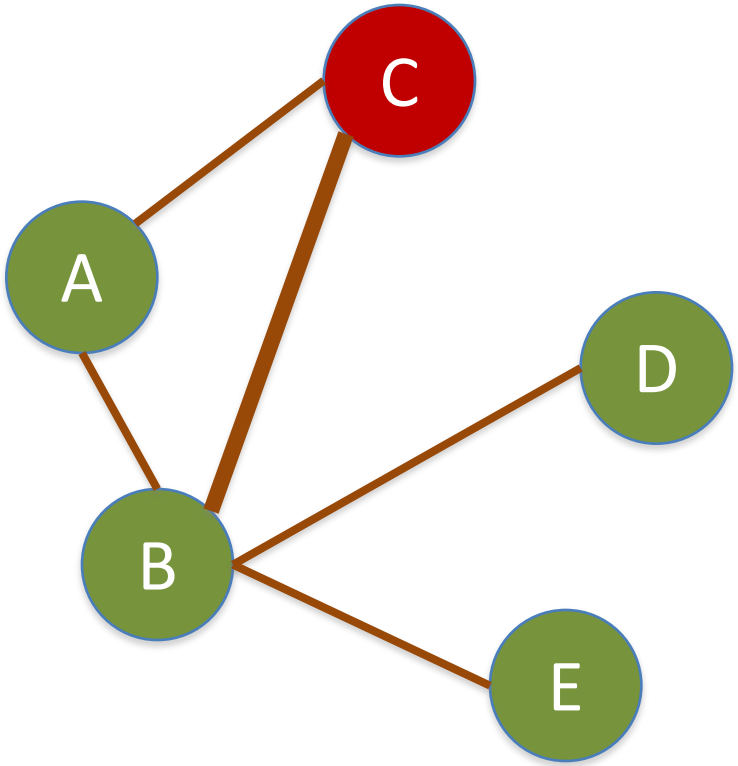


B:
A→C: 0/1 = 0
A→D: 1/1 = 1
A→E: 1/1 = 1
C→D: 1/1 = 1
C→E: 1/1 = 1
D→E: 1/1 = 1

Total: 5

B: Betweenness Centrality = 5

Betweenness Centrality

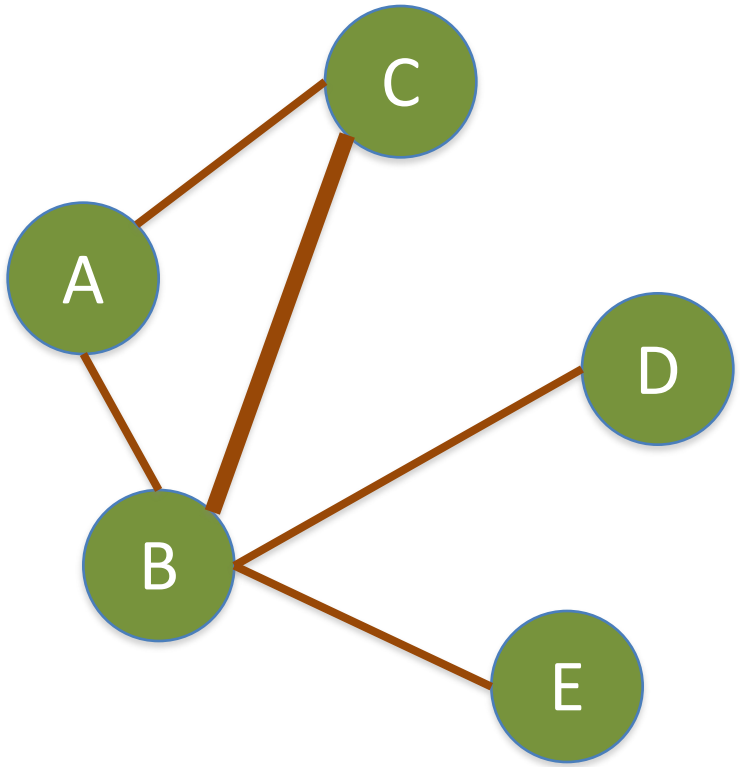


C:
A→B: 0/1 = 0
A→D: 0/1 = 0
A→E: 0/1 = 0
B→D: 0/1 = 0
B→E: 0/1 = 0
D→E: 0/1 = 0

Total: 0

C: Betweenness Centrality = 0

Betweenness Centrality



A: 0

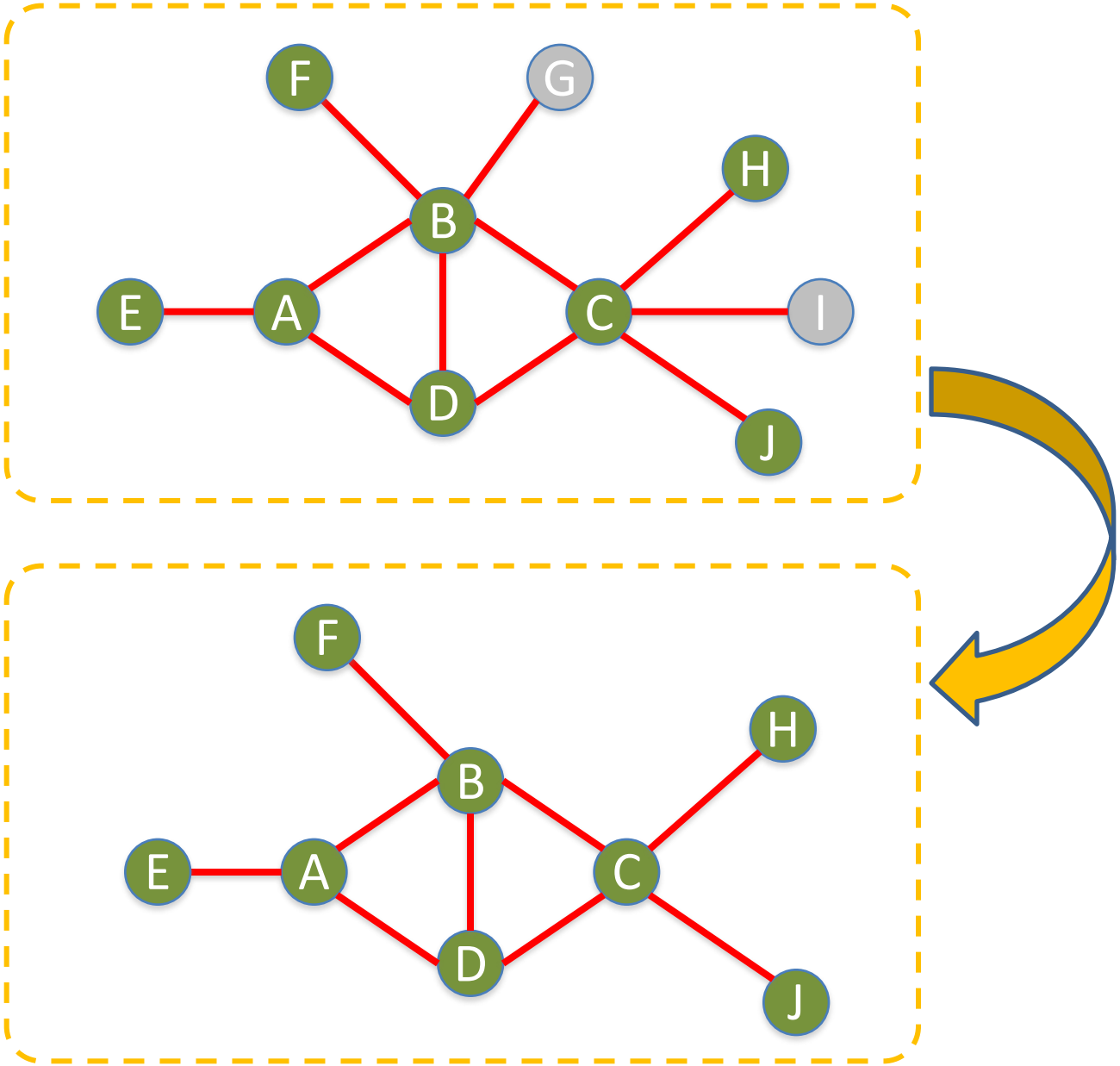
B: 5

C: 0

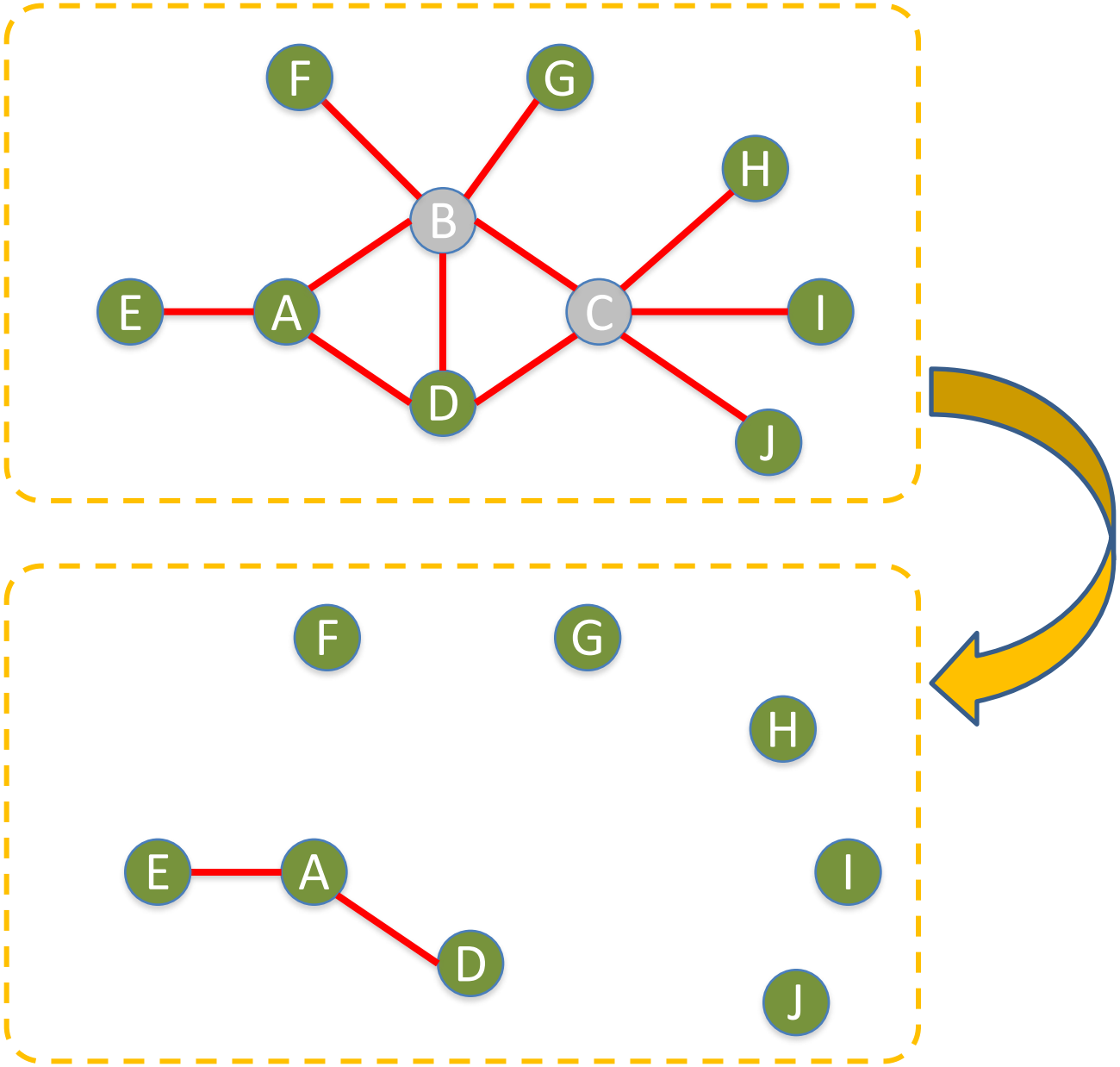
D: 0

E: 0

Which Node is Most Important?

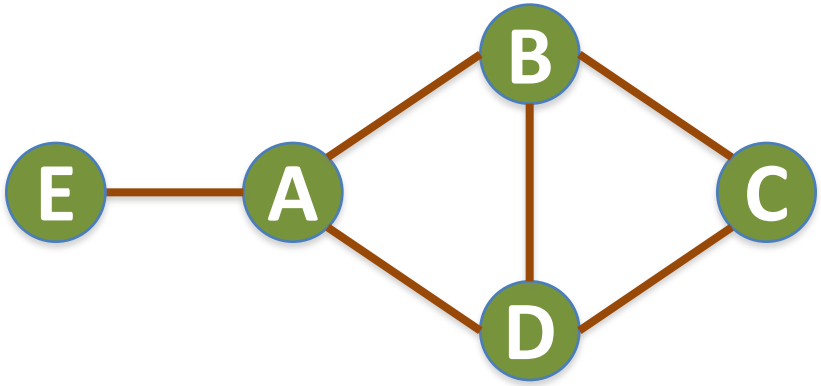


Which Node is Most Important?

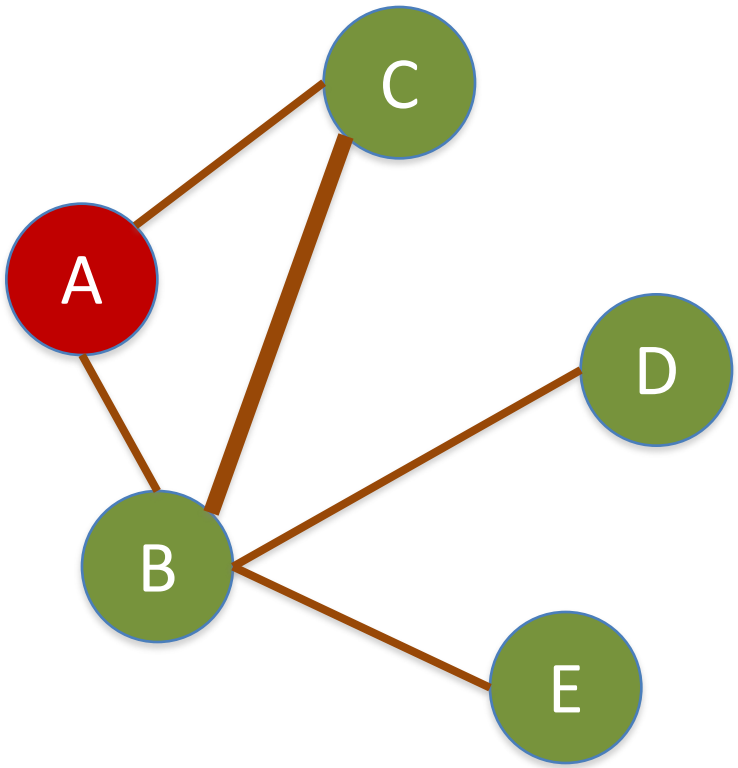


Betweenness Centrality

$$C_B(i) = \sum_{j<k} g_{ik}(i) / g_{jk}$$



Betweenness Centrality



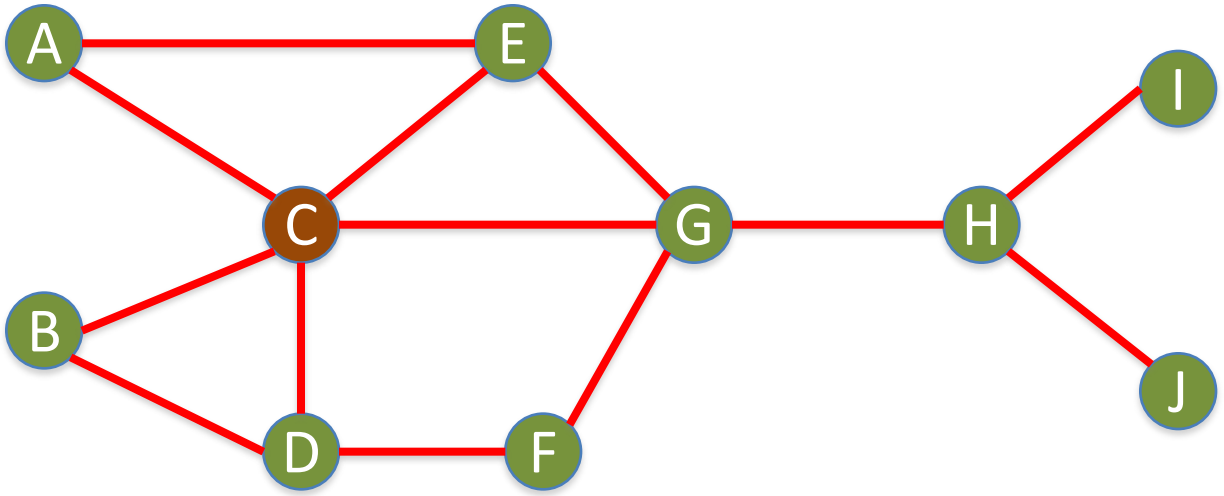
A:
B→C: 0/1 = 0
B→D: 0/1 = 0
B→E: 0/1 = 0
C→D: 0/1 = 0
C→E: 0/1 = 0
D→E: 0/1 = 0

Total: 0

A: Betweenness Centrality = 0

Closeness Centrality

Social Network Analysis: Closeness Centrality

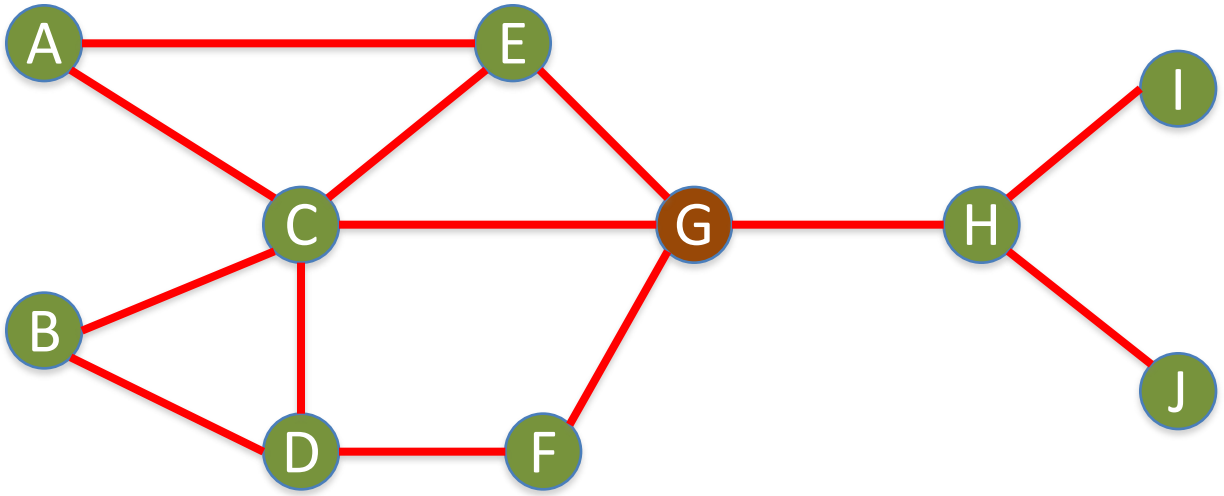


C→A: 1
C→B: 1
C→D: 1
C→E: 1
C→F: 2
C→G: 1
C→H: 2
C→I: 3
C→J: 3

Total=15

C: Closeness Centrality = 15/9 = 1.67

Social Network Analysis: Closeness Centrality

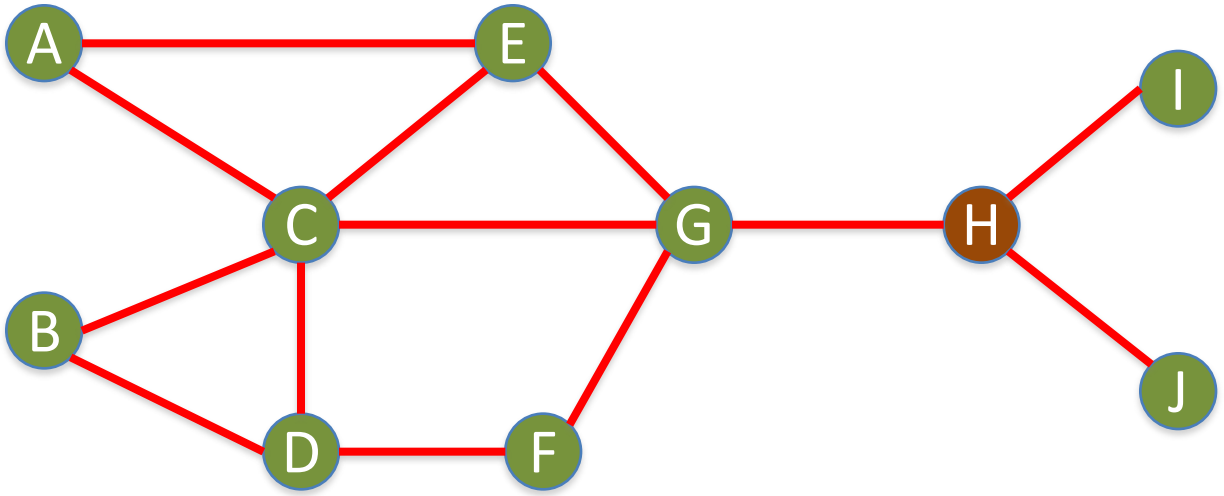


G→A: 2
G→B: 2
G→C: 1
G→D: 2
G→E: 1
G→F: 1
G→H: 1
G→I: 2
G→J: 2

Total=14

G: Closeness Centrality = 14/9 = 1.56

Social Network Analysis: Closeness Centrality

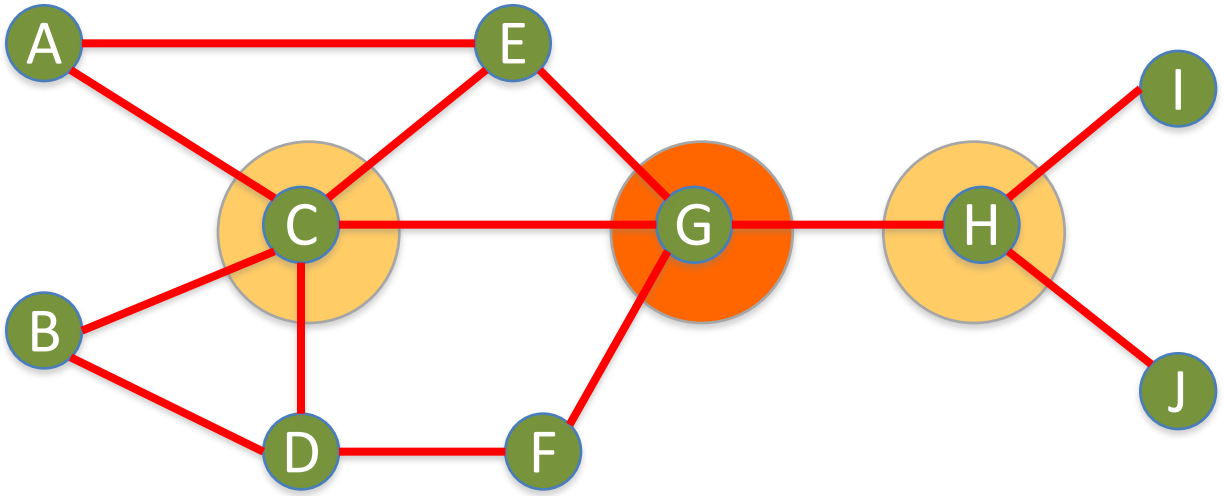


H→A: 3
H→B: 3
H→C: 2
H→D: 2
H→E: 2
H→F: 2
H→G: 1
H→I: 1
H→J: 1

Total=17

H: Closeness Centrality = 17/9 = 1.89

Social Network Analysis: Closeness Centrality



G: Closeness Centrality = 14/9 = 1.56 1

C: Closeness Centrality = 15/9 = 1.67 2

H: Closeness Centrality = 17/9 = 1.89 3

Social Network Analysis (SNA)

importance of neighbors

Eigenvector centrality

Eigenvector centrality:

Importance of a node
depends on
the importance of its neighbors

Social Network Analysis: Closeness Centrality

Sum of the reciprocal distances

$$C_C(p_k) = \sum_{i=1}^{n} d(p_i, p_k)^{-1}$$

where $d(p_j, p_k)$ is the geodesic distance (shortest paths) linking p_j, p_k

Social Network Analysis: Betweenness Centrality

$$C_B(p_k) = \sum_{i<j}^{n} \frac{g_{ij}(p_k)}{g_{ij}}; \quad i \neq j \neq k$$

where g_{ij} is the geodesic distance (shortest paths) linking p_i and p_j and $g_{ij}(p_k)$ is the geodesic distance linking p_i and p_j that contains p_k.

Source: Abbasi, A., Hossain, L., & Leydesdorff, L. (2012). Betweenness centrality as a driver of preferential attachment in the evolution of research collaboration networks. *Journal of Informetrics*, *6*(3), 403-412.

Social Network Analysis: Degree Centrality

$$C_D(p_k) = \sum_{i=1}^{n} a(p_i, p_k)$$

where $a(p_i, p_k) = 1$ if and only if p_i and p_k are connected by a line
0 otherwise

$$C'_D(p_k) = \frac{\sum_{i=1}^{n} a(p_i, p_k)}{n-1}$$

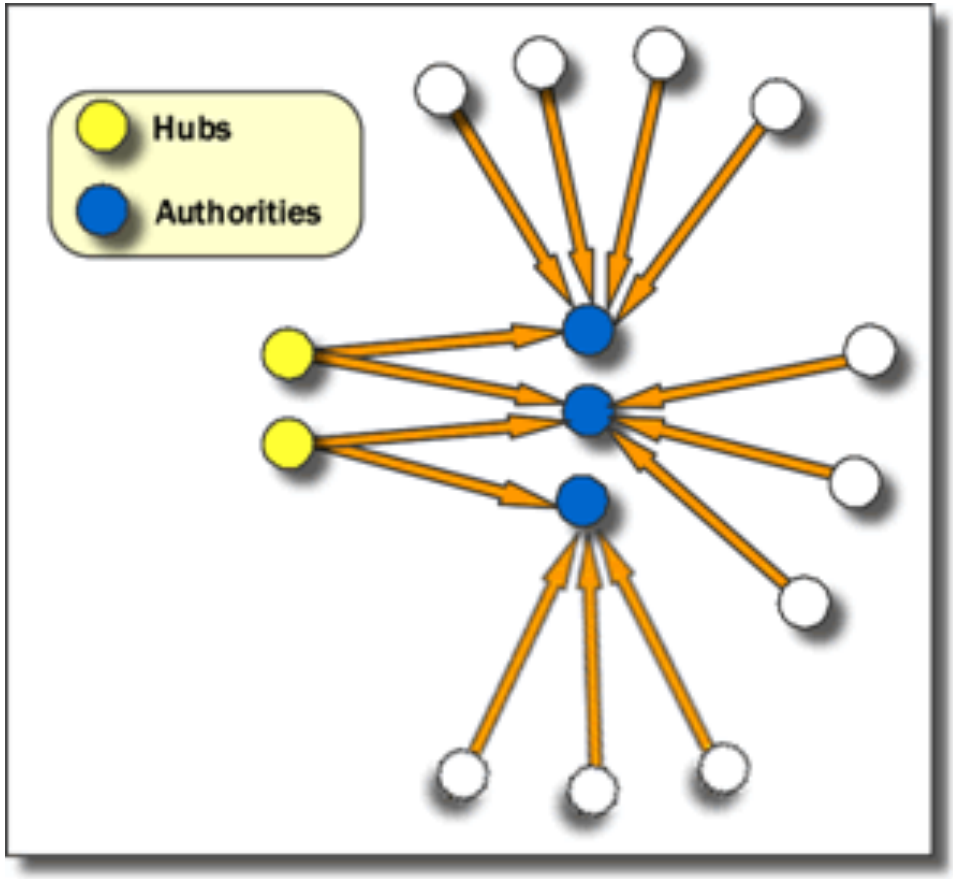
Social Networks, 1 (1978/79) 215–239

Centrality in Social Networks
Conceptual Clarification

Linton C. Freeman

*Lehigh University**

Social Network Analysis: Hub and Authority



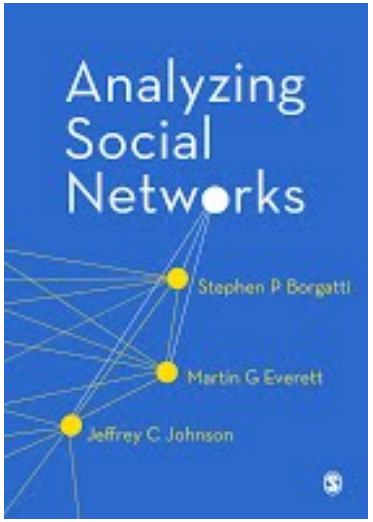
Hubs are entities that point to a relatively large number of authorities. They are essentially the mutually reinforcing analogues to authorities. Authorities point to high hubs. Hubs point to high authorities. You cannot have one without the other.

Source: http://www.fmsasg.com/SocialNetworkAnalysis/

Tools of Social Network Analysis

Social Network Analysis (SNA) Tools

- **NetworkX**
- **igraph**
- **Gephi**
- **UCINet**
- **Pajek**



Tools of Social Network Analysis

- Focused Desktop Tools
  - **Gephi**
  - Ucinet
  - Pajek
  - NodeXL
  - Cytoscape

Source: https://www.researchgate.net/post/Which_open_source_software_is_best_for_network_data_analysis

Tools of Social Network Analysis

- Developer Tools
  - –NetworkX
  - –iGraph
  - –SNAP
  - –sigma.js

Source: https://www.researchgate.net/post/Which_open_source_software_is_best_for_network_data_analysis

Gephi

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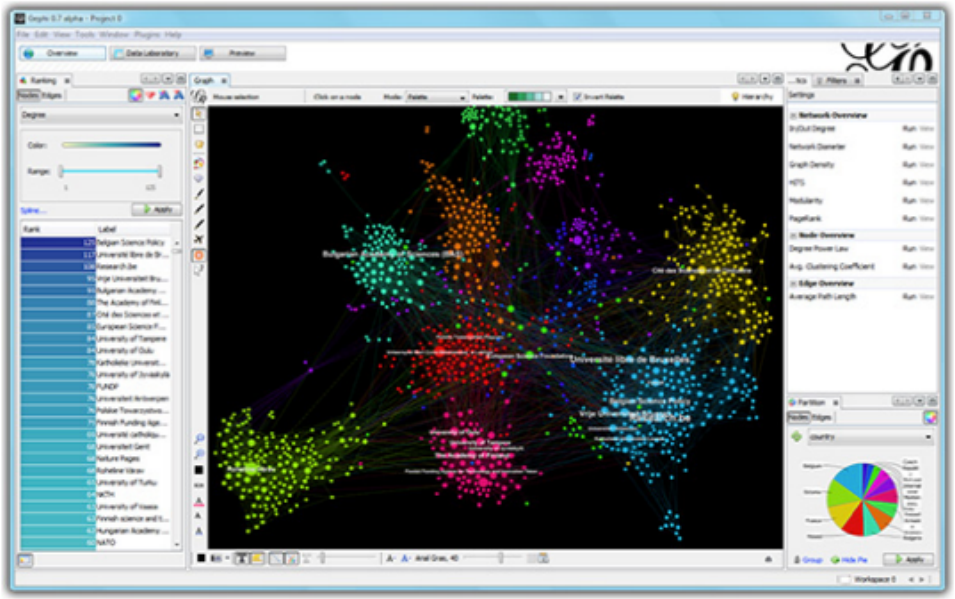
- Features
- Quick start
- Screenshots
- Videos



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- **Exploratory Data Analysis**: intuition-oriented analysis by networks manipulations in real time.
- **Link Analysis**: revealing the underlying structures of associations between objects.
- **Social Network Analysis**: easy creation of social

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— the Community

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Gephi updates with 0.9.1 version

PAPERS

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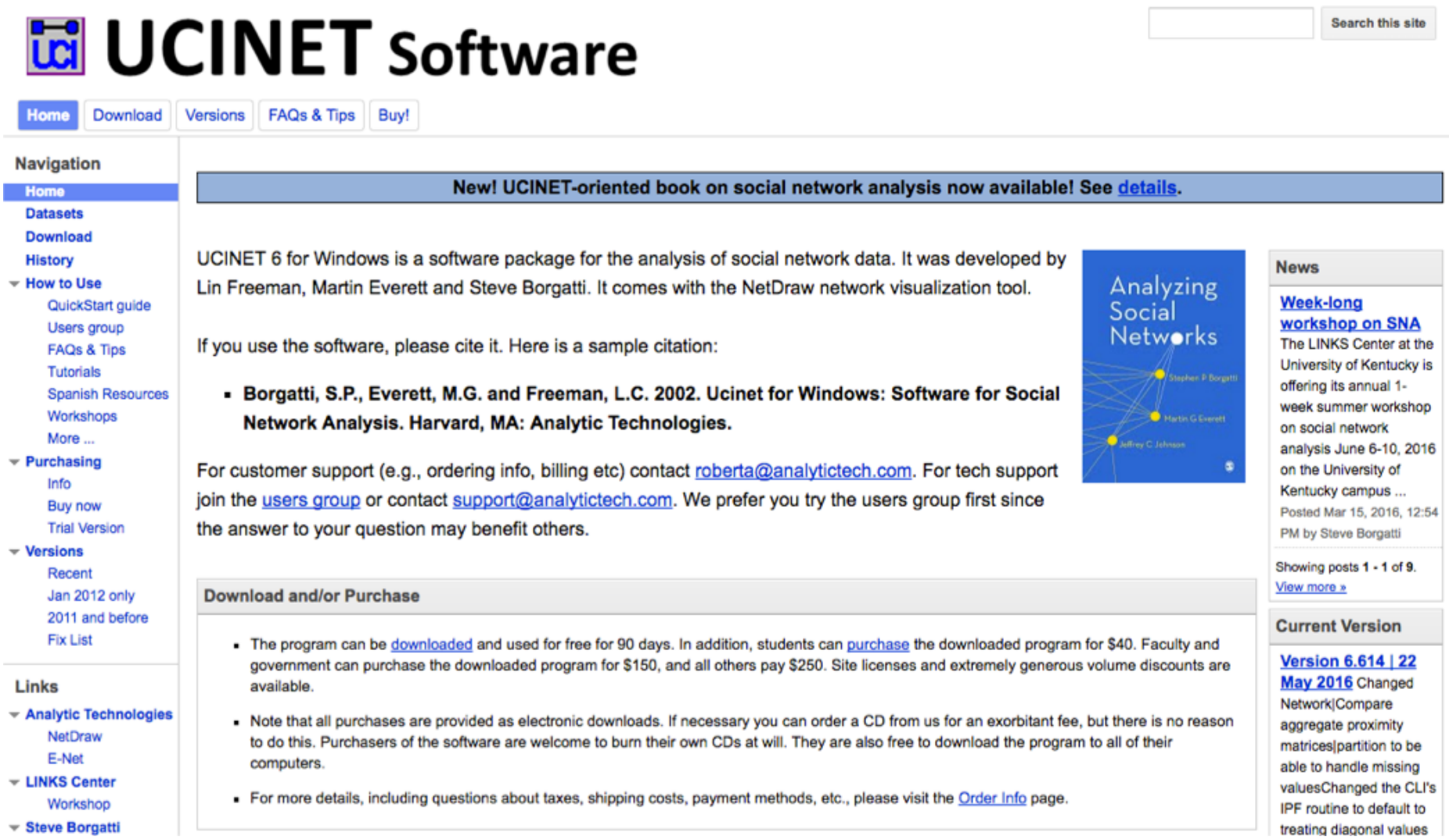
UCINET



https://sites.google.com/site/ucinetsoftware/home

Pajek

Networks / Pajek

Program for Large Network Analysis

In January 2008 this page was replaced by Pajek Wiki.

Pajek runs on Windows and is free for noncommercial use.

DOWNLOAD Pajek

Data: test networks, GPHs, GEDs, PDB files.

Screenshots; History; Manual (pdf); Papers/presentations; Applications; in News; Examples: SVG, PDF.

How to ? English / Slovene / Japanese (problems with IE - download and use Acrobat reader).
Pajek nicely runs on Linux via Wine, **Converting Excel/text into Pajek format**.
Pajek to SVG animation. **WoS to Pajek**.

Slides from **NICTA workshop**, Sydney, Australia, June 14-17, 2005.
Slides from **workshop at GD'05**, Limerick, Ireland, Sept 11-14, 2005.
Pajek workshop at **XXVIII Sunbelt Conference**, St. Pete Beach, Florida, USA, January 22-27, 2008: slides.
Network analysis course at **ECPR Summer School in Methods and Techniques**, Ljubljana, Slovenia, July 30 - August 16, 2008.

W. de Nooy, A. Mrvar, V. Batagelj: ***Exploratory Social Network Analysis with Pajek***, CUP, January 2005; ESNA page.
P. Doreian, V. Batagelj, A. Ferligoj: ***Generalized Blockmodeling***, CUP, November 2004.

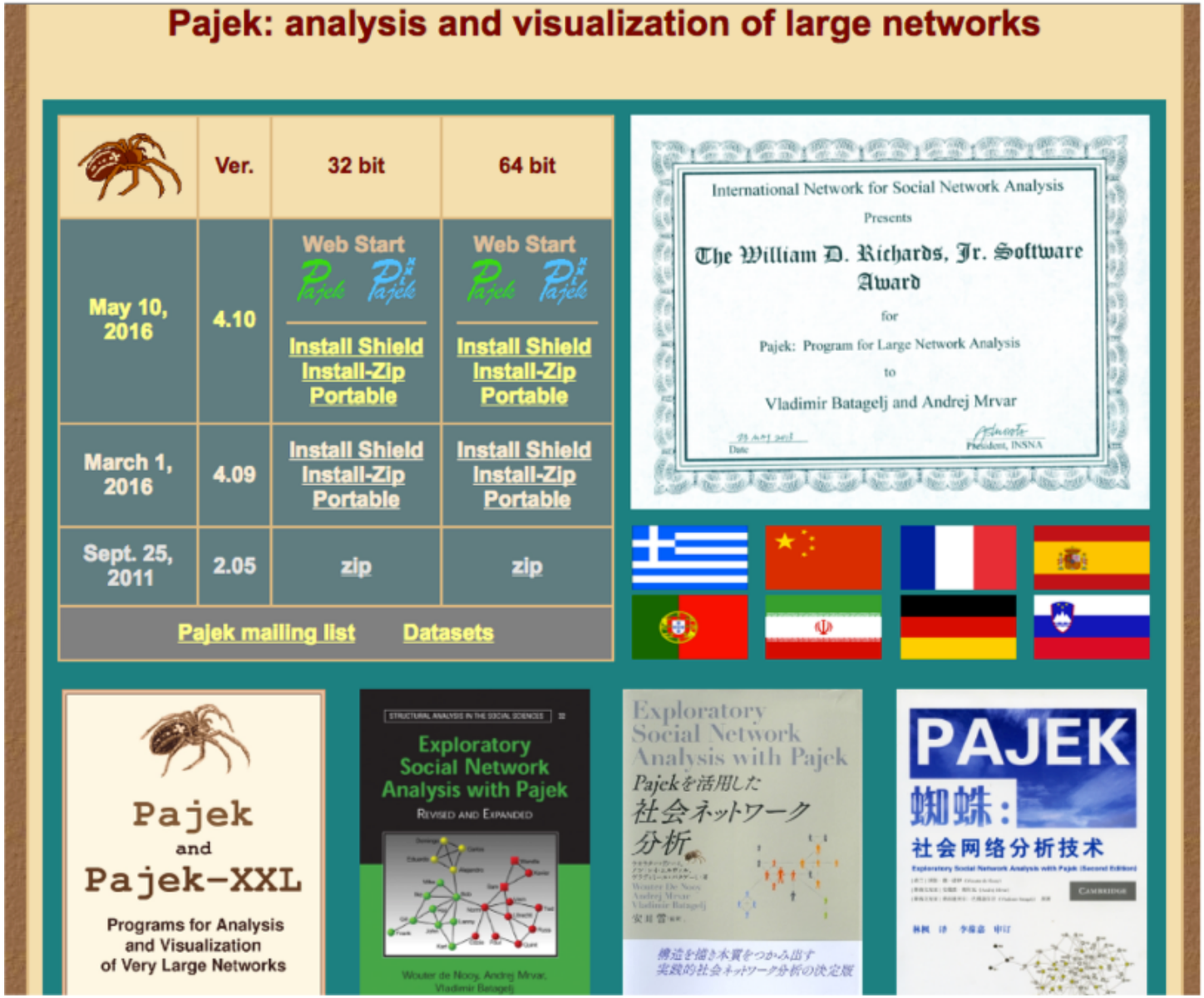
Chapter about Pajek: V. Batagelj, A. Mrvar: ***Pajek - Analysis and Visualization of Large Networks***.
in Jünger, M., Mutzel, P., (Eds.) *Graph Drawing Software*. Springer, Berlin 2003. p. 77-103 / Amazon.

An improved version of the paper presented at Sunbelt'97 was published in Connections 21(1998)2, 47-57 - V. Batagelj, A. Mrvar: ***Pajek - Program for Large Network Analysis*** (PDF; PRISON.KIN).

Our layouts for ***Graph-Drawing Competitions***: GD95, GD96, GD97, GD98, GD99, GD00, GD01 and GD05.

http://vlado.fmf.uni-lj.si/pub/networks/pajek/

Pajek



http://mrvar.fdv.uni-lj.si/pajek/

NodeXL

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Network Graphs
The Social Media Research Foundation

NodeXL: Network Overview, Discovery and Exploration for Excel

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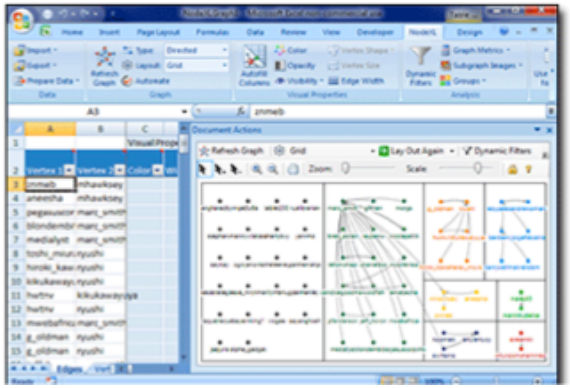
Review this release

NodeXL Basic is a free, open-source template for Microsoft® Excel® 2007, 2010, 2013 and 2016 that makes it easy to explore network graphs. With NodeXL, you can enter a network edge list in a worksheet, click a button and see your graph, all in the familiar environment of the Excel window.

NodeXL Pro offers additional features that extend NodeXL Basic, providing easy access to social media network data streams, advanced network metrics, and text and sentiment analysis, and



MOST HELPFUL REVIEWS

★★★☆☆ Install on Windows 10 Pro 64-bit I gives an error message: 'Customized functionality in this application will not work because the c... (more)

https://nodexl.codeplex.com/

Cytoscape

http://www.cytoscape.org/

NetworkX

NetworkX

NetworkX Home | Documentation | Download | Developer (Github)

High-productivity software for complex networks

NetworkX is a Python language software package for the creation, manipulation, and study of the structure, dynamics, and functions of complex networks.

Documentation
all documentation

Examples
using the library

Reference
all functions and methods

Features

- Python language data structures for graphs, digraphs, and multigraphs.
- Many standard graph algorithms
- Network structure and analysis measures
- Generators for classic graphs, random graphs, and synthetic networks
- Nodes can be "anything" (e.g. text, images, XML records)
- Edges can hold arbitrary data (e.g. weights, time-series)
- Open source BSD license
- Well tested: more than 1800 unit tests, >90% code coverage
- Additional benefits from Python: fast prototyping, easy to teach, multi-platform

Versions

Latest Release

networkx-1.11
30 January 2016
downloads | docs | pdf

Development

2.0dev
github | docs | pdf
build passing
coverage 94%

Contact

Mailing list
Issue tracker

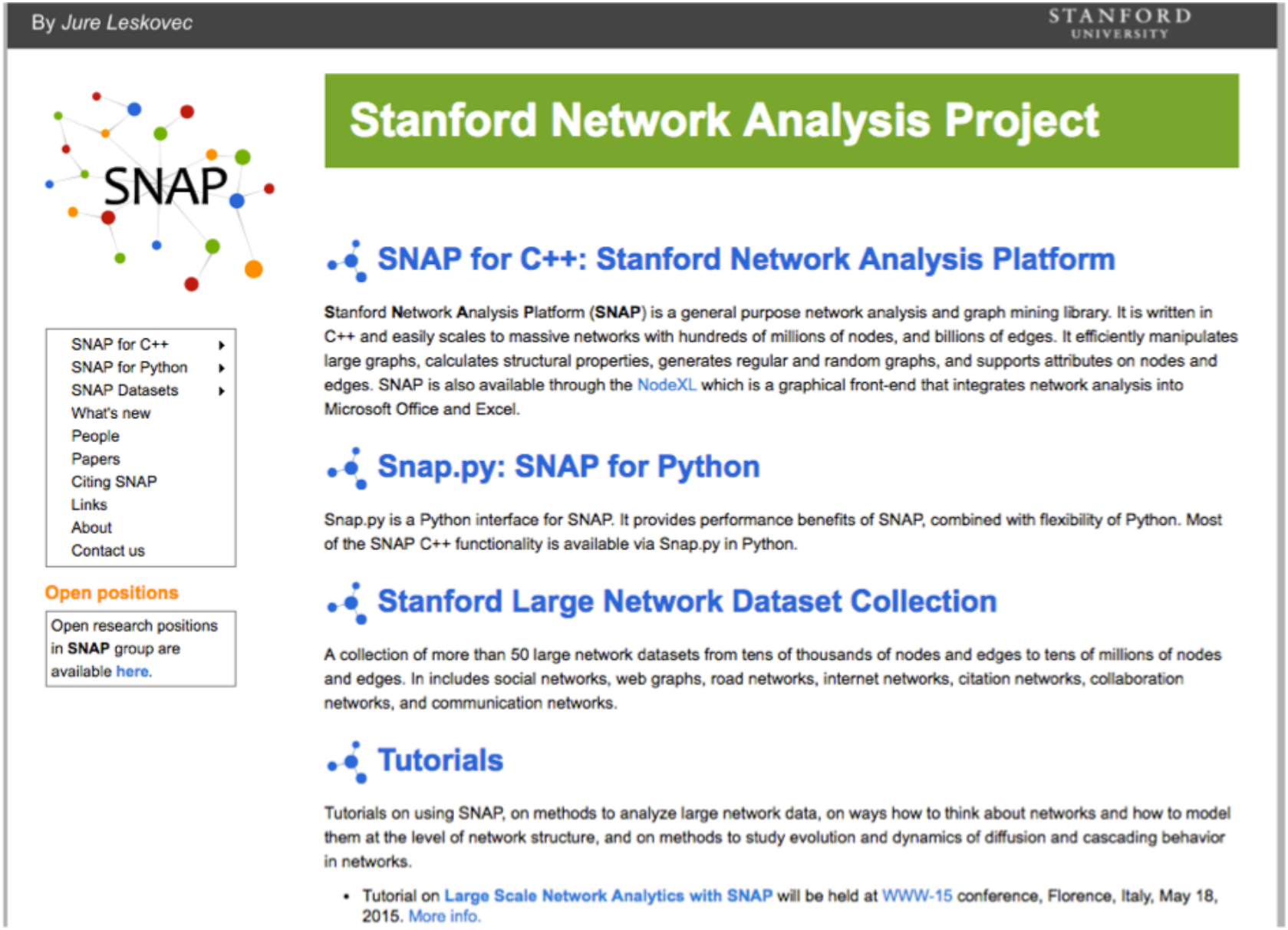
NetworkX Home | Documentation | Download | Developer (Github)

https://networkx.github.io/

igraph

http://igraph.org/redirect.html

SNAP



http://snap.stanford.edu/

sigma.js

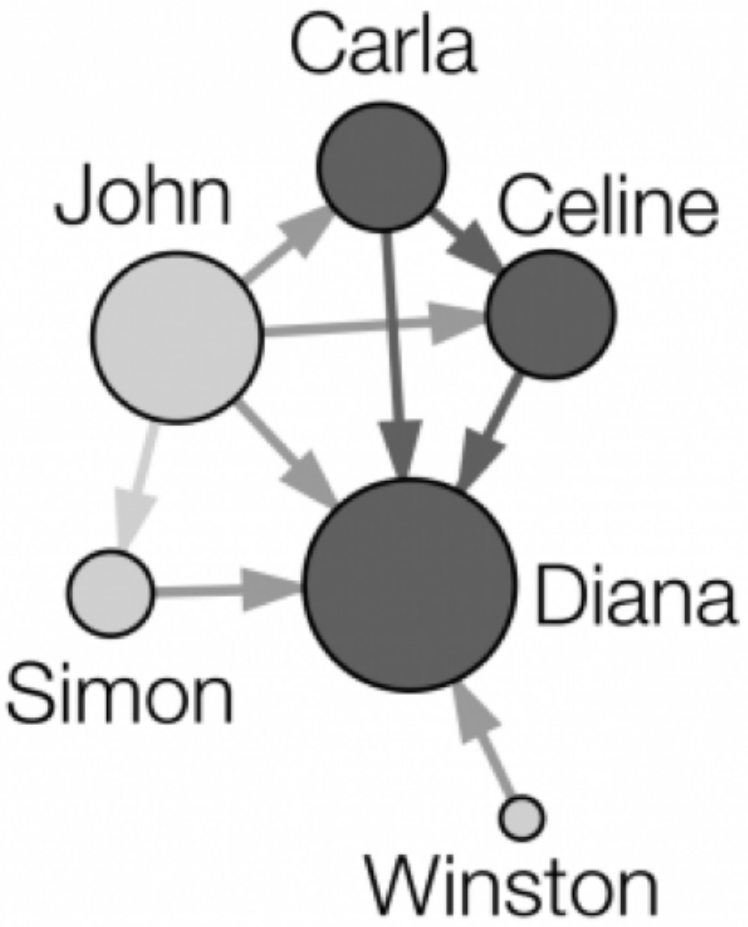
http://sigmajs.org/

Gephi

Gephi.app

Gephi: Social Network Analysis and Visualization

Network Analysis and Visualization with Gephi



Nodes

Id,Label,Attribute
1,John,1
2,Carla,2
3,Simon,1
4,Celine,2
5,Winston,1
6,Diana,2

Edges

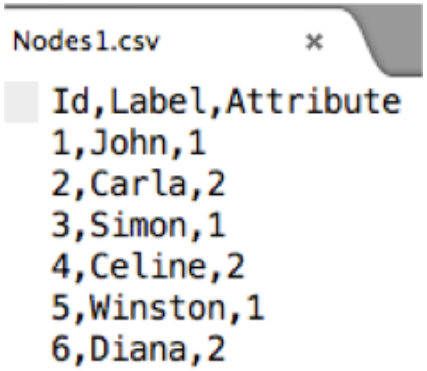
Source,Target
1,2
1,3
1,4
1,6
2,4
2,6
3,6
4,6
5,6

Source: http://www.martingrandjean.ch/gephi-introduction/

Nodes and Edges
CSV Text Data for Gephi

Nodes1.csv

```
Id,Label,Attribute
1,John,1
2,Carla,2
3,Simon,1
4,Celine,2
5,Winston,1
6,Diana,2
```



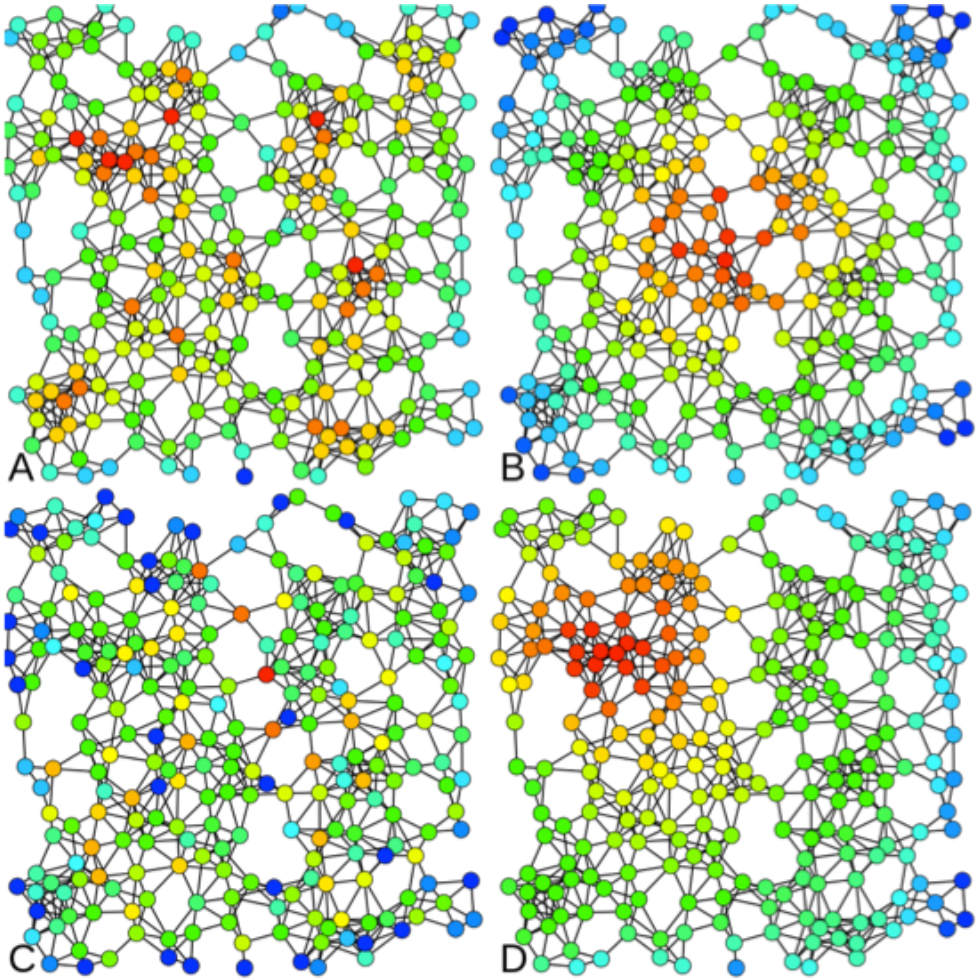
Edges1.csv

```
Source,Target
1,2
1,3
1,4
1,6
2,4
2,6
3,6
4,6
5,6
```

Source: http://www.martingrandjean.ch/gephi-introduction/

A = Degree centrality
number of connexions

B = Closeness centrality
closeness to the entire network

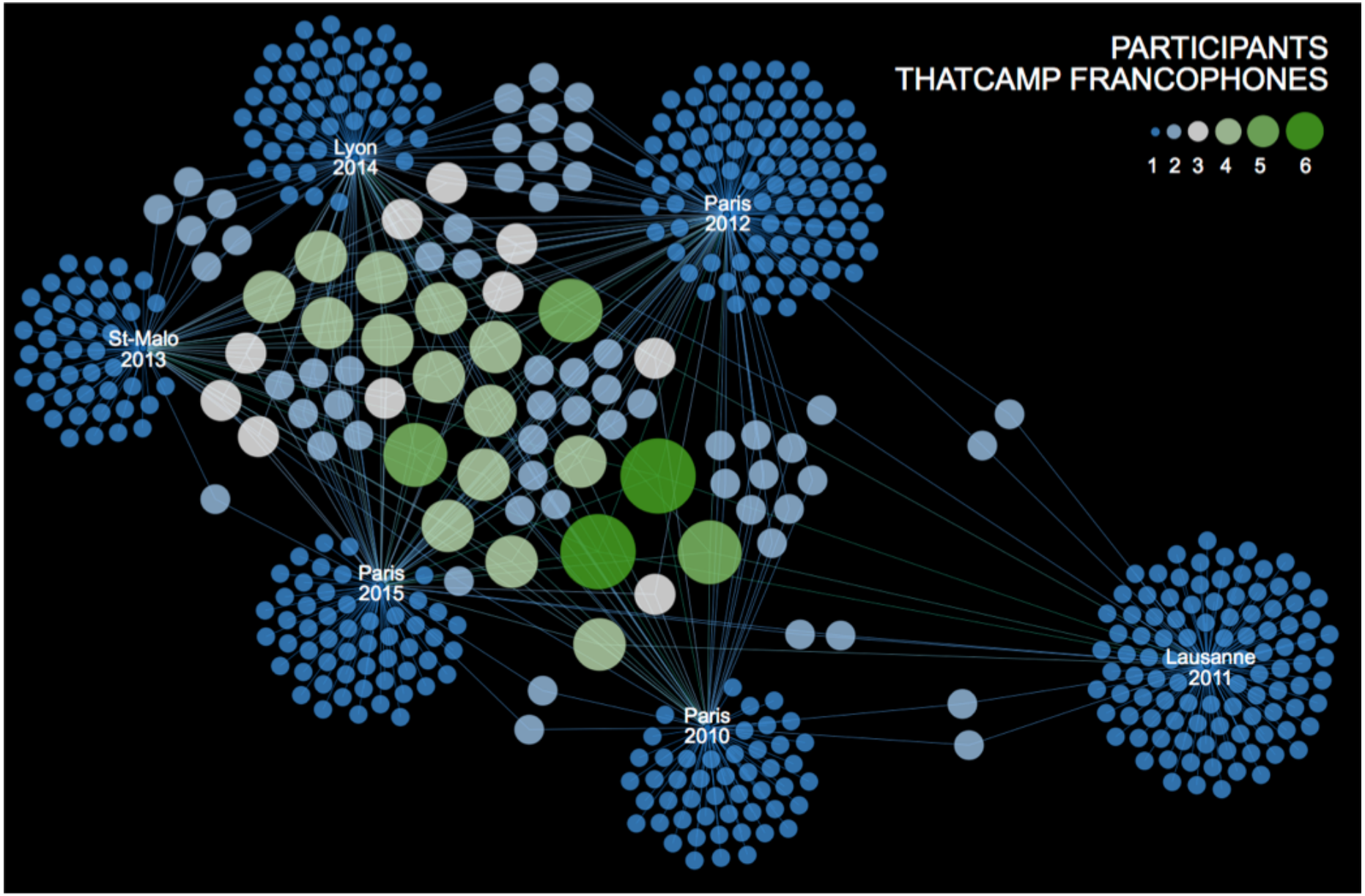


C = Betweenness centrality
bridges nodes

D = Eigenvector centrality
connection to well-connected nodes

Source: http://www.martingrandjean.ch/gephi-introduction/

Conference Participants



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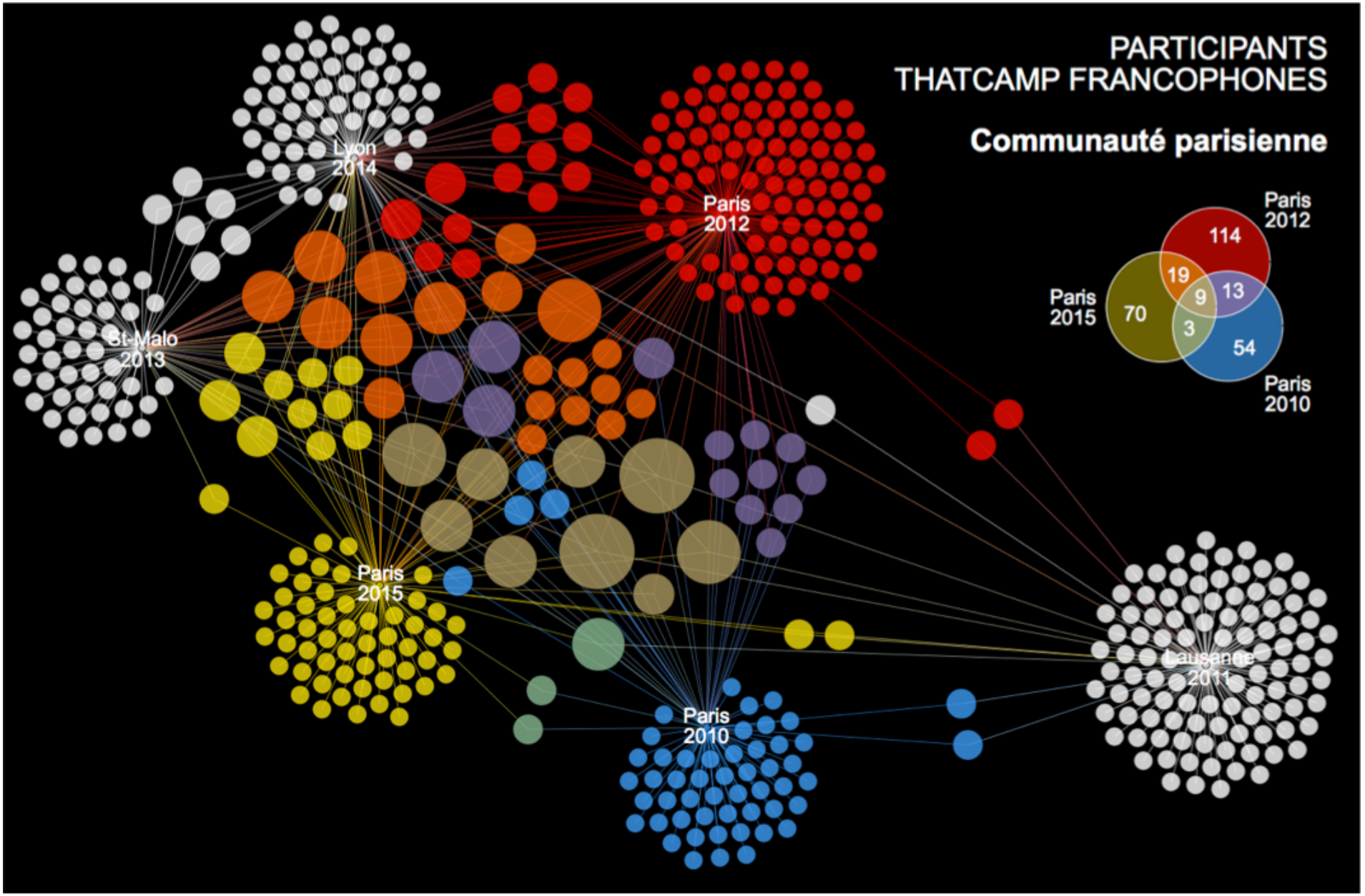

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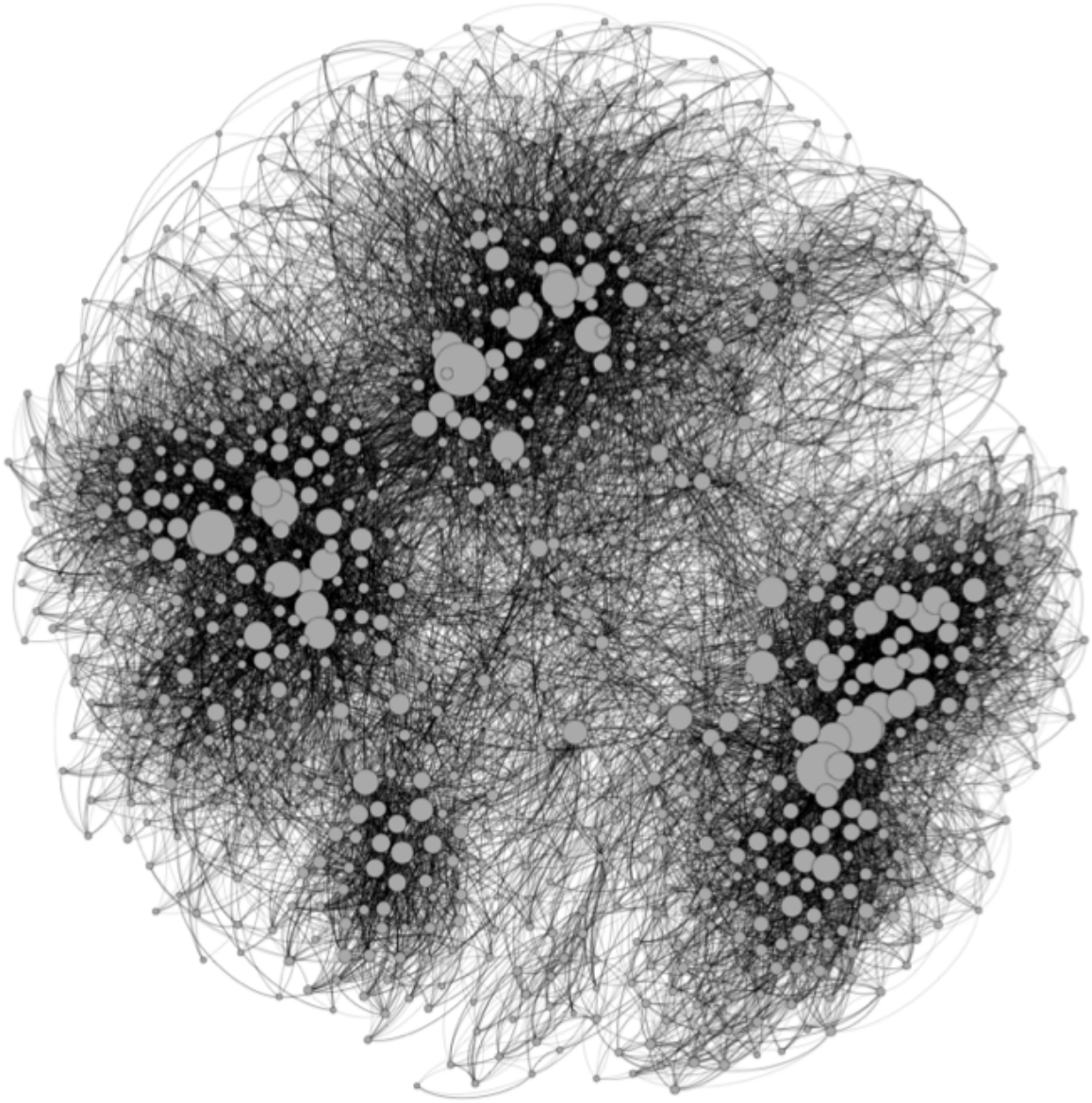
Fruchterman Reingold



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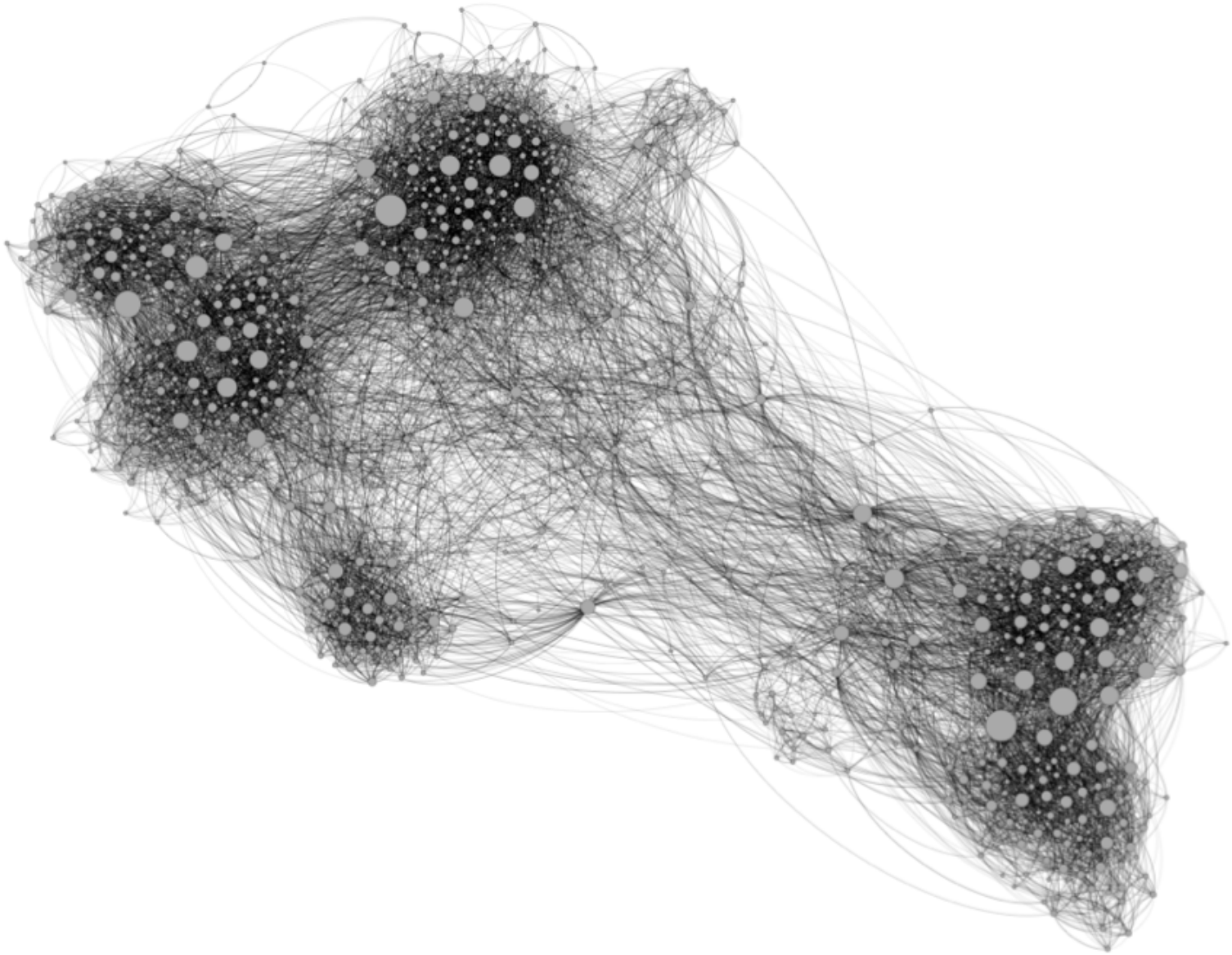
Force Atlas 2



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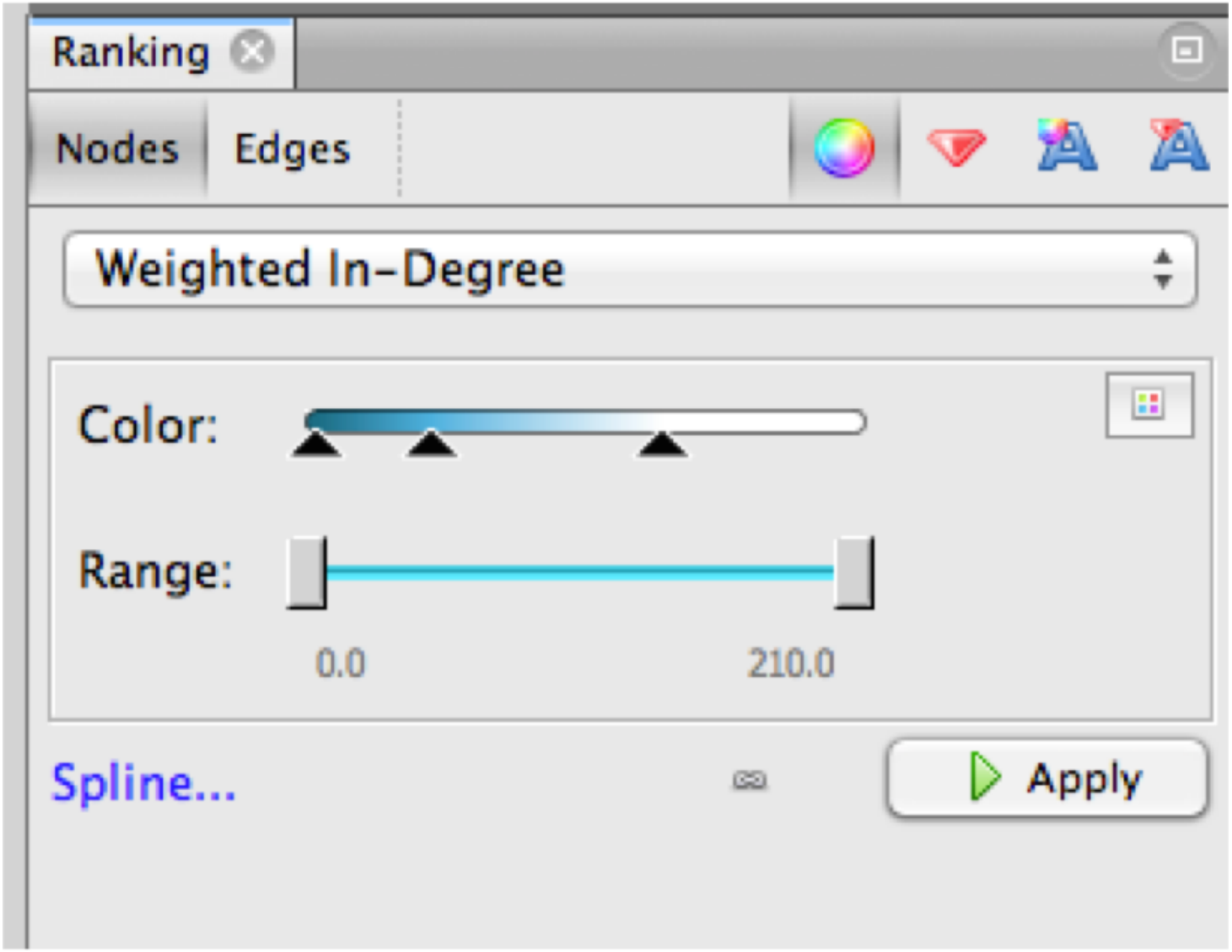
Nodes' color
Weighted In-Degree



Source: http://www.martingrandjean.ch/gephi-introduction/

Weighted In-Degree

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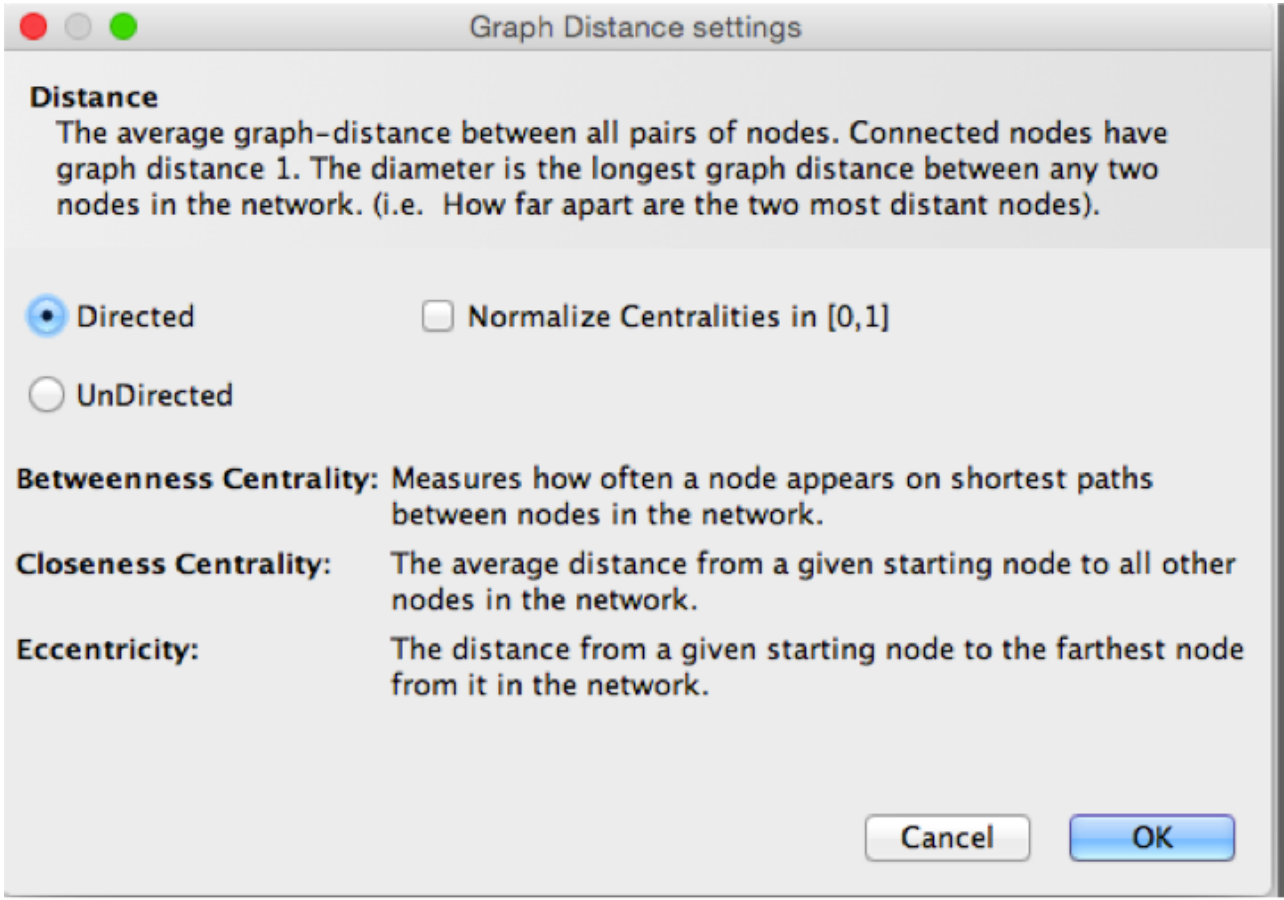
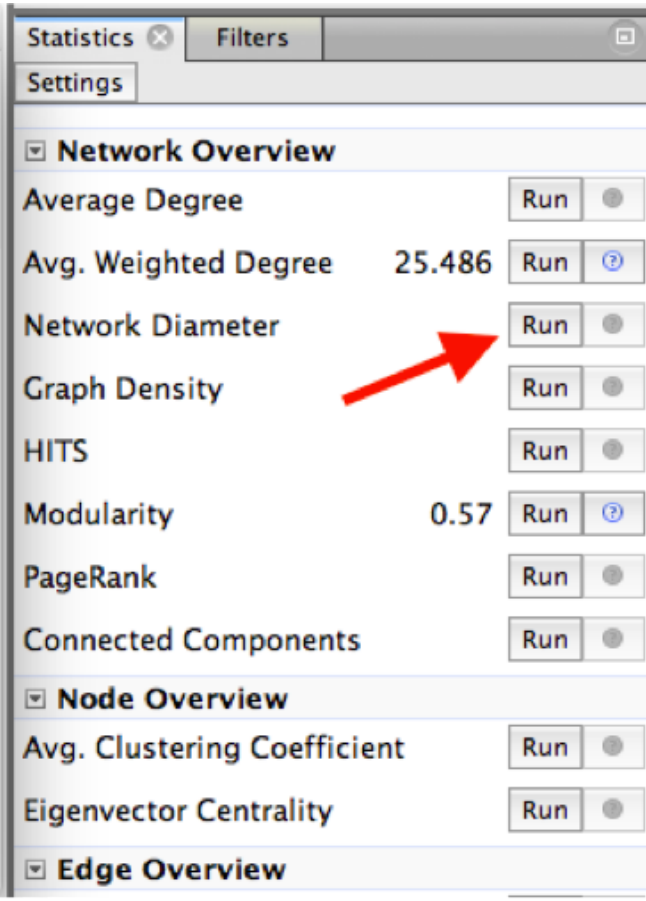
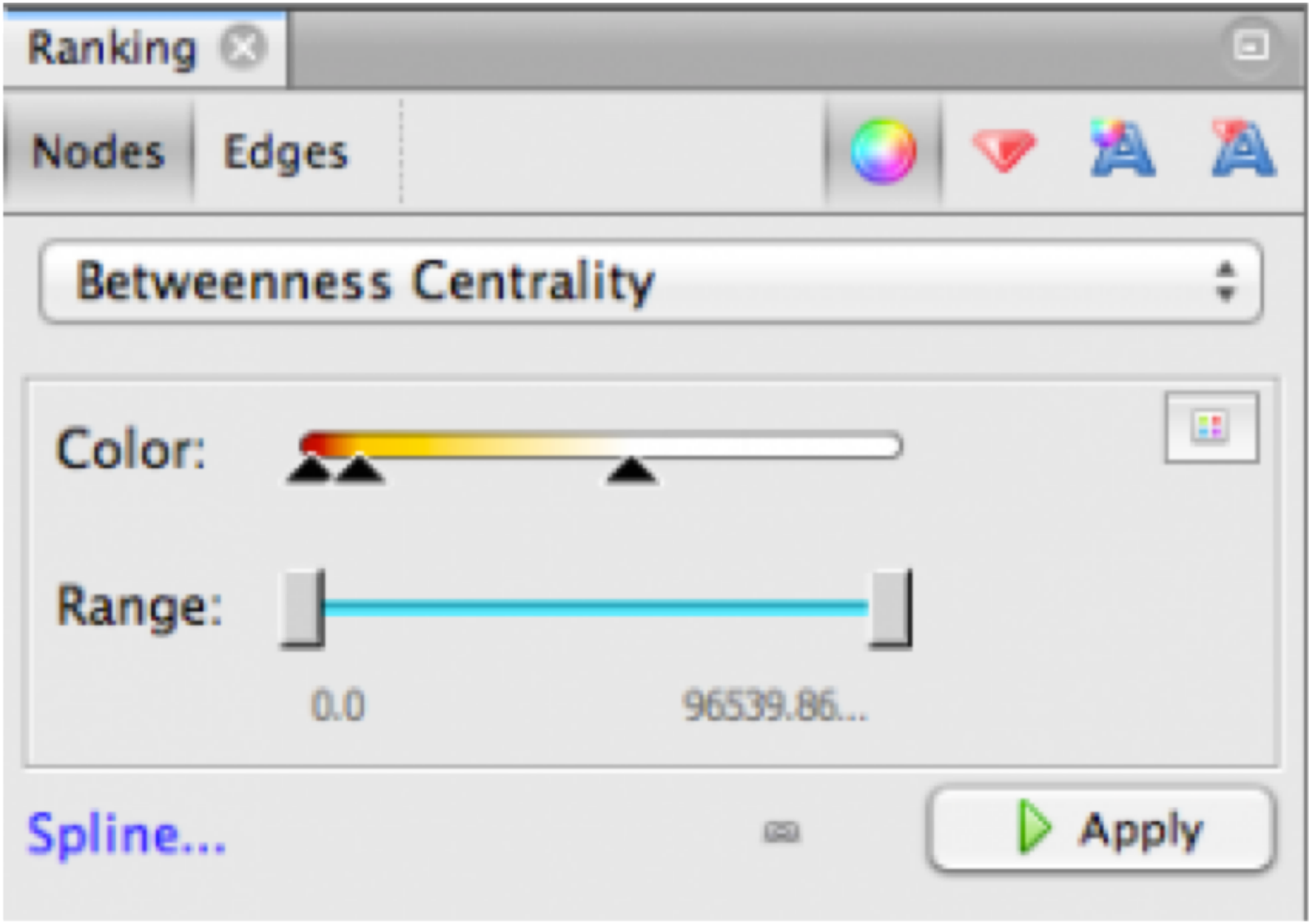
Network Diameter
Betweenness Centrality
Closeness Centrality





Source: http://www.martingrandjean.ch/gephi-introduction/

Nodes' color
Betweenness Centrality



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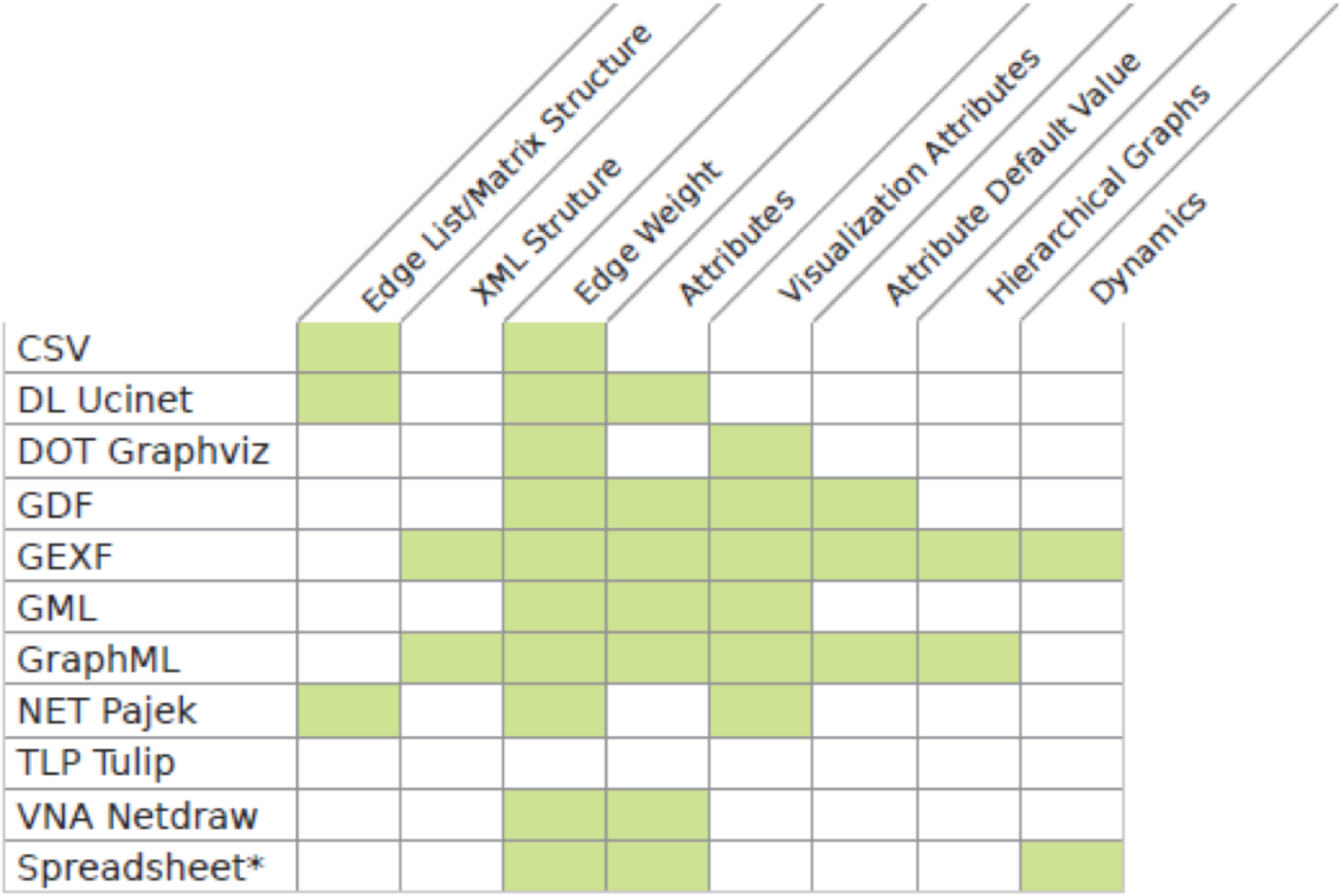
Gephi Supported Graph Formats



	Edge List/Matrix Structure	XML Struture	Edge Weight	Attributes	Visualization Attributes	Attribute Default Value	Hierarchical Graphs	Dynamics
CSV	■		■					
DL Ucinet	■		■	■				
DOT Graphviz			■		■			
GDF			■	■	■	■		
GEXF		■	■	■	■	■	■	■
GML			■	■	■			
GraphML		■	■	■	■	■	■	
NET Pajek	■		■		■			
TLP Tulip								
VNA Netdraw			■	■				
Spreadsheet*			■	■				■

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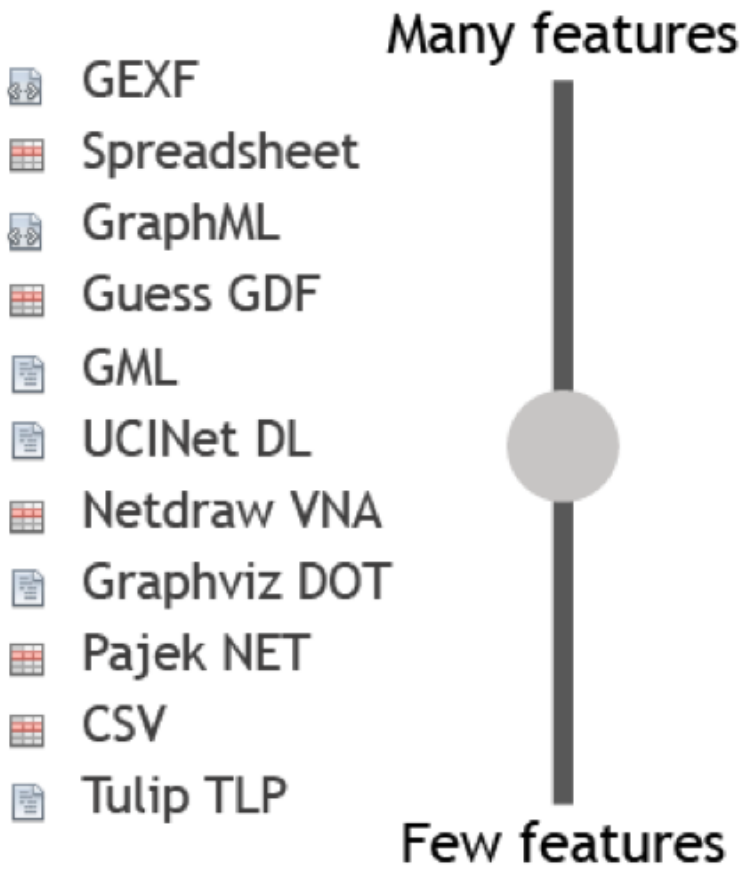
Gephi Supported Graph Formats

Do you need...



File Type
- XML
- Tabular
- Text

Source: https://gephi.org/users/supported-graph-formats/

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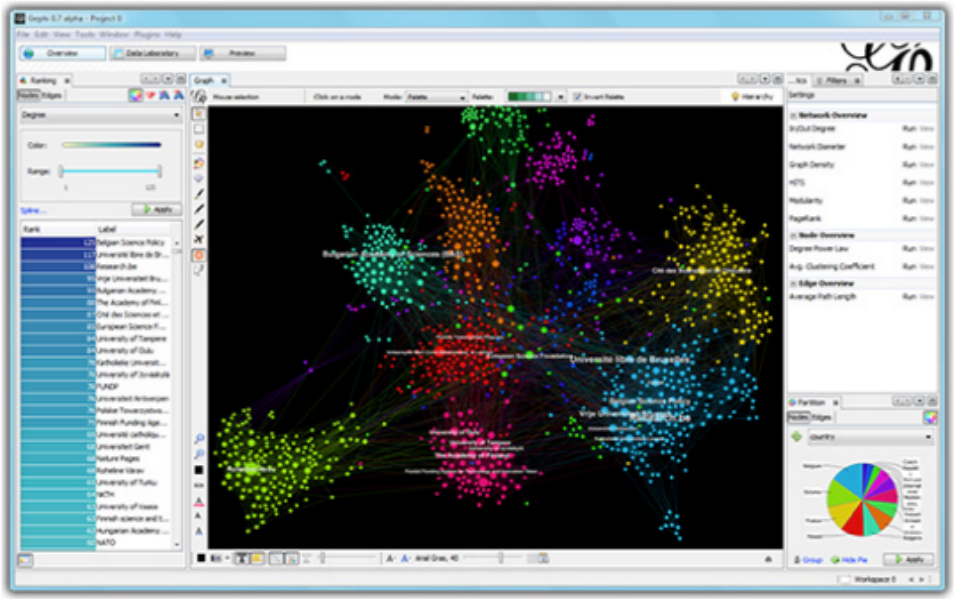
- Features
- Quick start
- Screenshots
- Videos



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- **Link Analysis**: revealing the underlying structures of associations between objects.
- **Social Network Analysis**: easy creation of social

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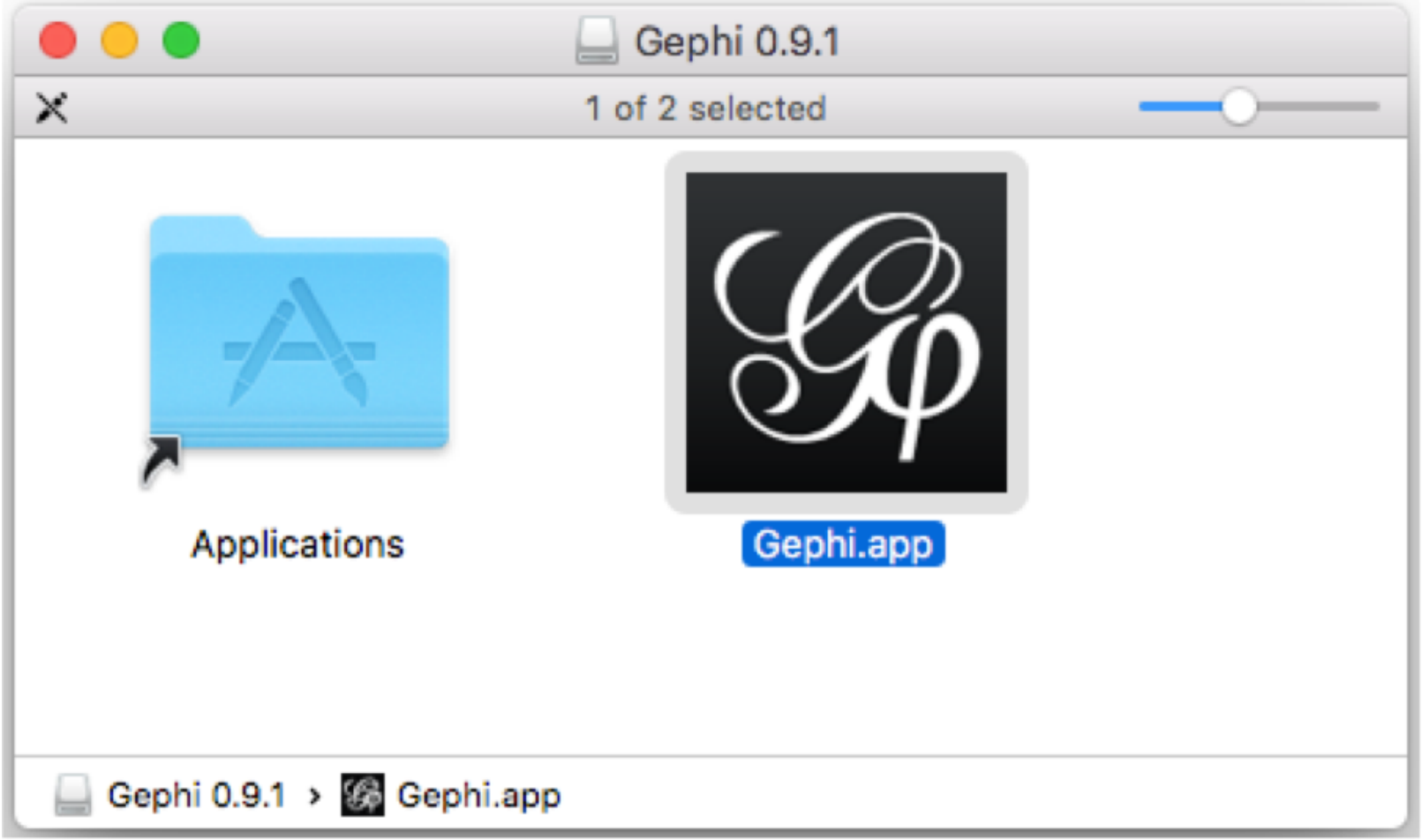
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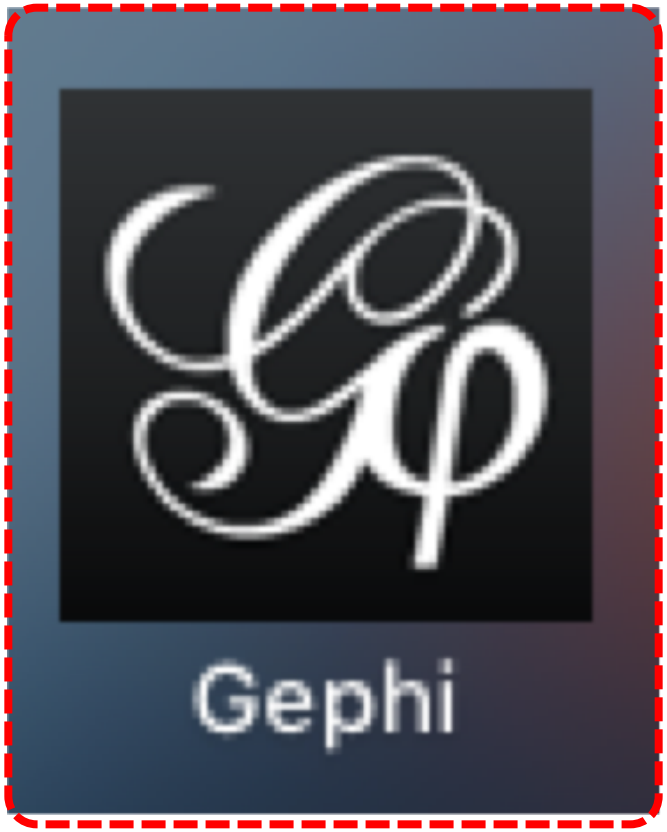
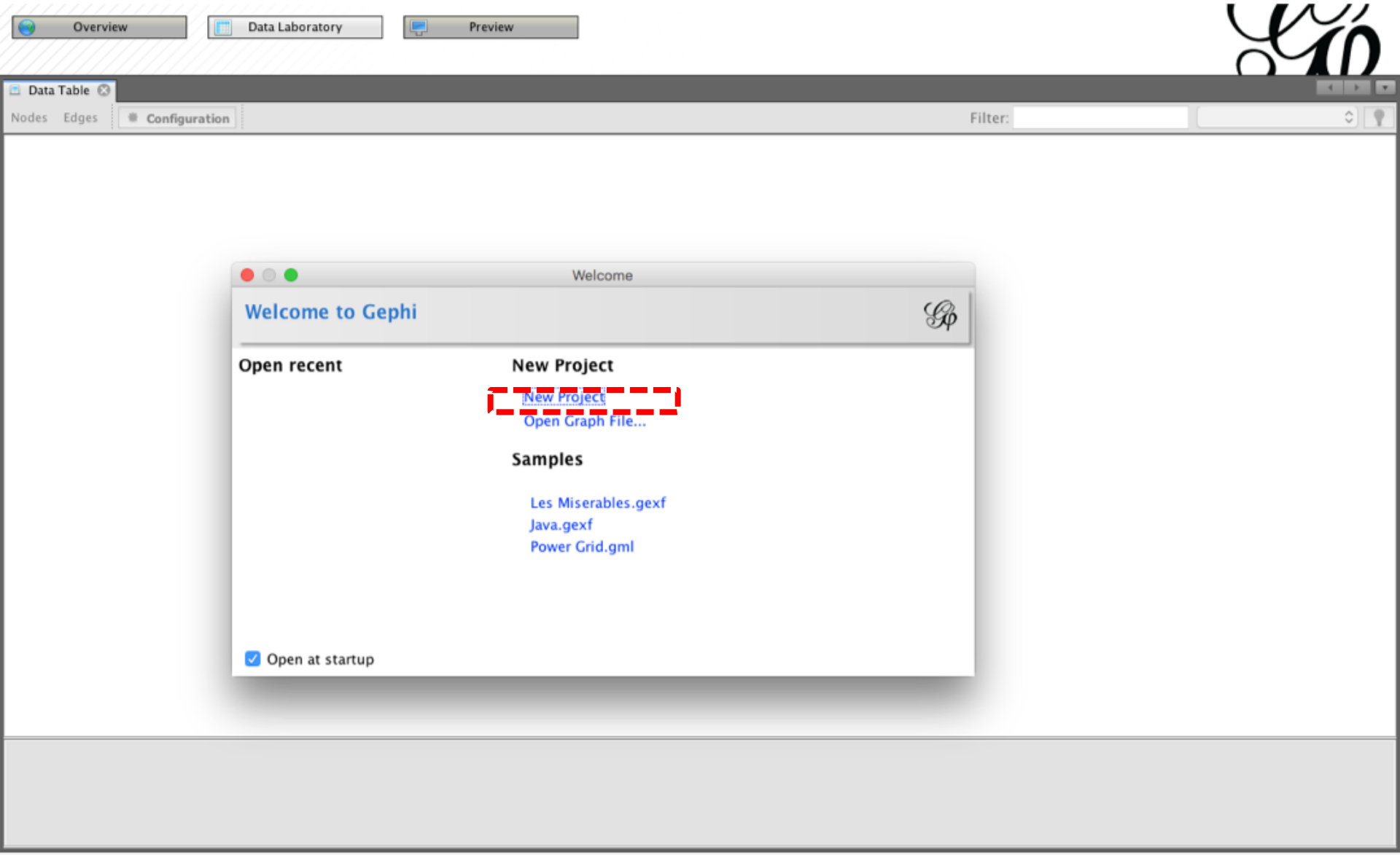
Gephi 0.9.1 › Gephi.app

Gephi

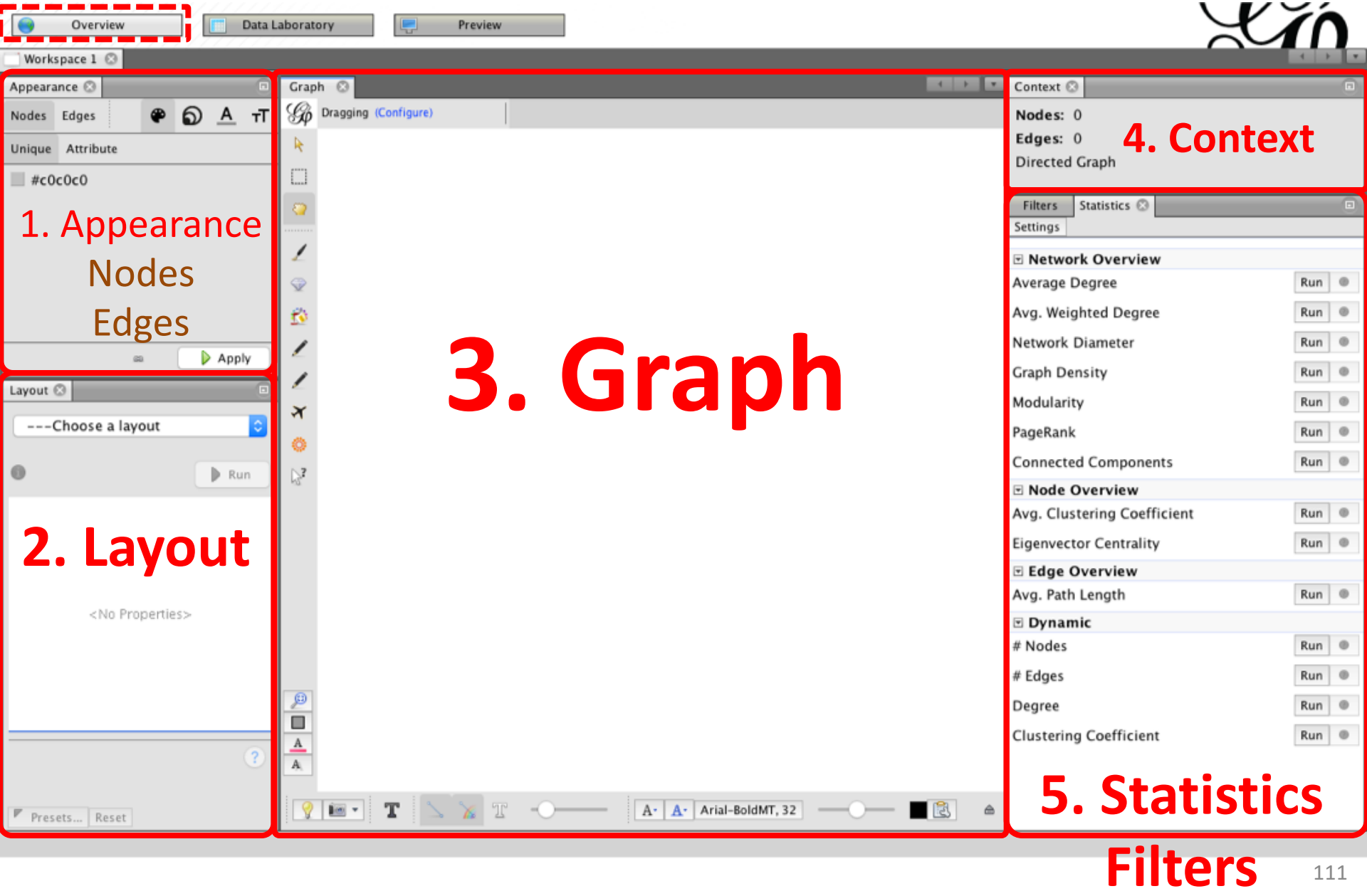


Gephi:
New Project
Import
Nodes1.csv and
Edges1.csv
to Gephi

Gephi New Project

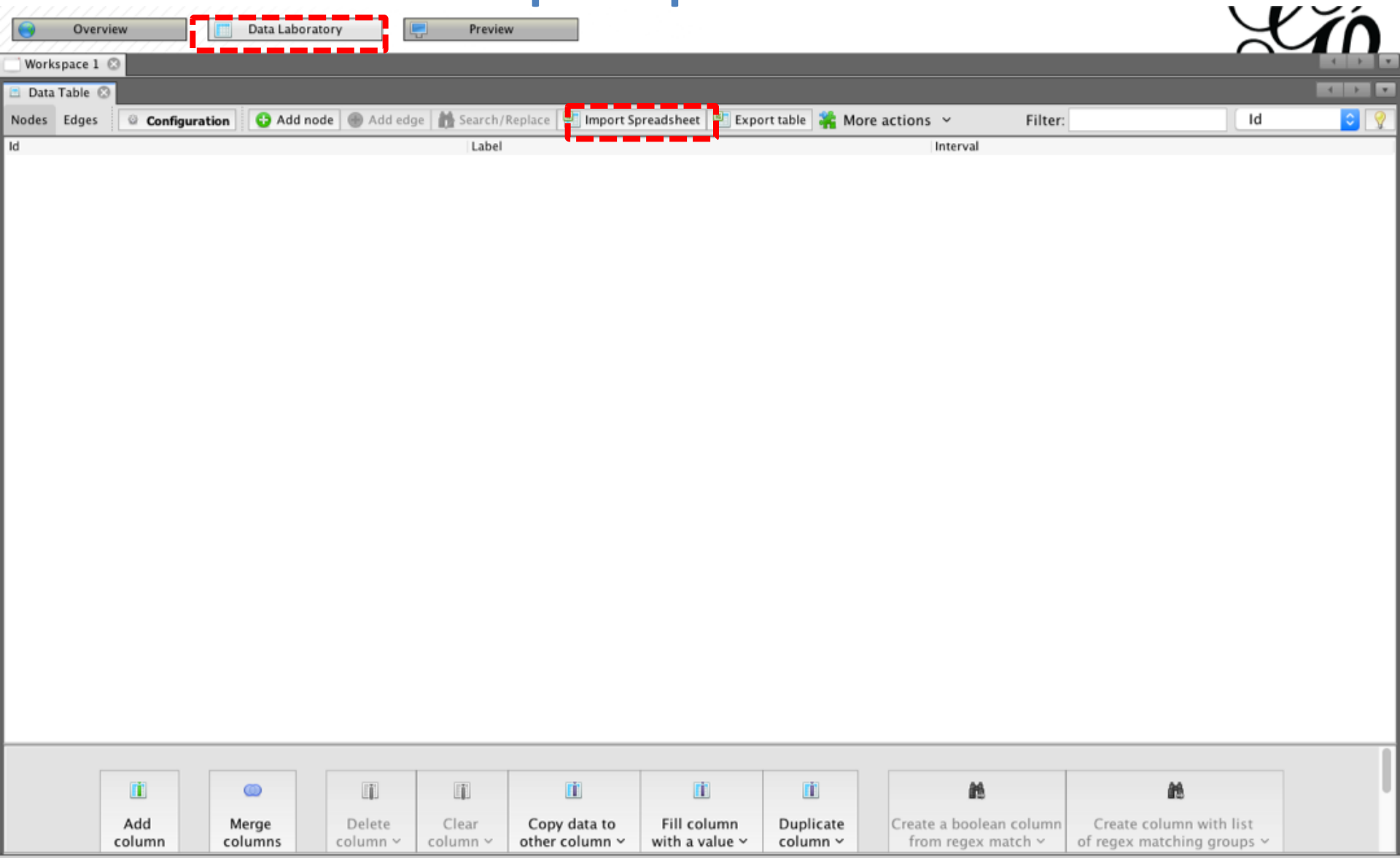


Gephi Overview

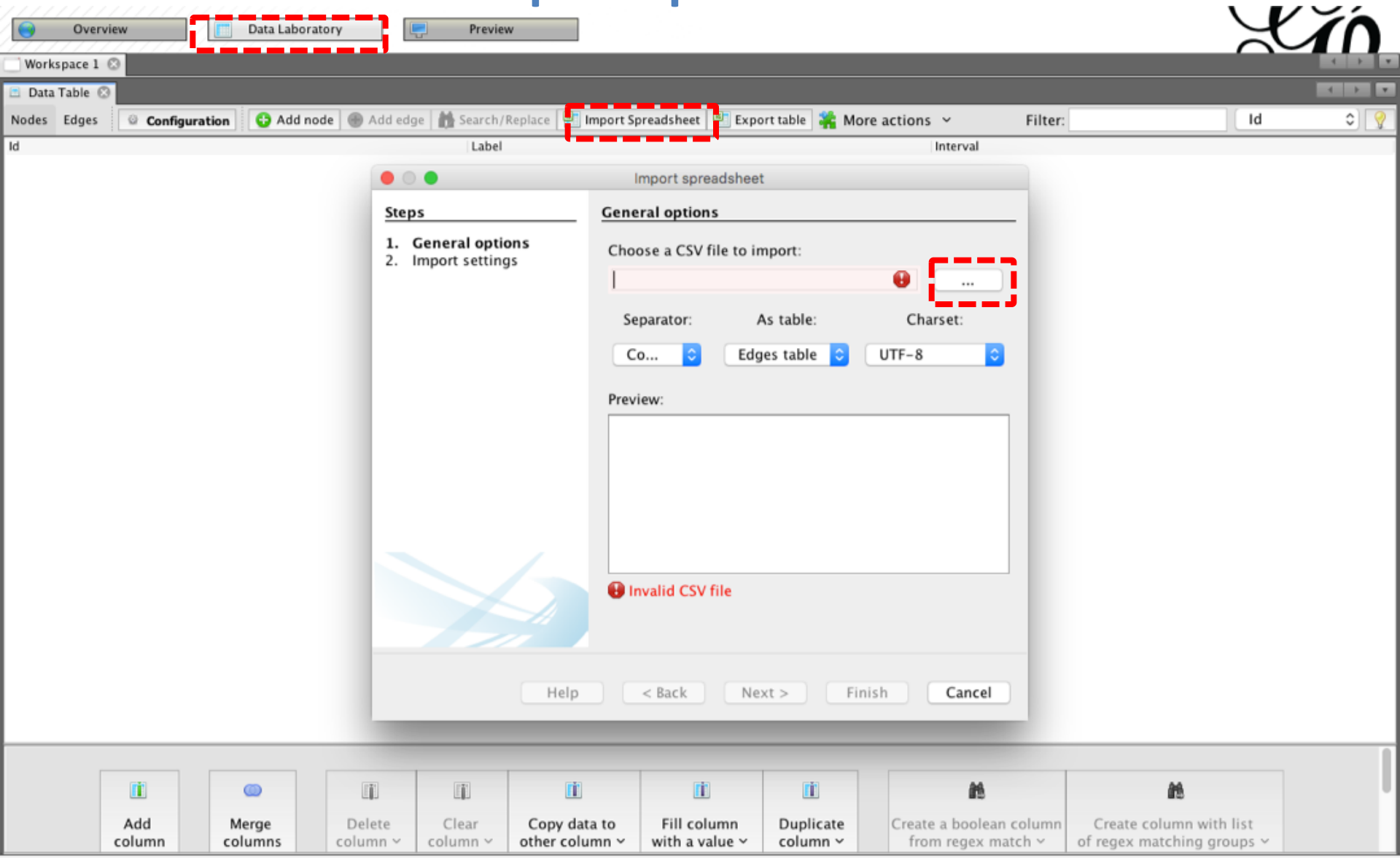


Gephi Data Laboratory:

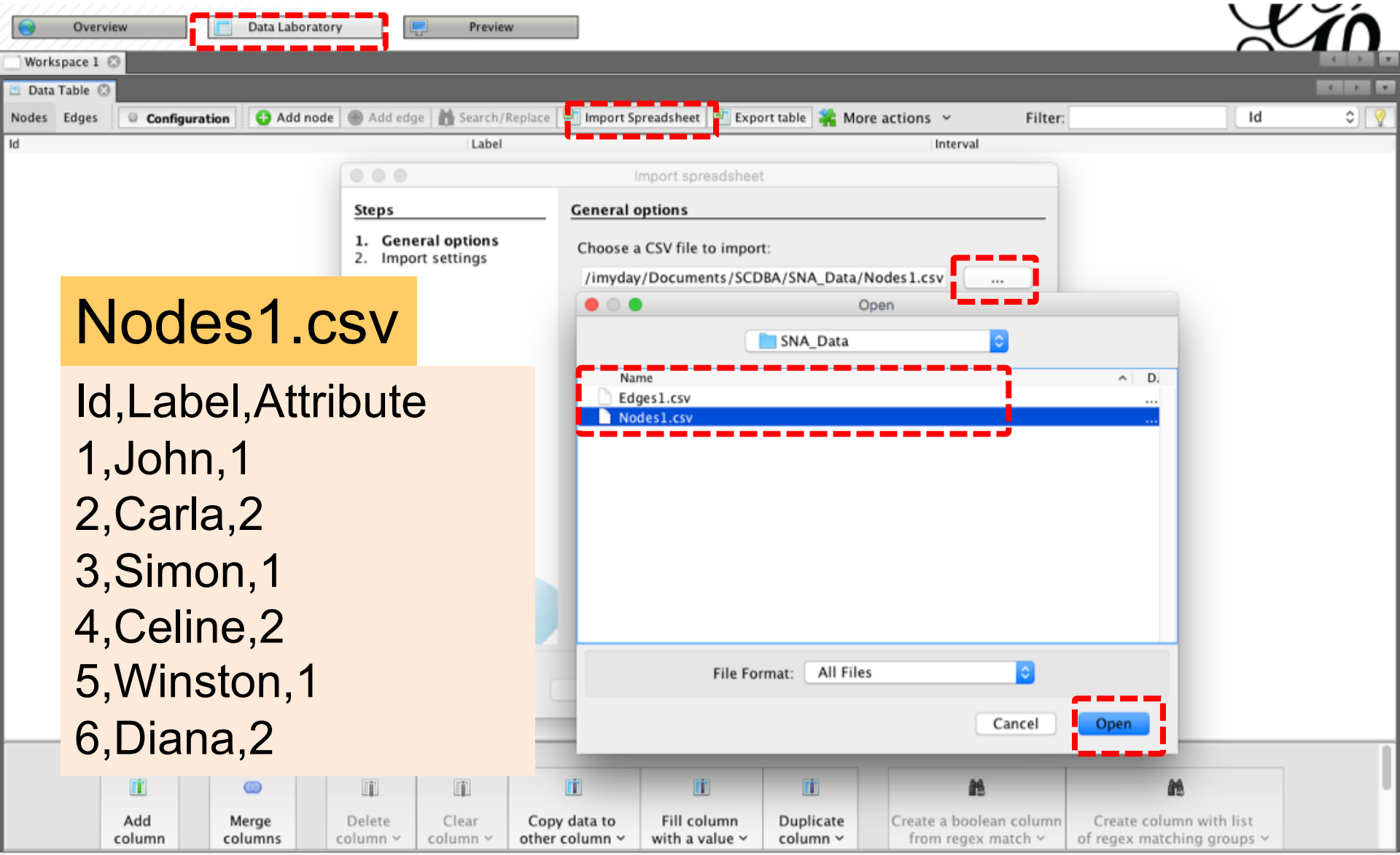
Import Spreadsheet



Gephi Data Laboratory:
Import Spreadsheet



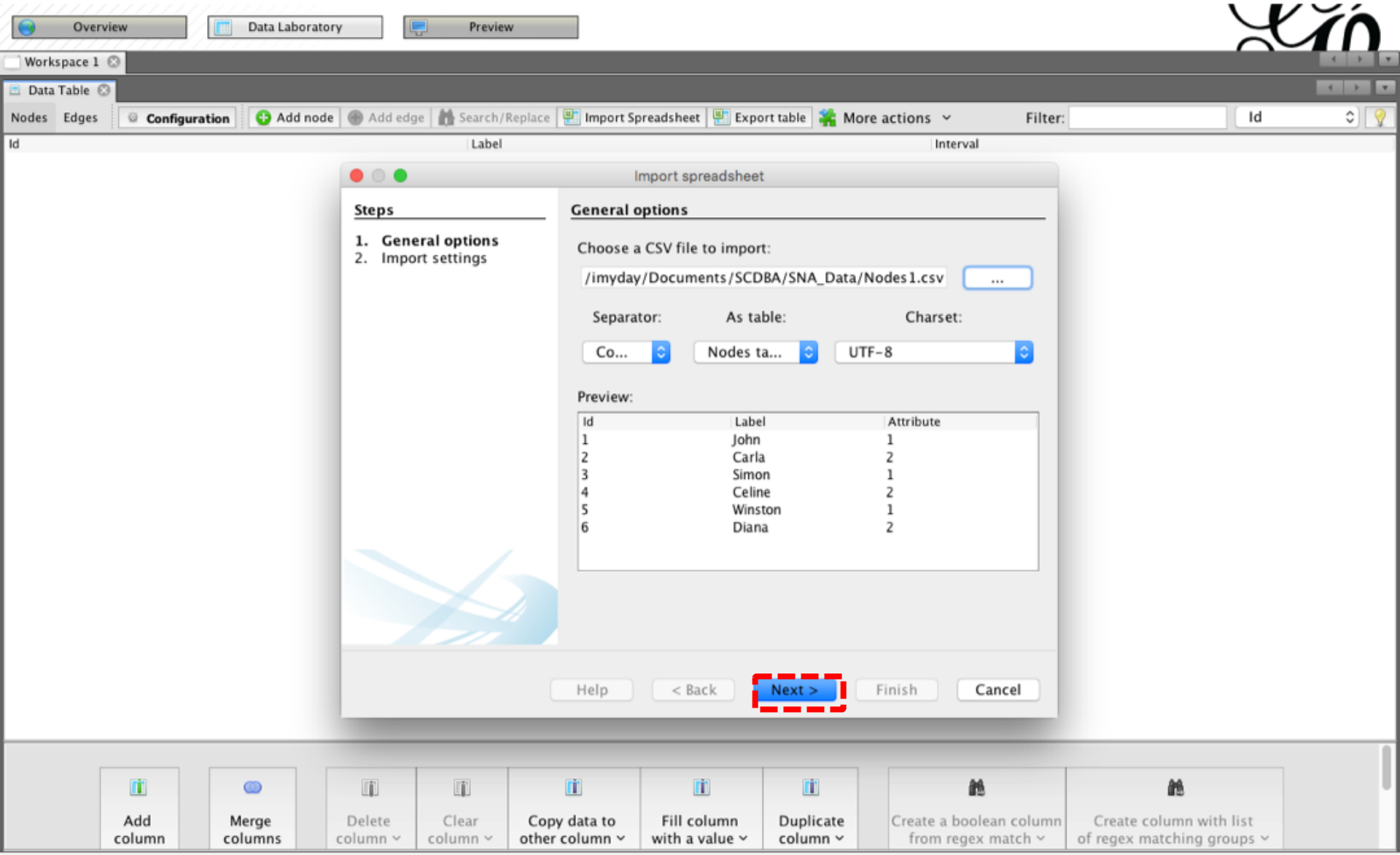
Import Nodes1.csv to Gephi



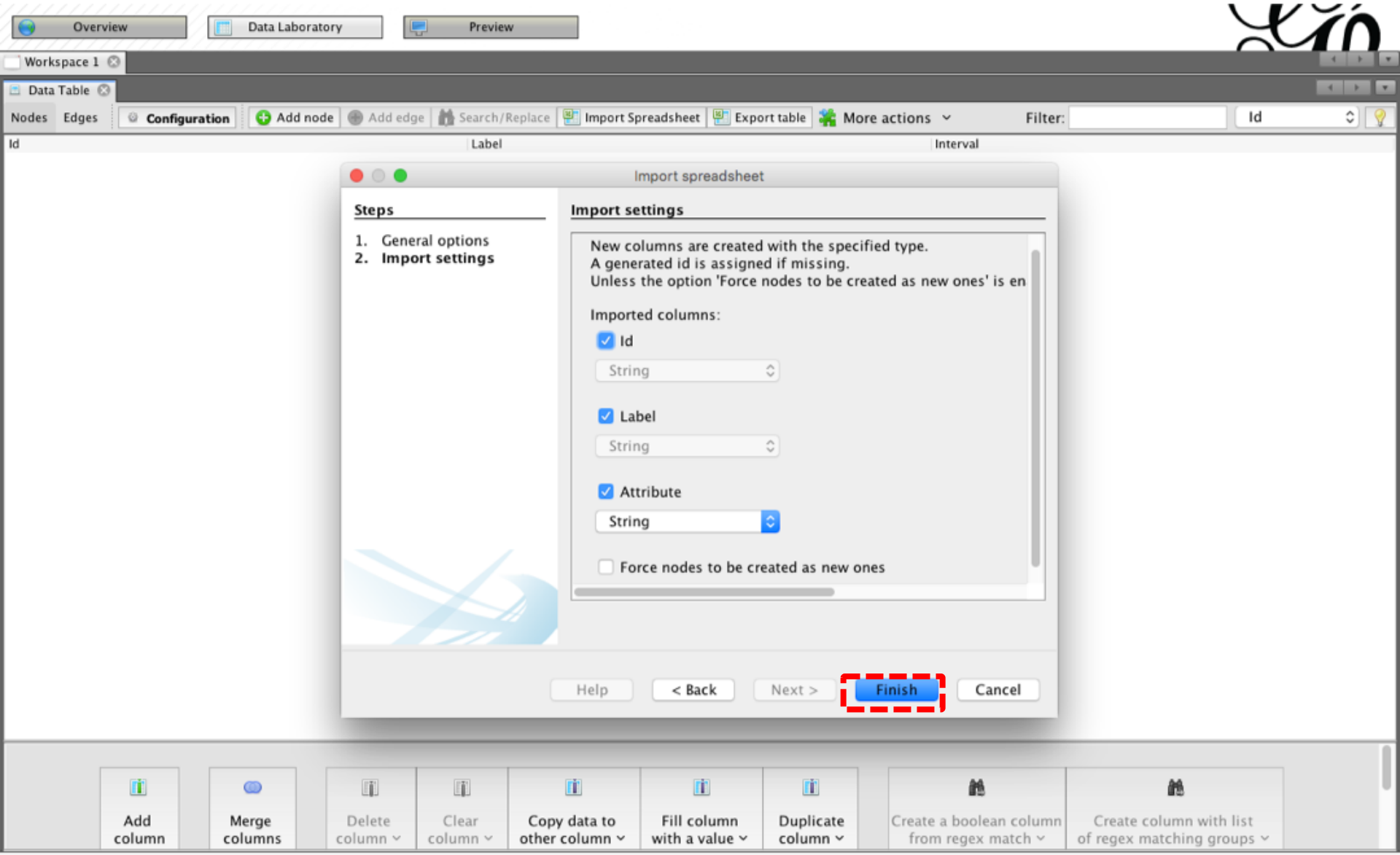
Nodes1.csv

```
Id,Label,Attribute
1,John,1
2,Carla,2
3,Simon,1
4,Celine,2
5,Winston,1
6,Diana,2
```

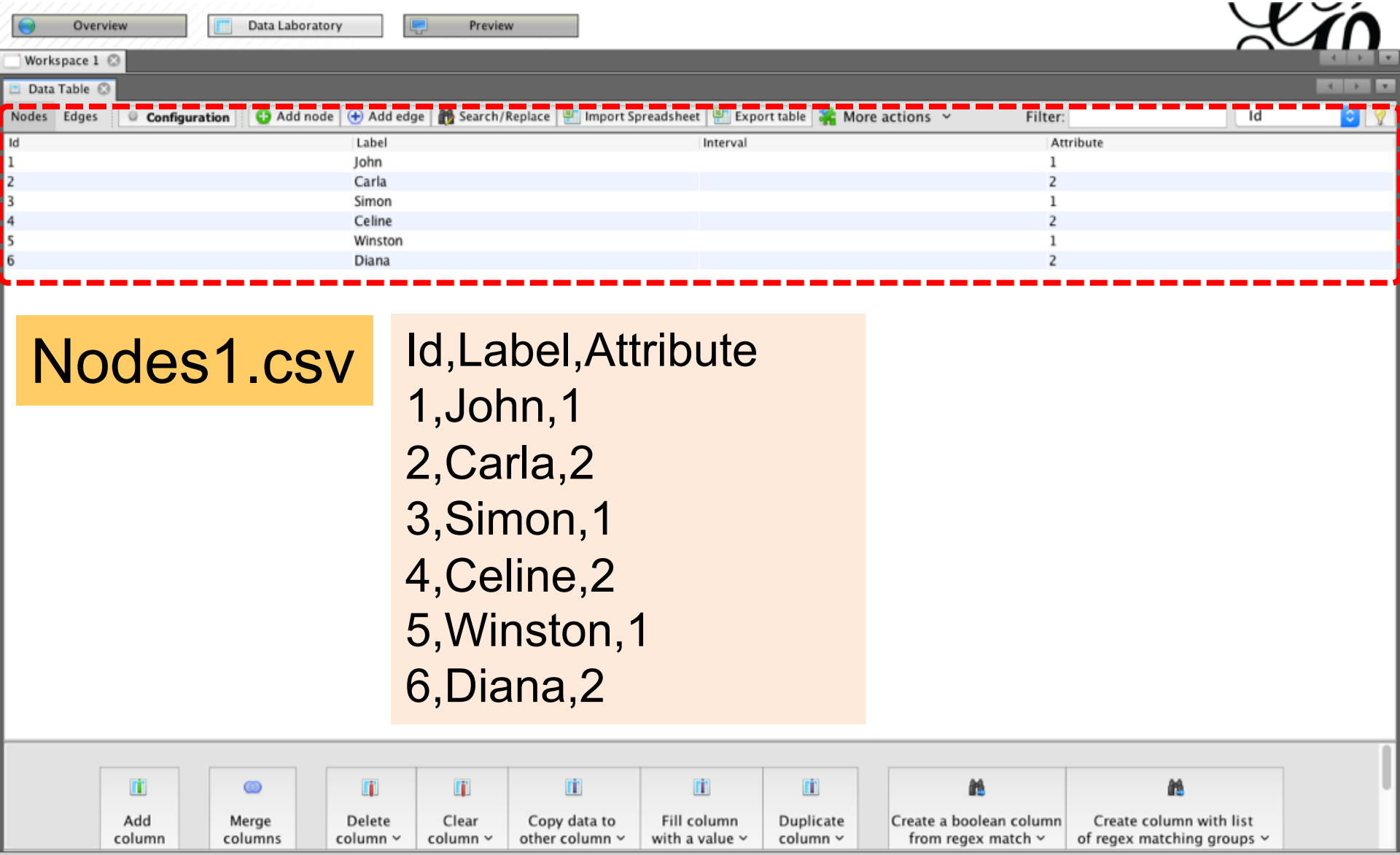
Import Nodes1.csv to Gephi



Import Nodes1.csv to Gephi



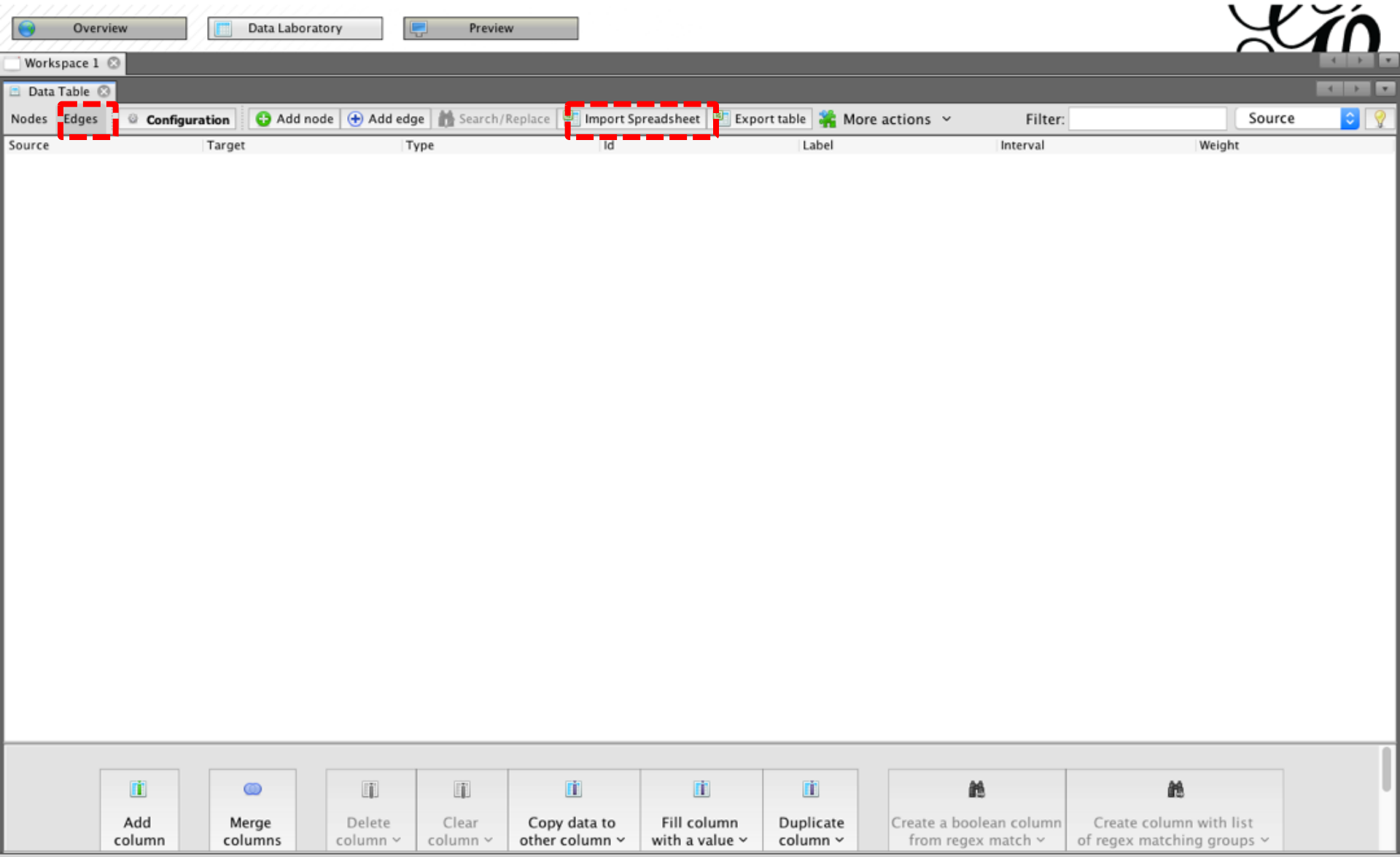
Import Nodes1.csv to Gephi



Nodes1.csv

```
Id,Label,Attribute
1,John,1
2,Carla,2
3,Simon,1
4,Celine,2
5,Winston,1
6,Diana,2
```

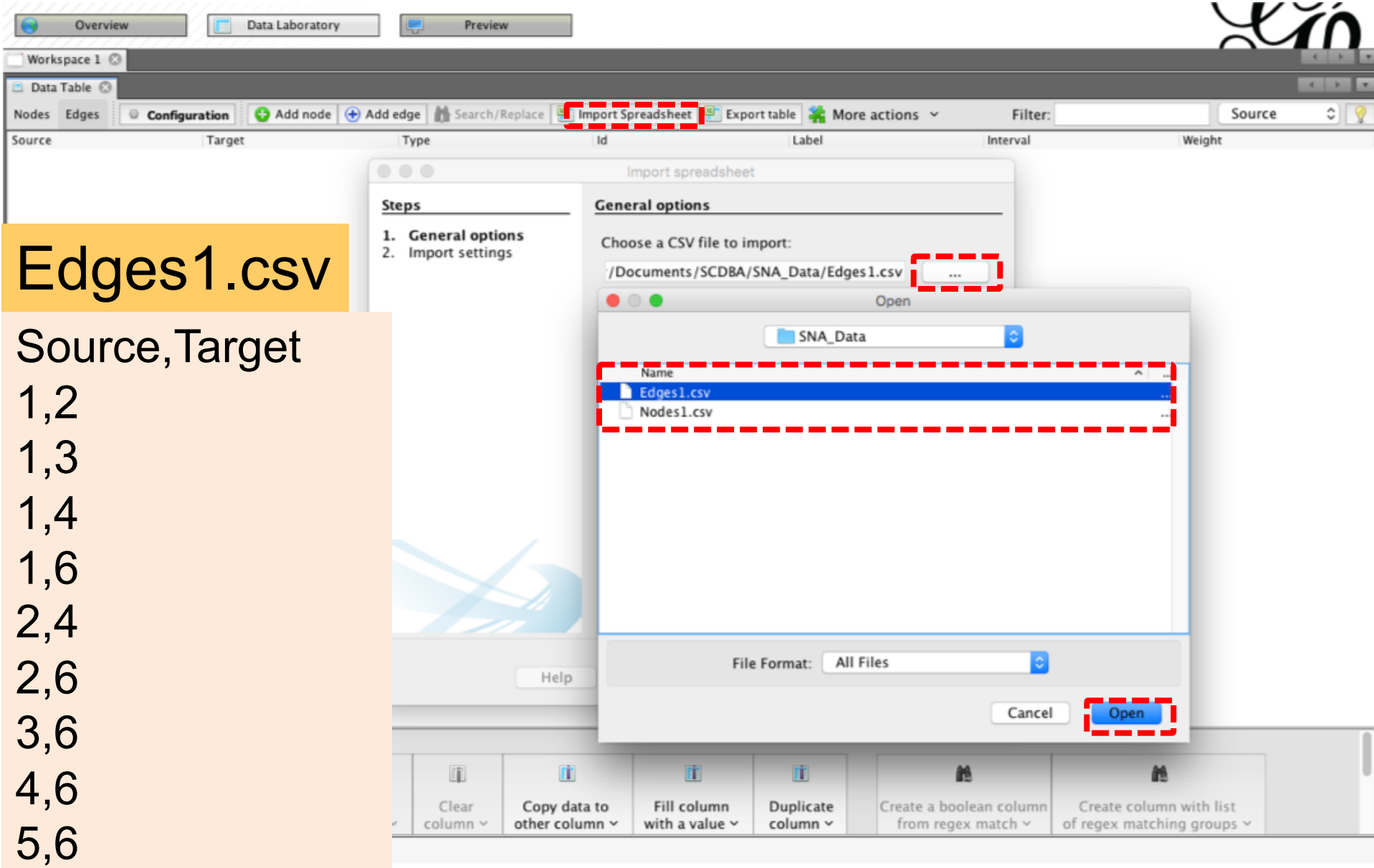
Import Edges1.csv to Gephi



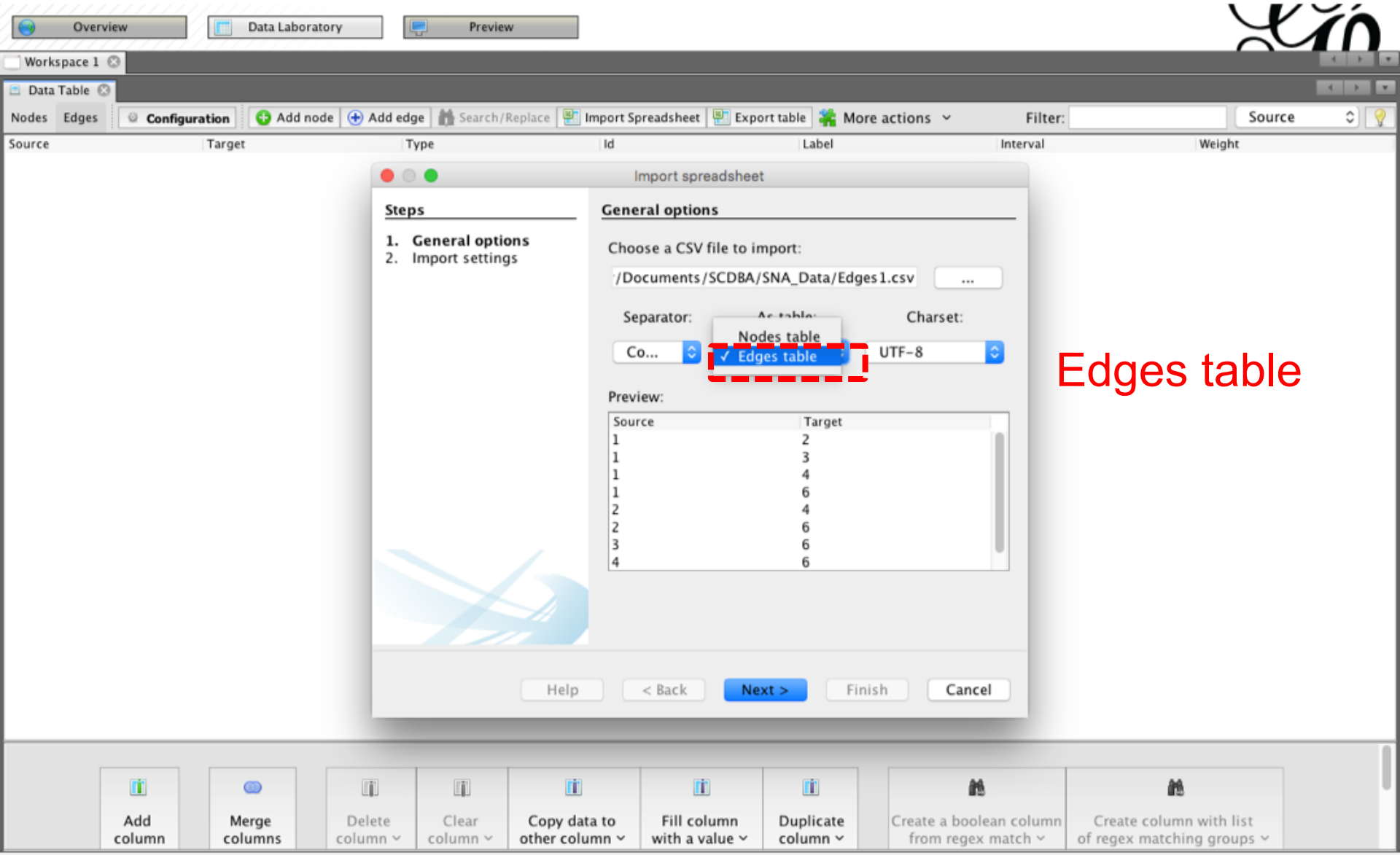
Import Edges1.csv to Gephi

Edges1.csv

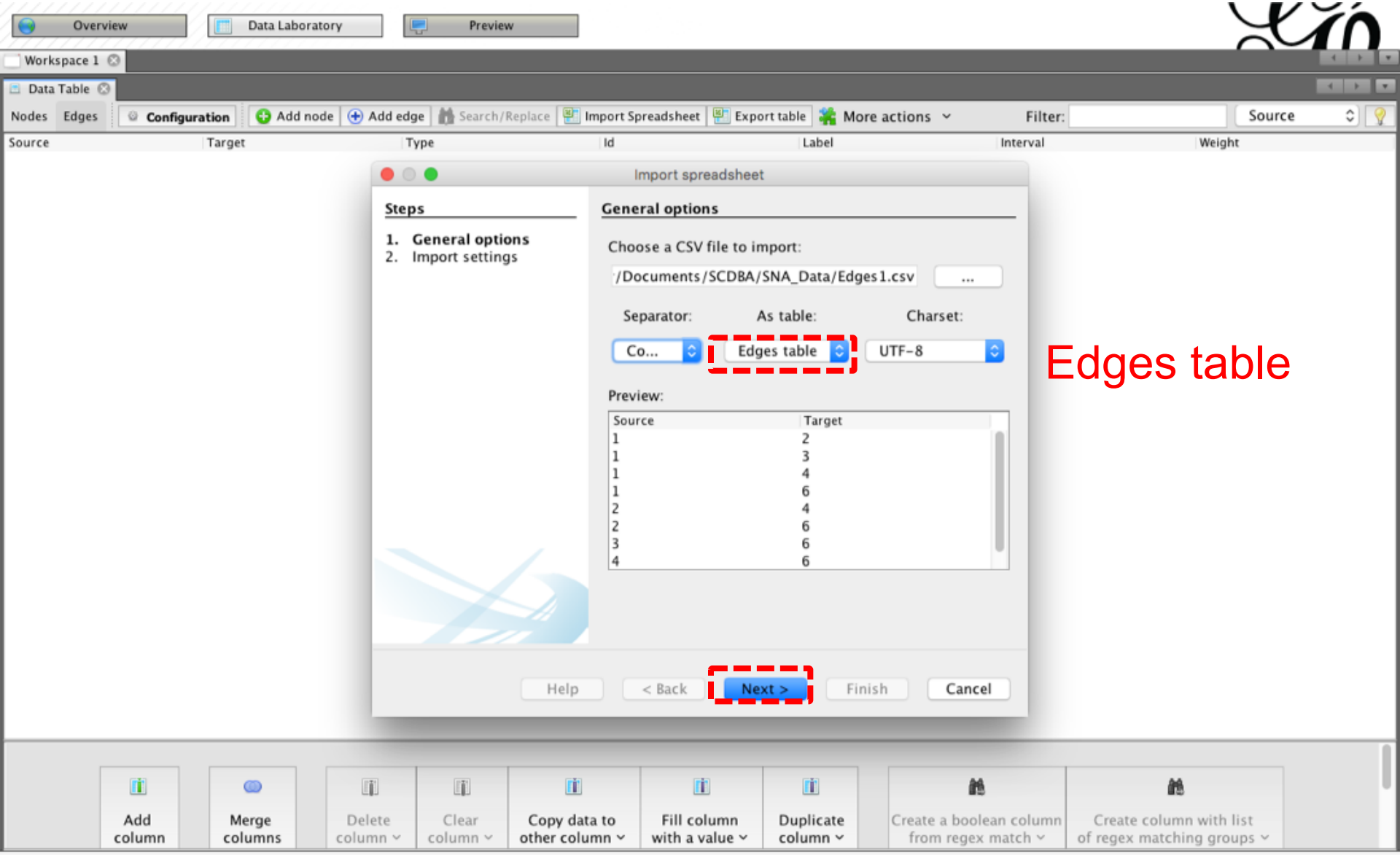
Source,Target
1,2
1,3
1,4
1,6
2,4
2,6
3,6
4,6
5,6



Import Edges1.csv to Gephi

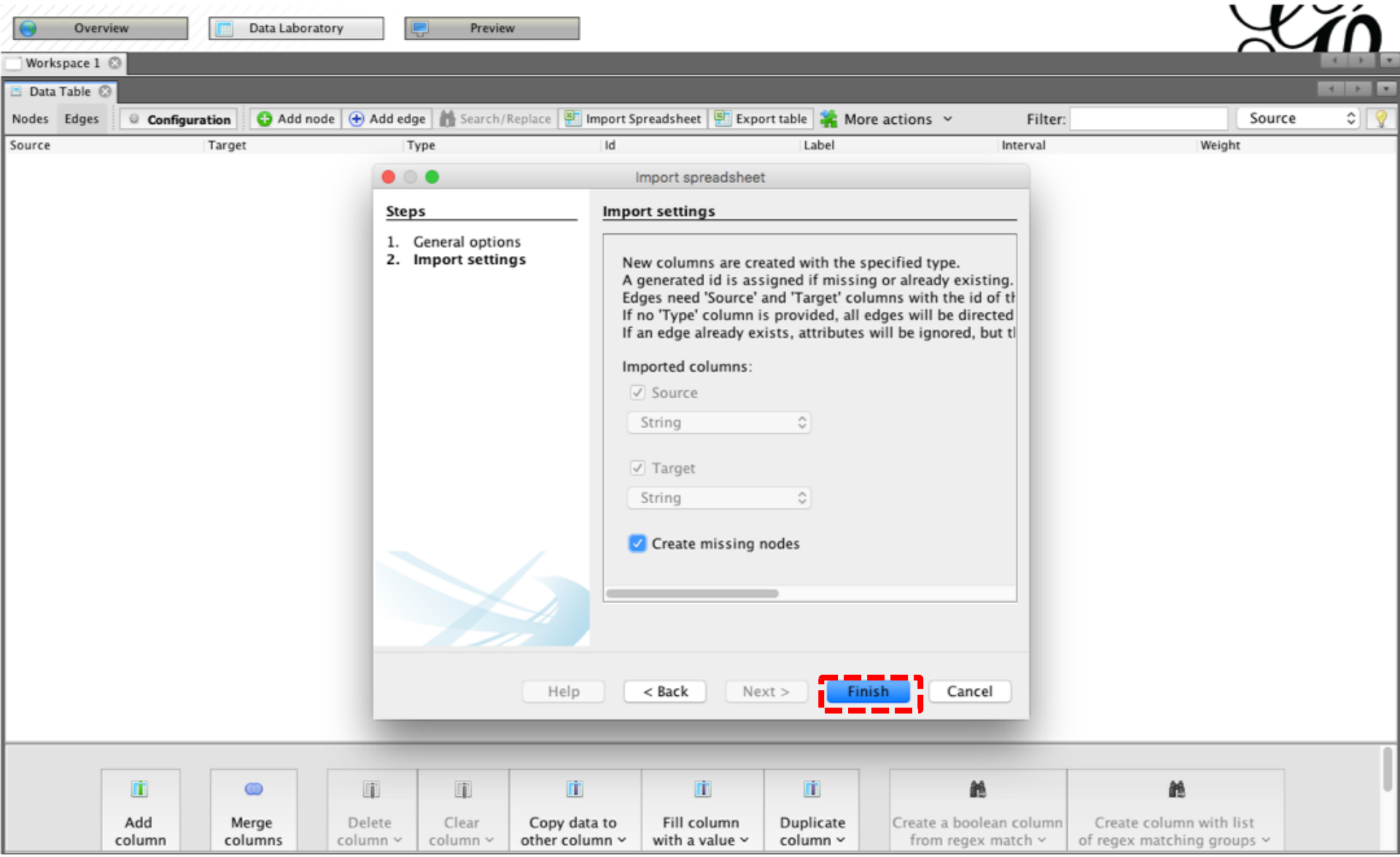


Import Edges1.csv to Gephi

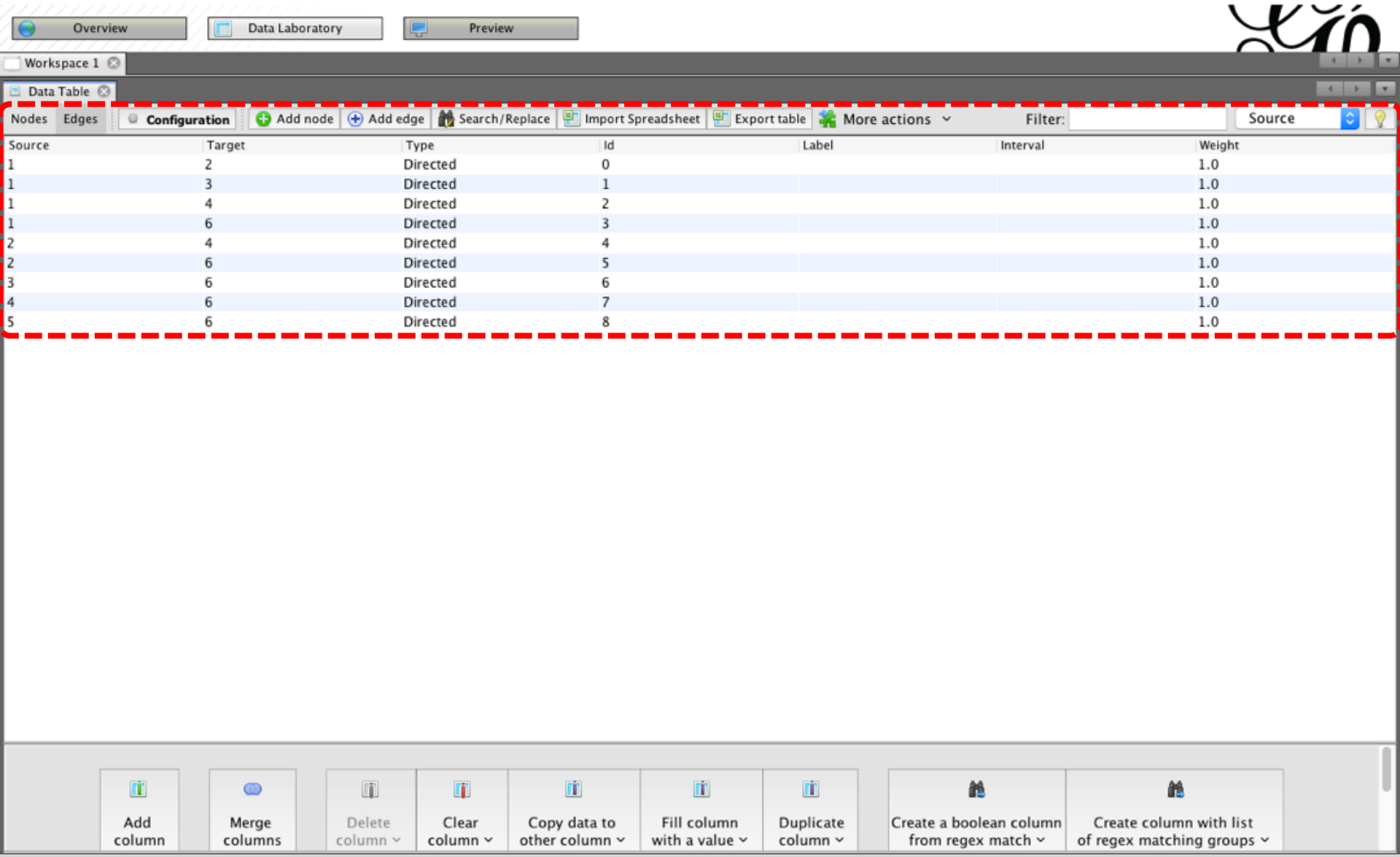


Edges table

Import Edges1.csv to Gephi

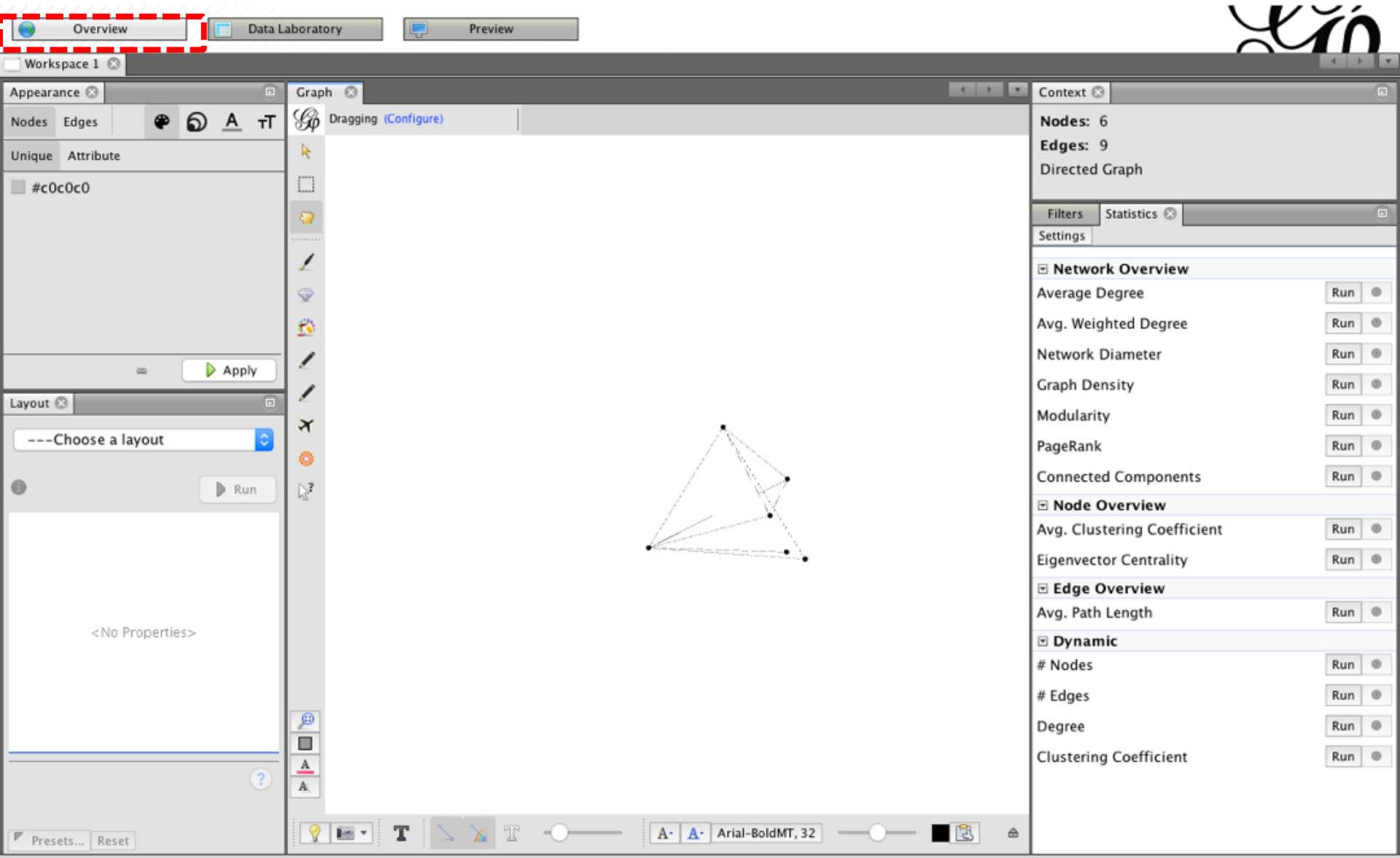


Import Edges1.csv to Gephi

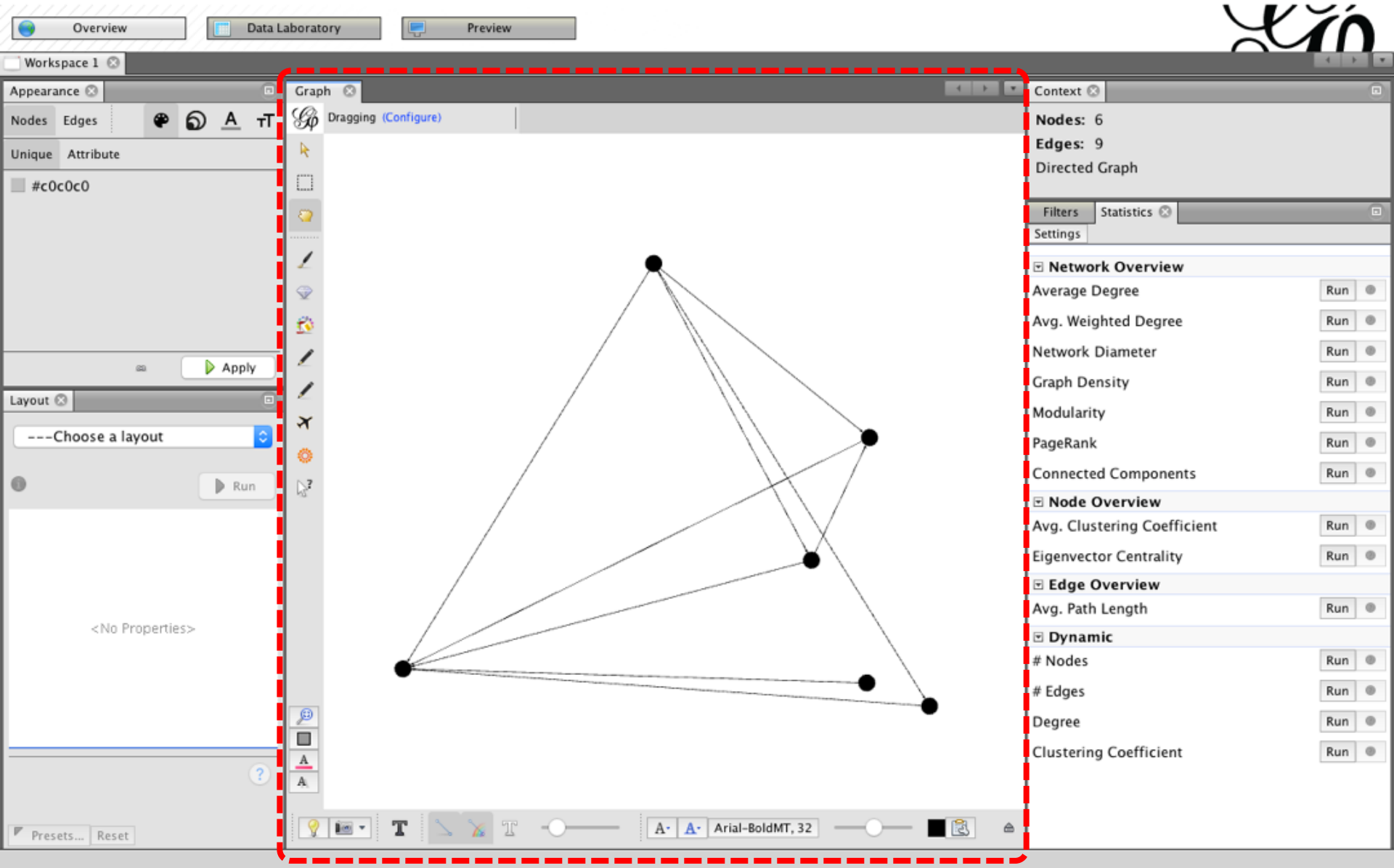


Source	Target	Type	Id	Label	Interval	Weight
1	2	Directed	0			1.0
1	3	Directed	1			1.0
1	4	Directed	2			1.0
1	6	Directed	3			1.0
2	4	Directed	4			1.0
2	6	Directed	5			1.0
3	6	Directed	6			1.0
4	6	Directed	7			1.0
5	6	Directed	8			1.0

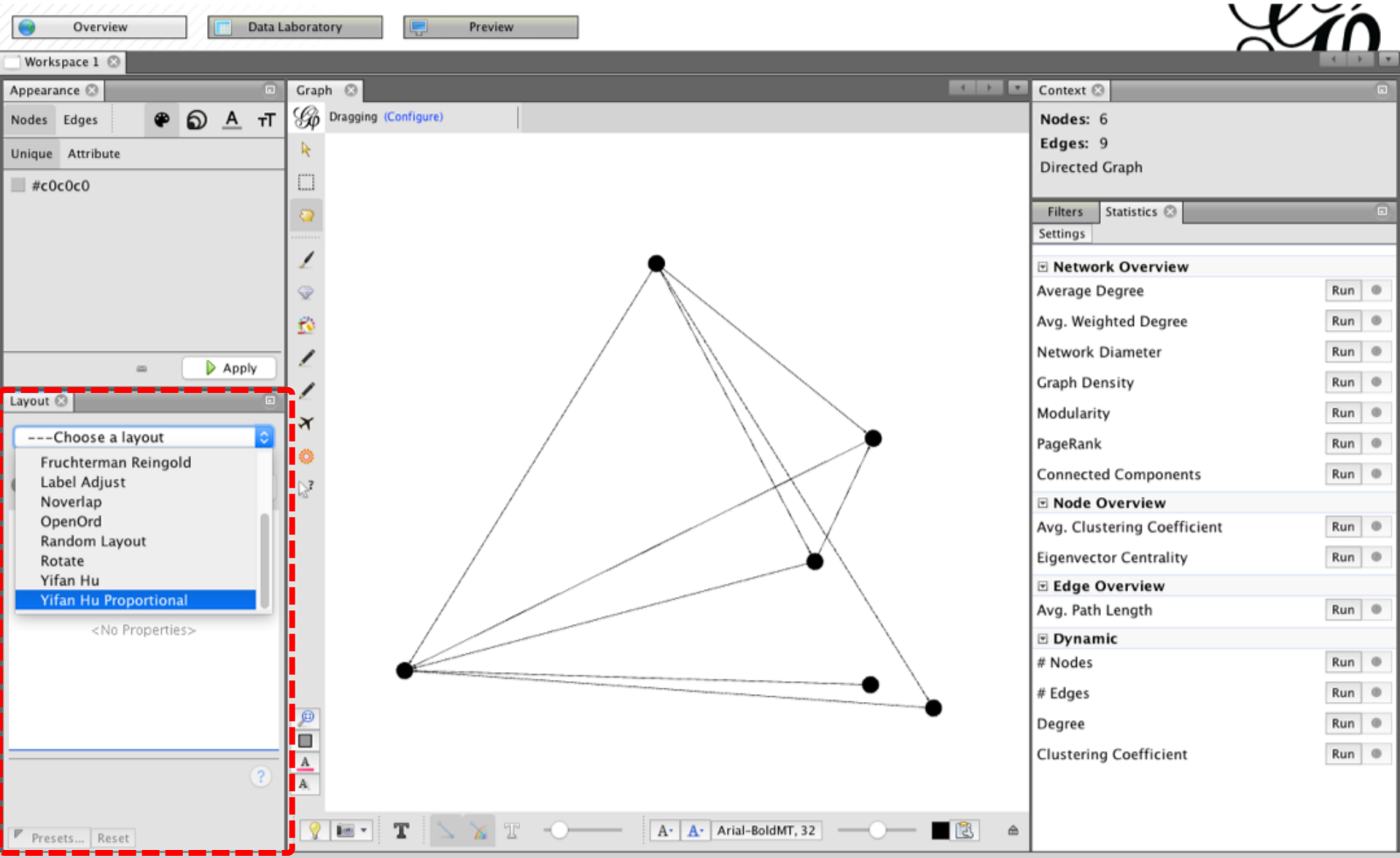
Gephi Overview



Gephi Overview: Graph

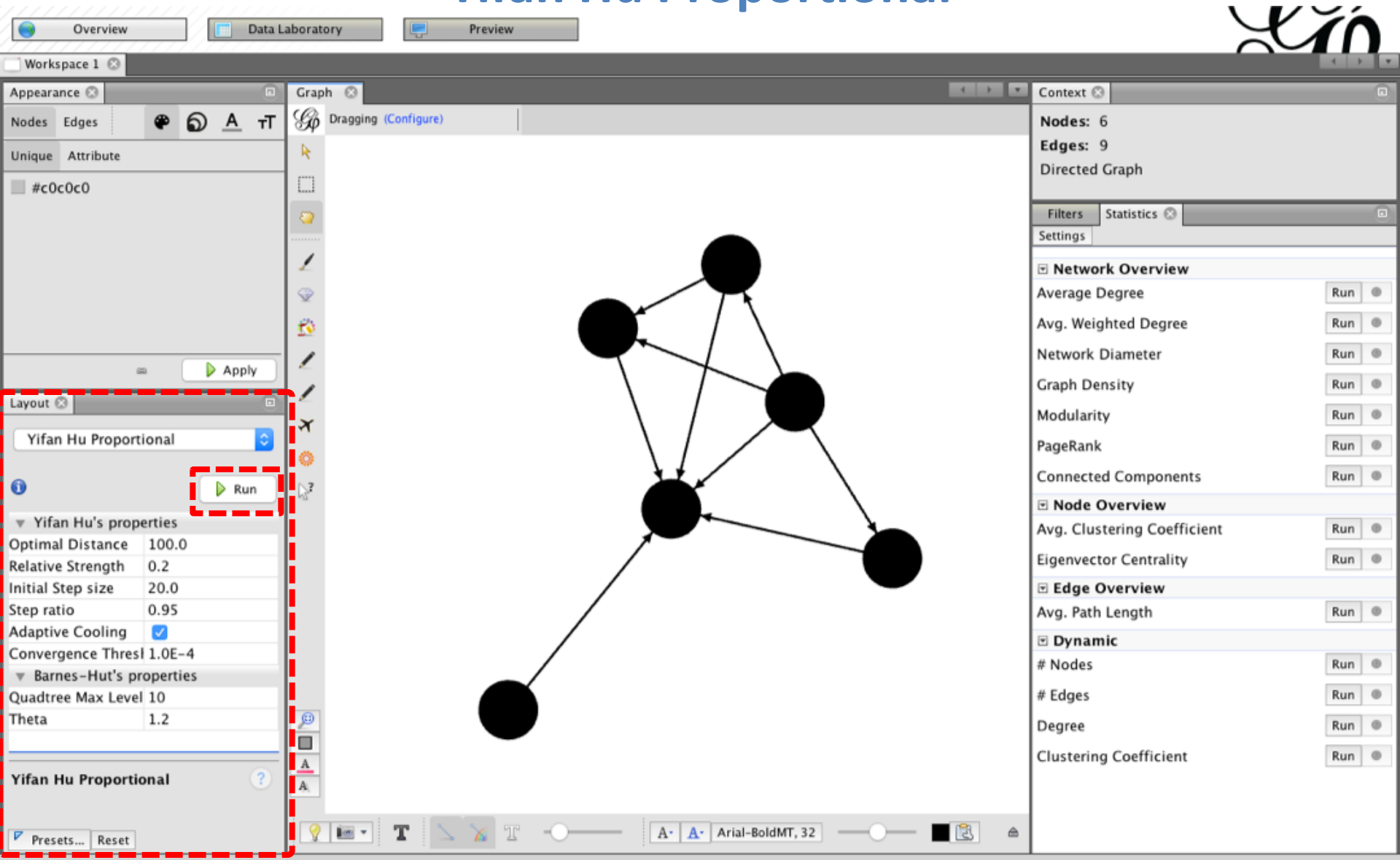


Gephi Overview: Layout



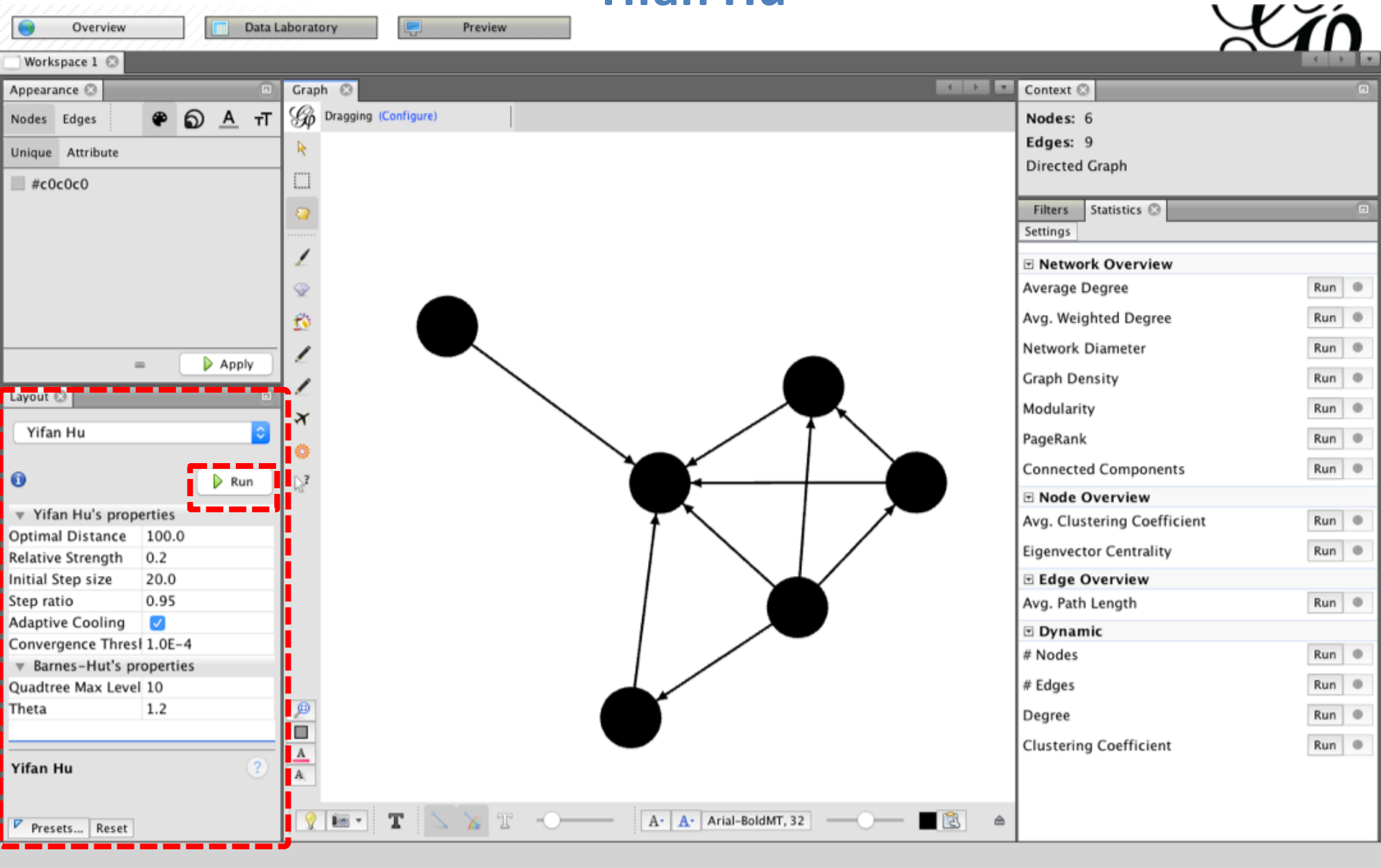
Gephi Overview: Layout

Yifan Hu Proportional

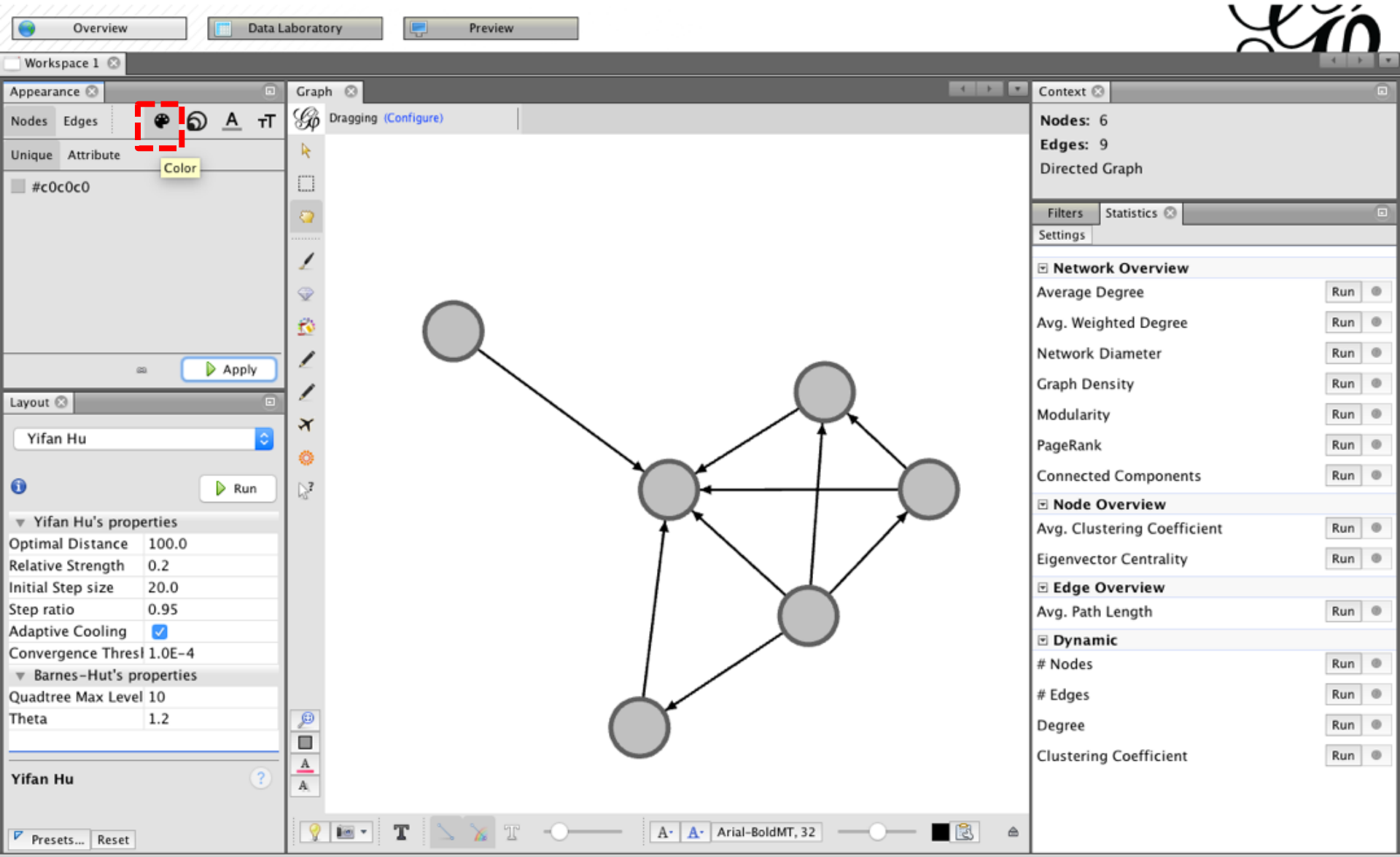


Gephi Overview: Layout

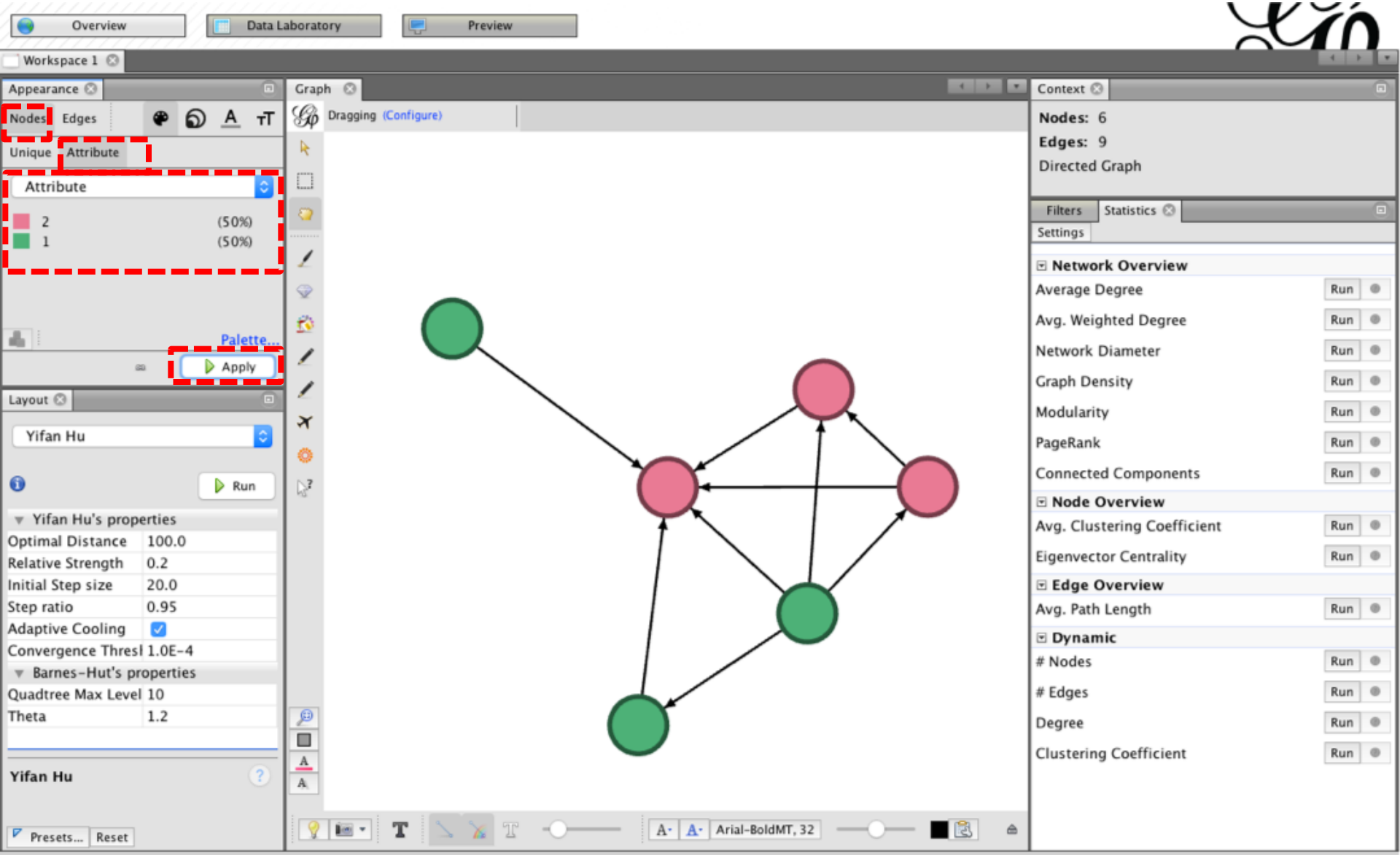
Yifan Hu



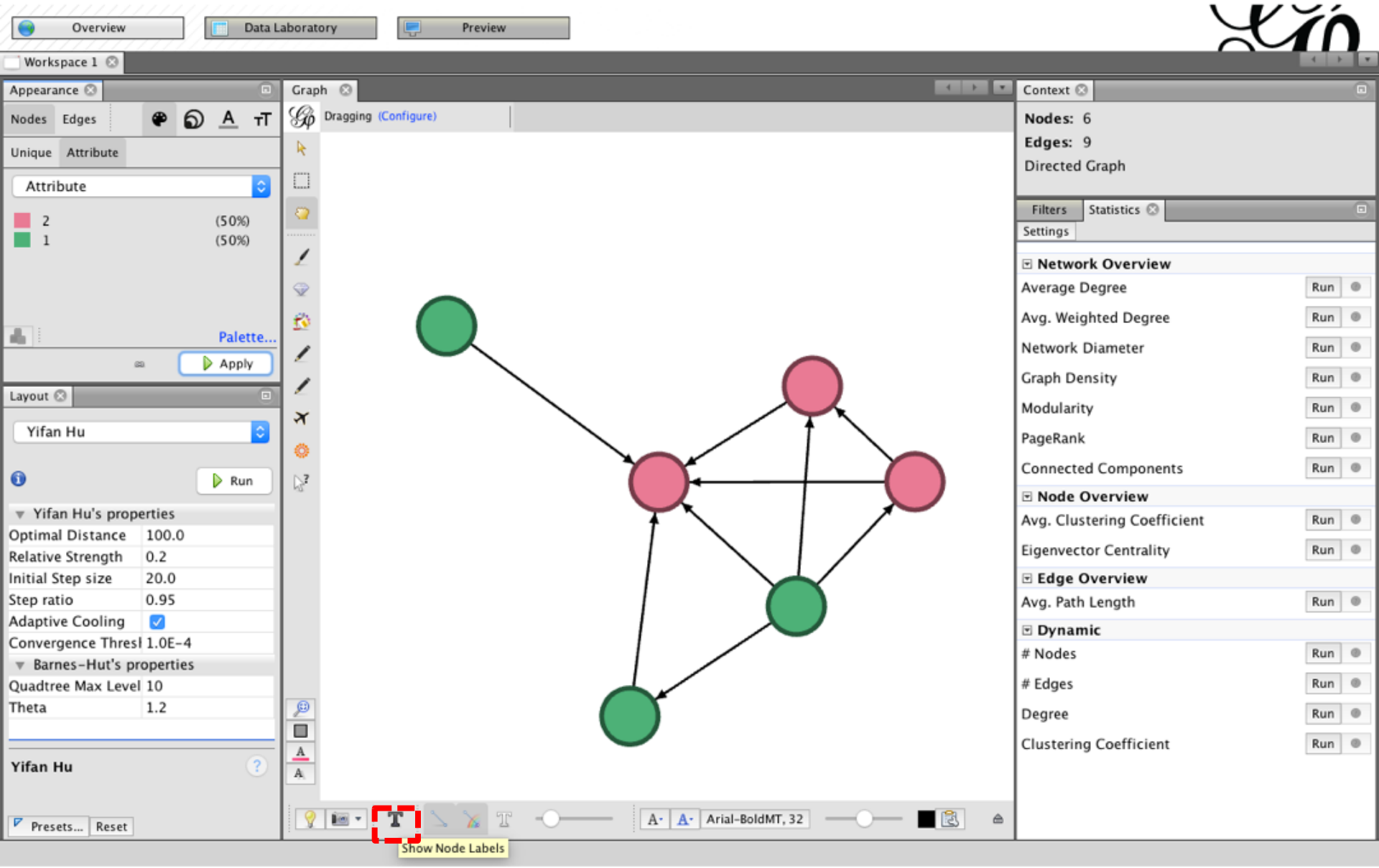
Appearance: Nodes Color



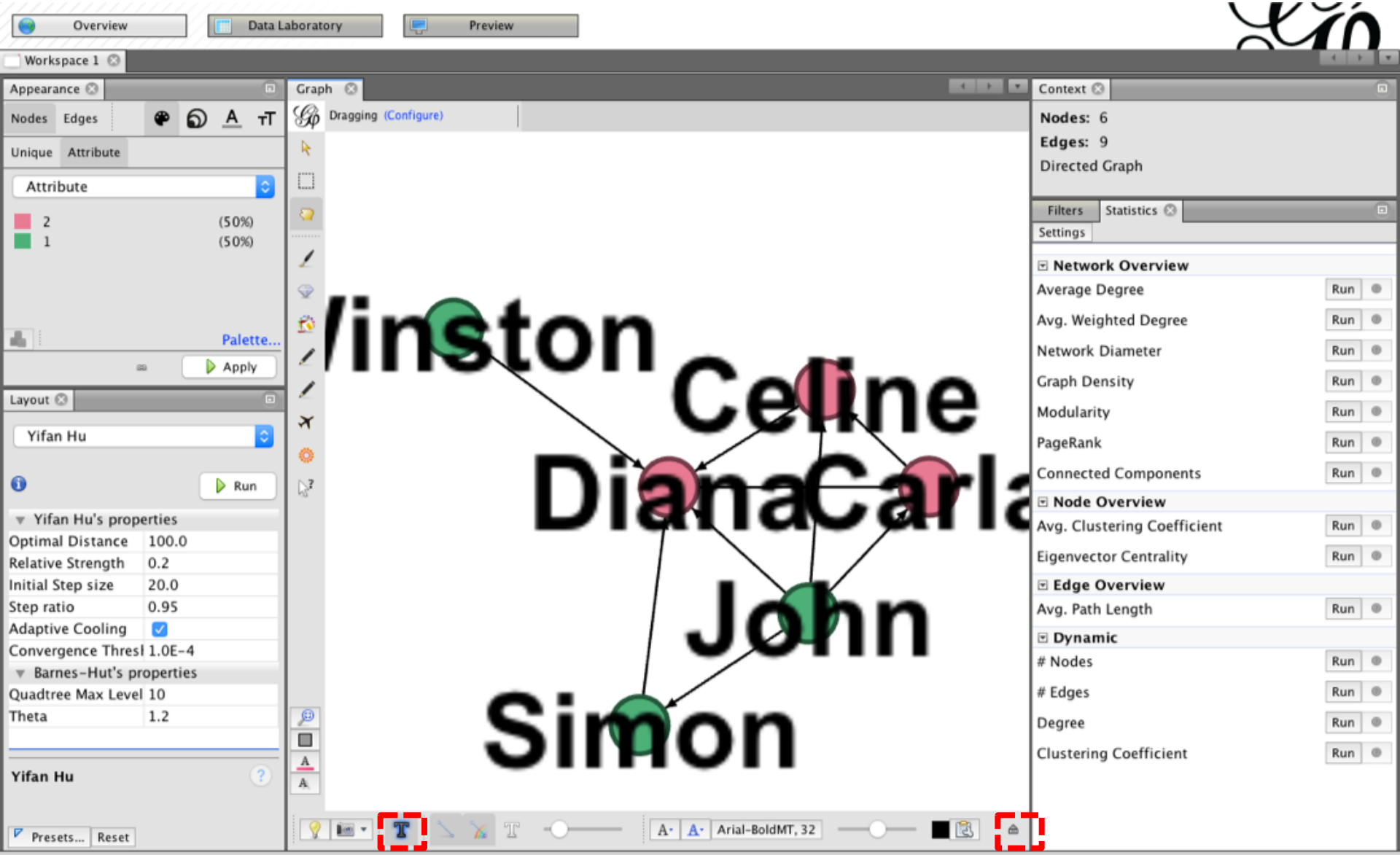
Nodes Color / Attribute / Apply



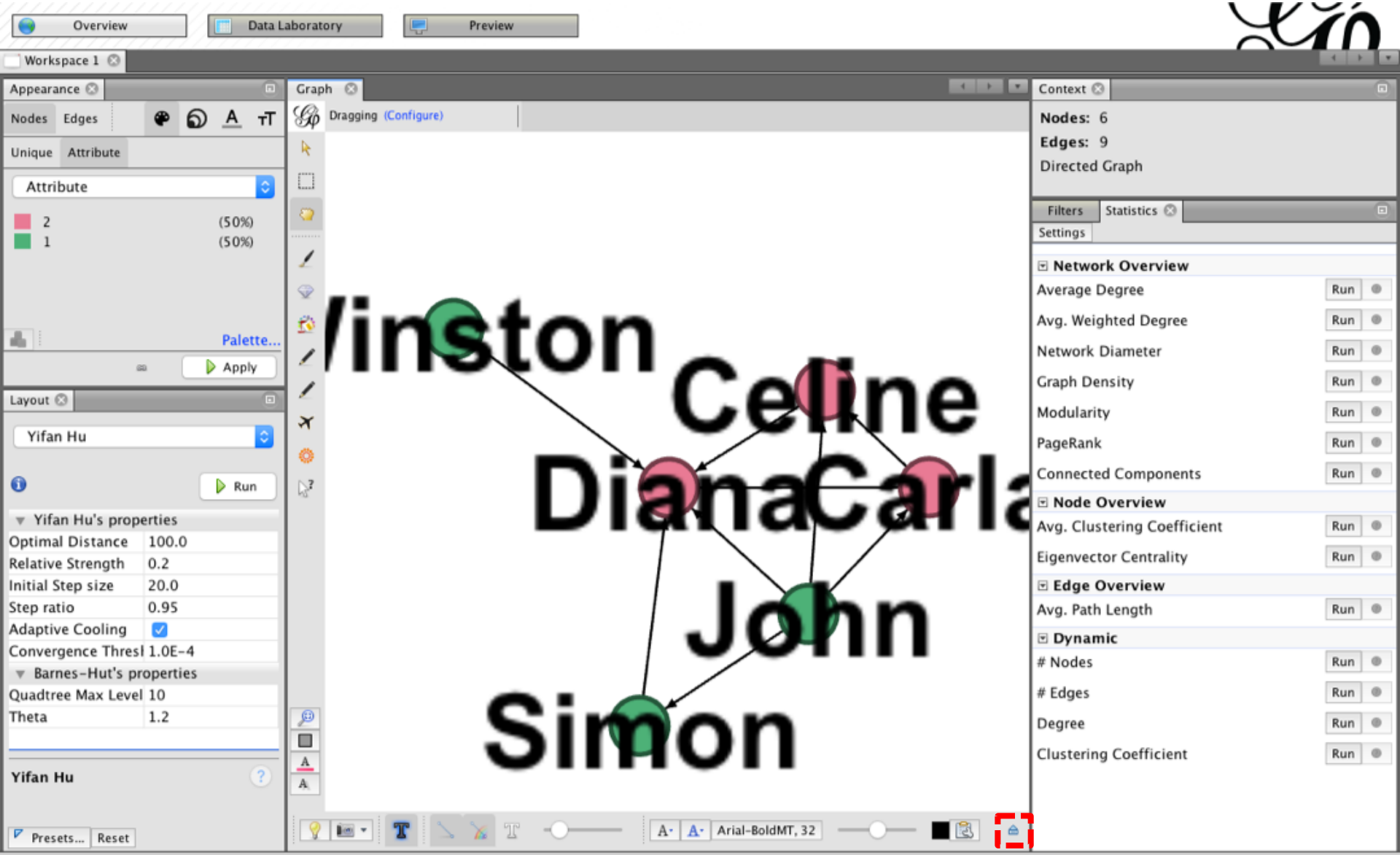
Show Node Labels



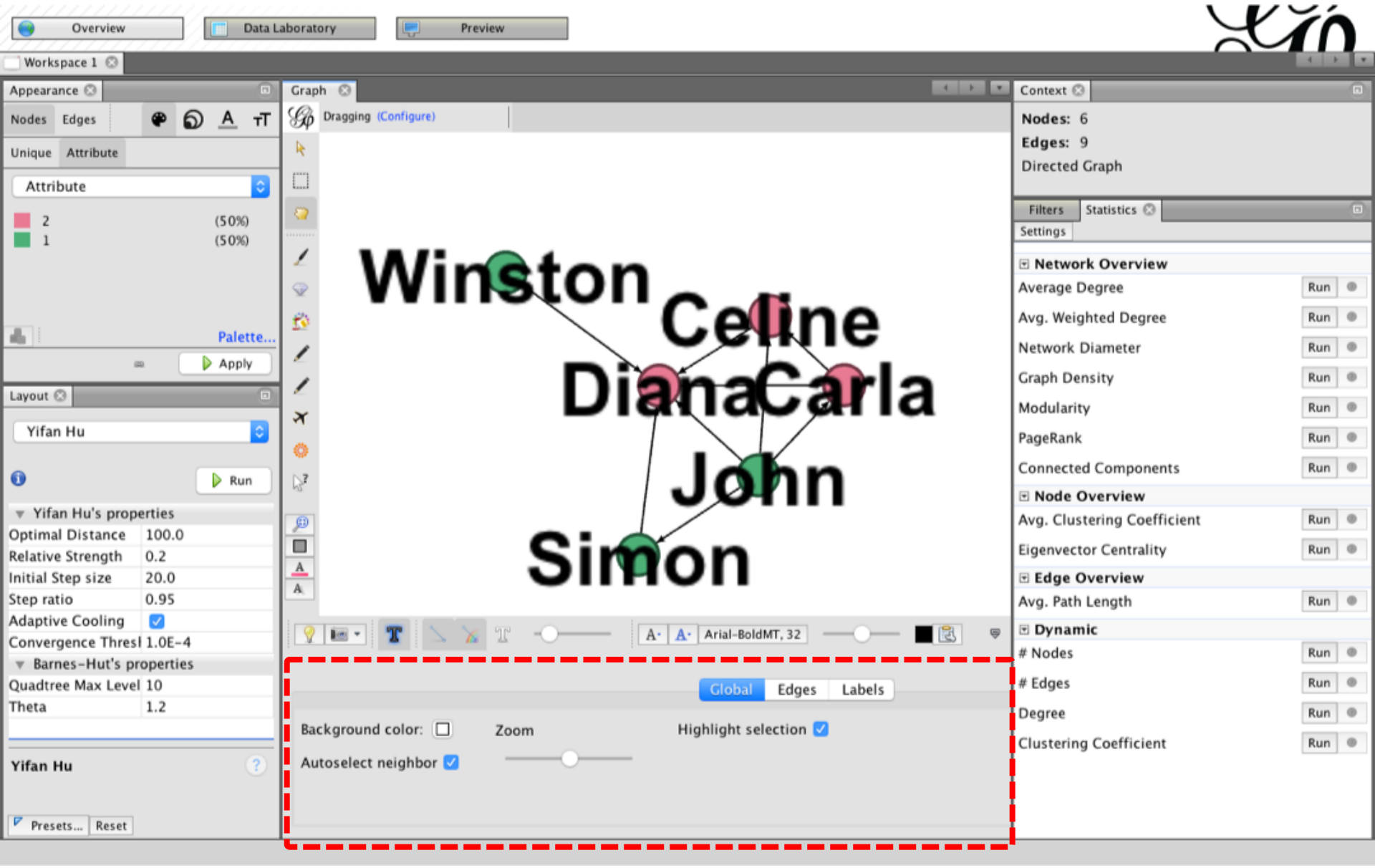
Show Node Labels



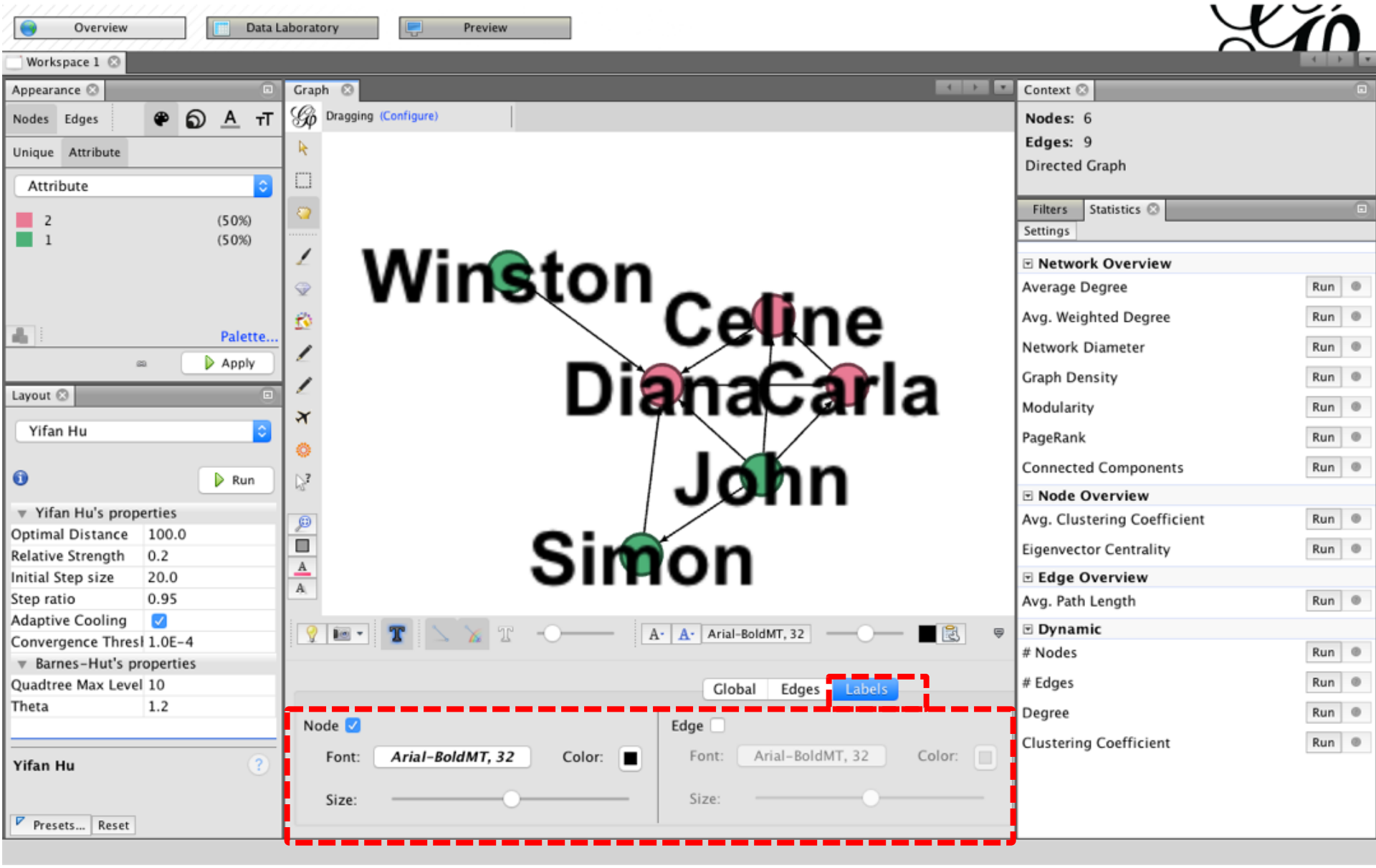
Show Labels


Overview
Data Laboratory
Preview
Workspace 1
Appearance
Nodes
Edges
Unique
Attribute
Attribute
2 (50%)
1 (50%)
Palette...
Apply
Layout
Yifan Hu
Run
Yifan Hu's properties
Optimal Distance 100.0
Relative Strength 0.2
Initial Step size 20.0
Step ratio 0.95
Adaptive Cooling
Convergence Thresl 1.0E-4
Barnes-Hut's properties
Quadtree Max Level 10
Theta 1.2
Yifan Hu
Presets...
Reset
Graph
Dragging (Configure)
Winston
Celine
Diana
Carla
John
Simon
Arial-BoldMT, 32
Context
Nodes: 6
Edges: 9
Directed Graph
Filters
Statistics
Settings
Network Overview
Average Degree Run
Avg. Weighted Degree Run
Network Diameter Run
Graph Density Run
Modularity Run
PageRank Run
Connected Components Run
Node Overview
Avg. Clustering Coefficient Run
Eigenvector Centrality Run
Edge Overview
Avg. Path Length Run
Dynamic
Nodes Run
Edges Run
Degree Run
Clustering Coefficient Run

Global Edges Labels



Labels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Edges
Labels
Node
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Color:
Size:
Edge
Font: Arial-BoldMT, 32
Color:
Size:
Context
Nodes: 6
Edges: 9
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PageRank Run
Connected Components Run
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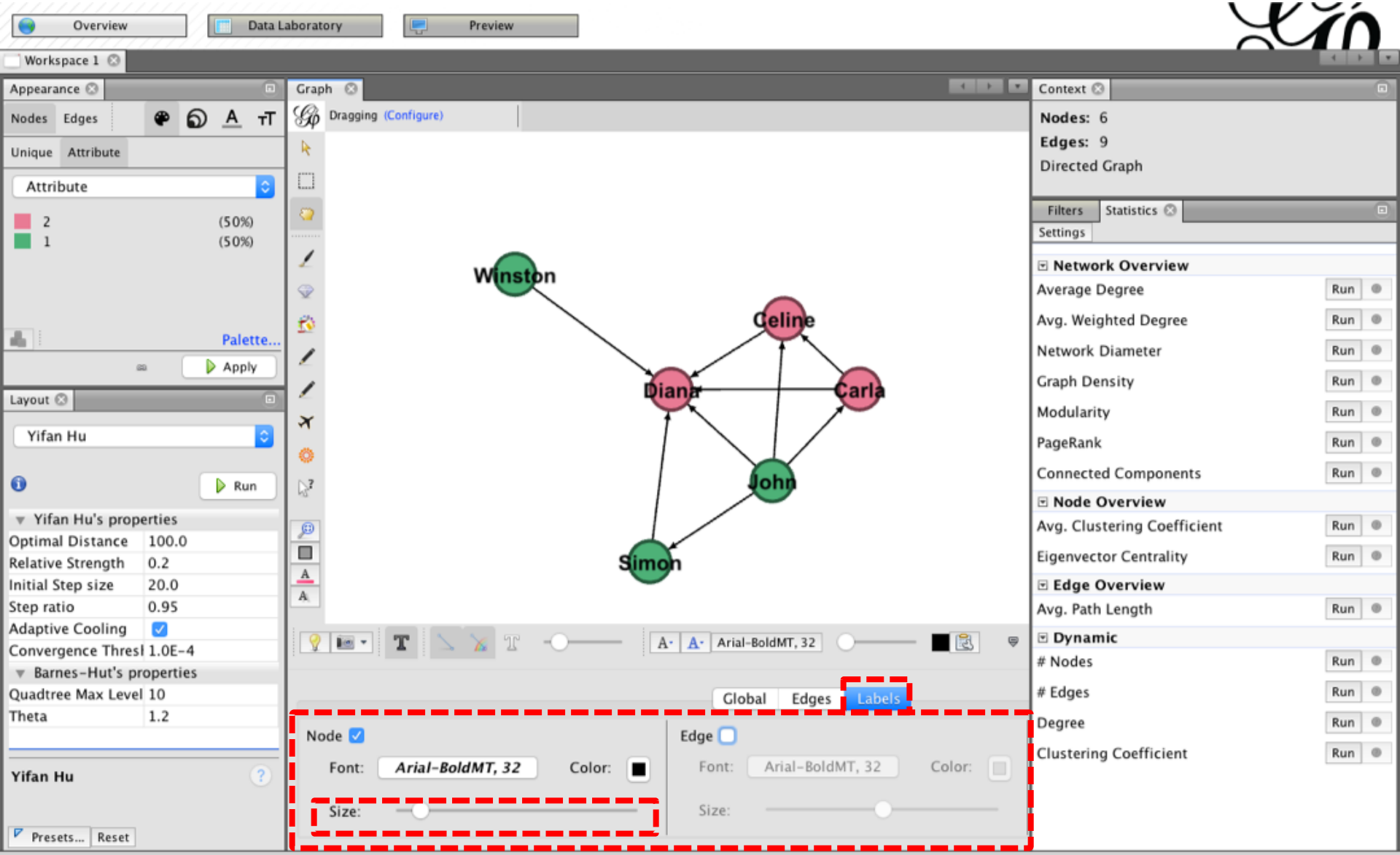
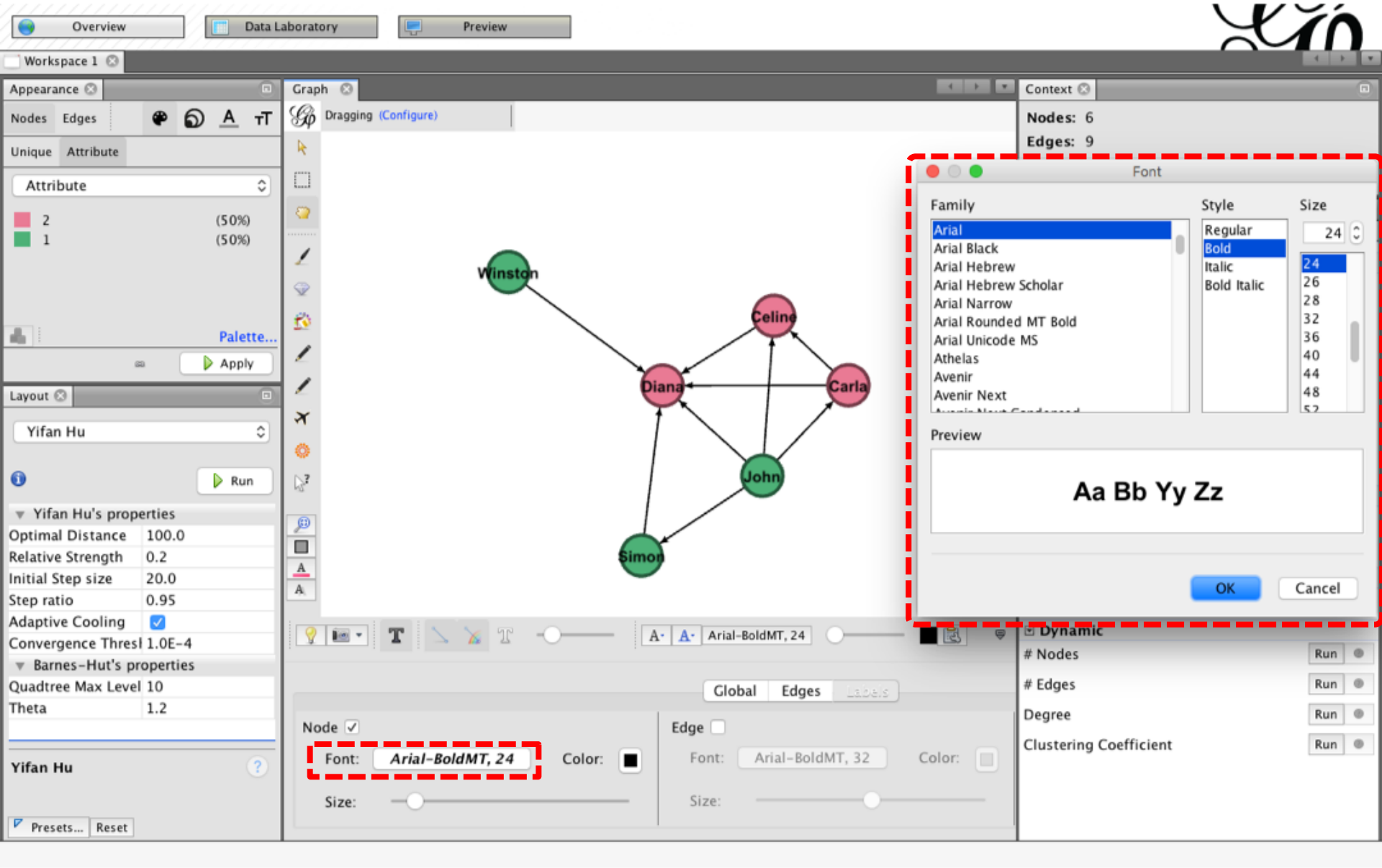
Avg. Clustering Coefficient Run
Eigenvector Centrality Run
Edge Overview
Avg. Path Length Run
Dynamic
Nodes Run
Edges Run
Degree Run
Clustering Coefficient Run

Labels Node Size



Labels Node Font Size



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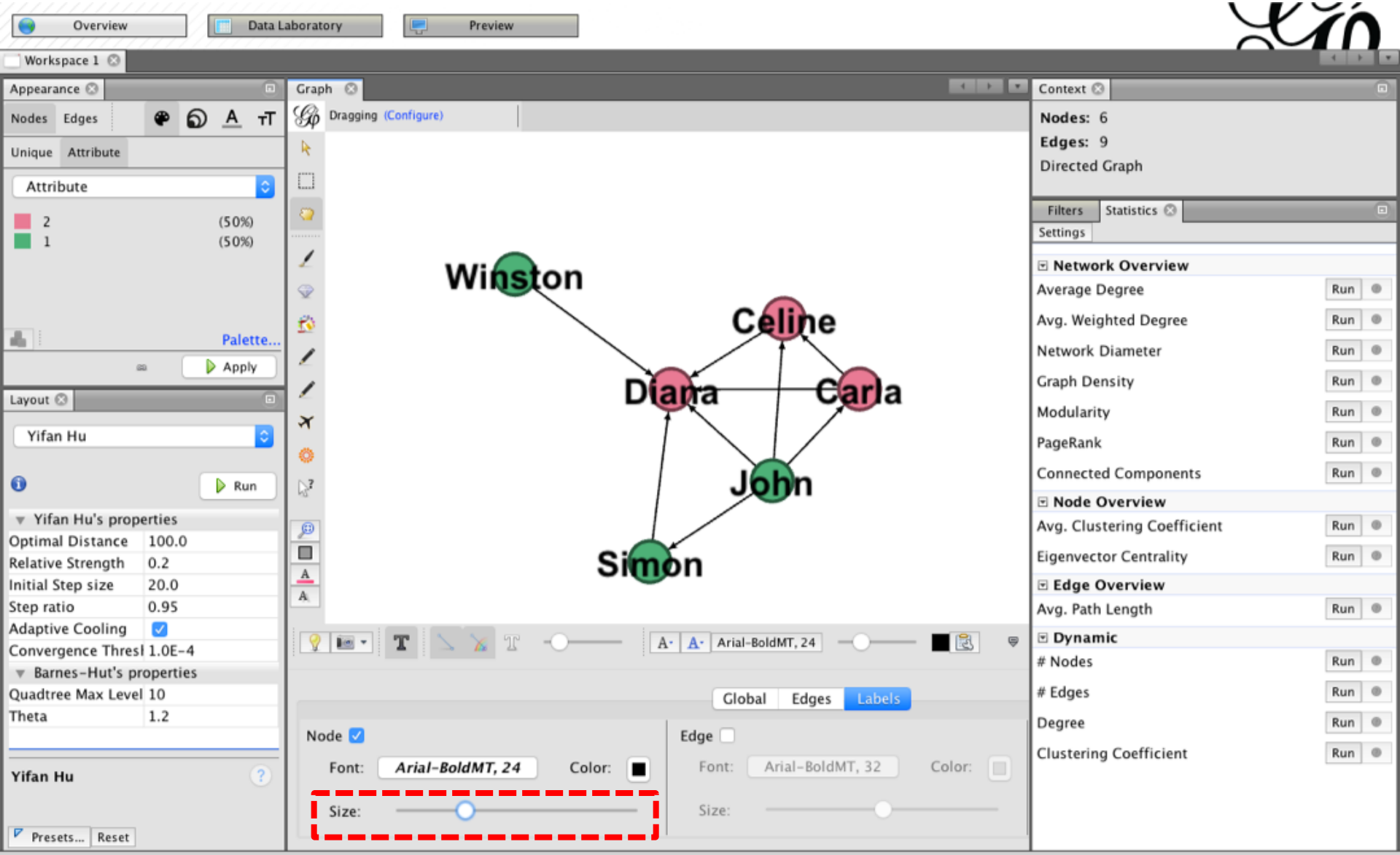
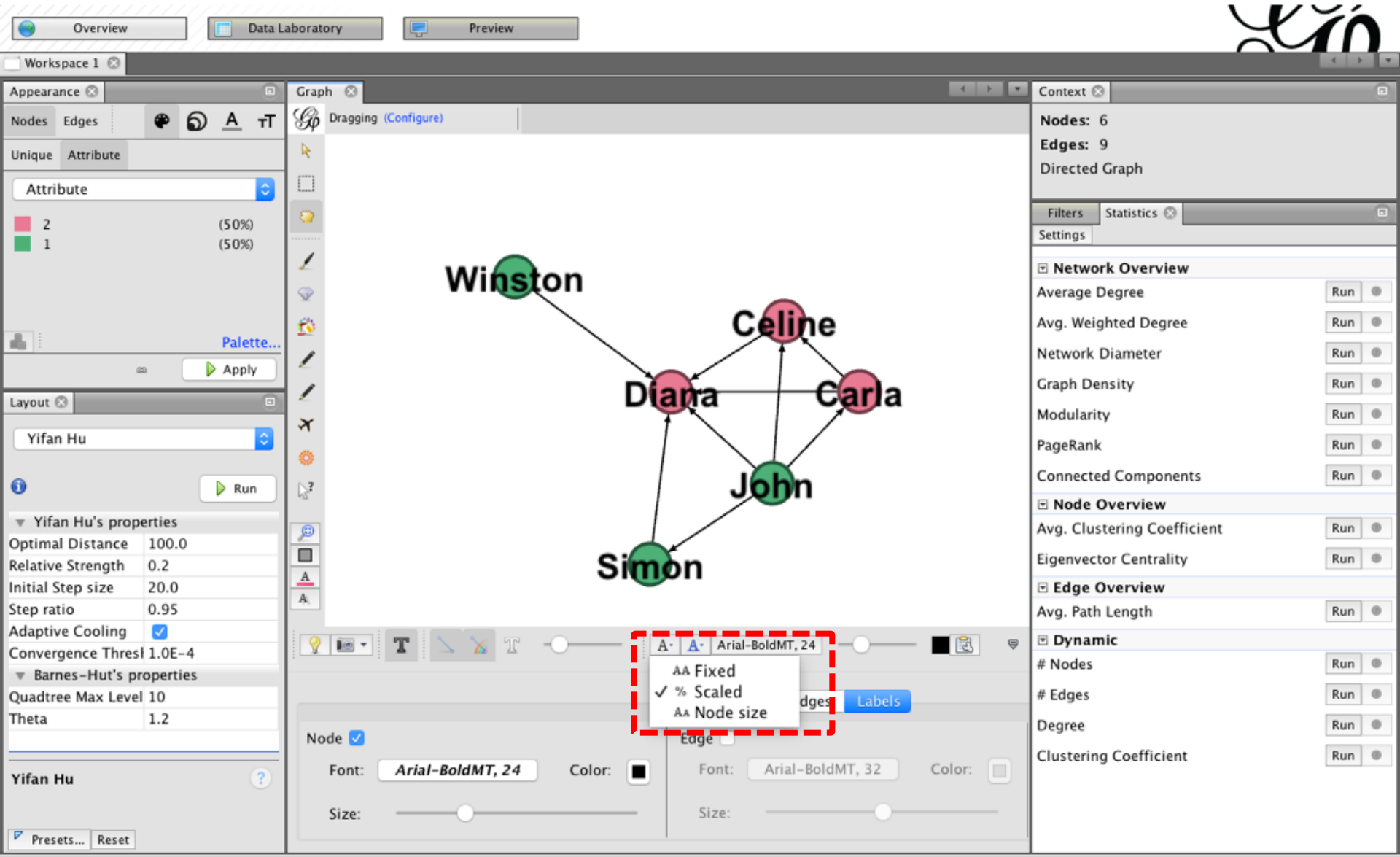
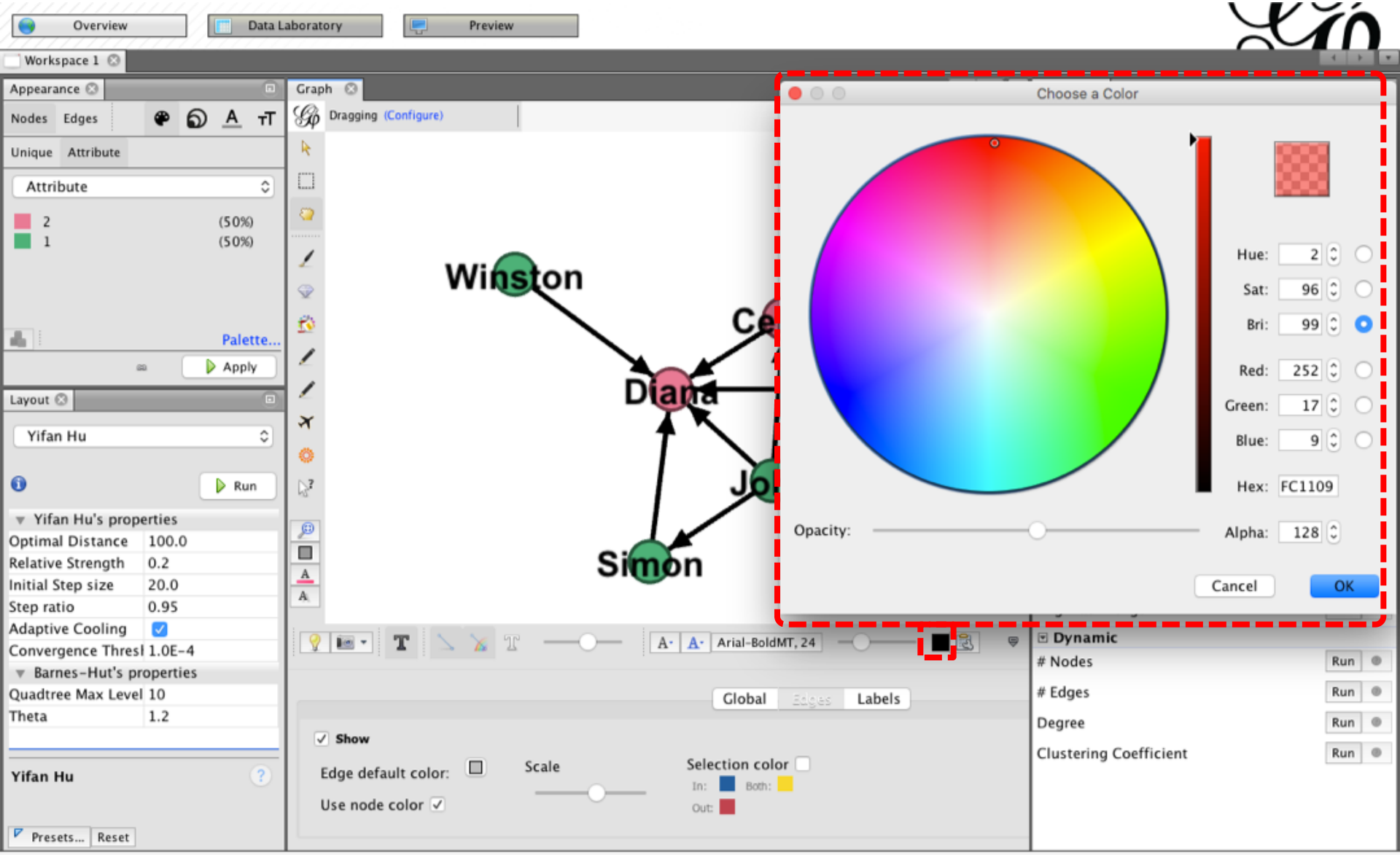


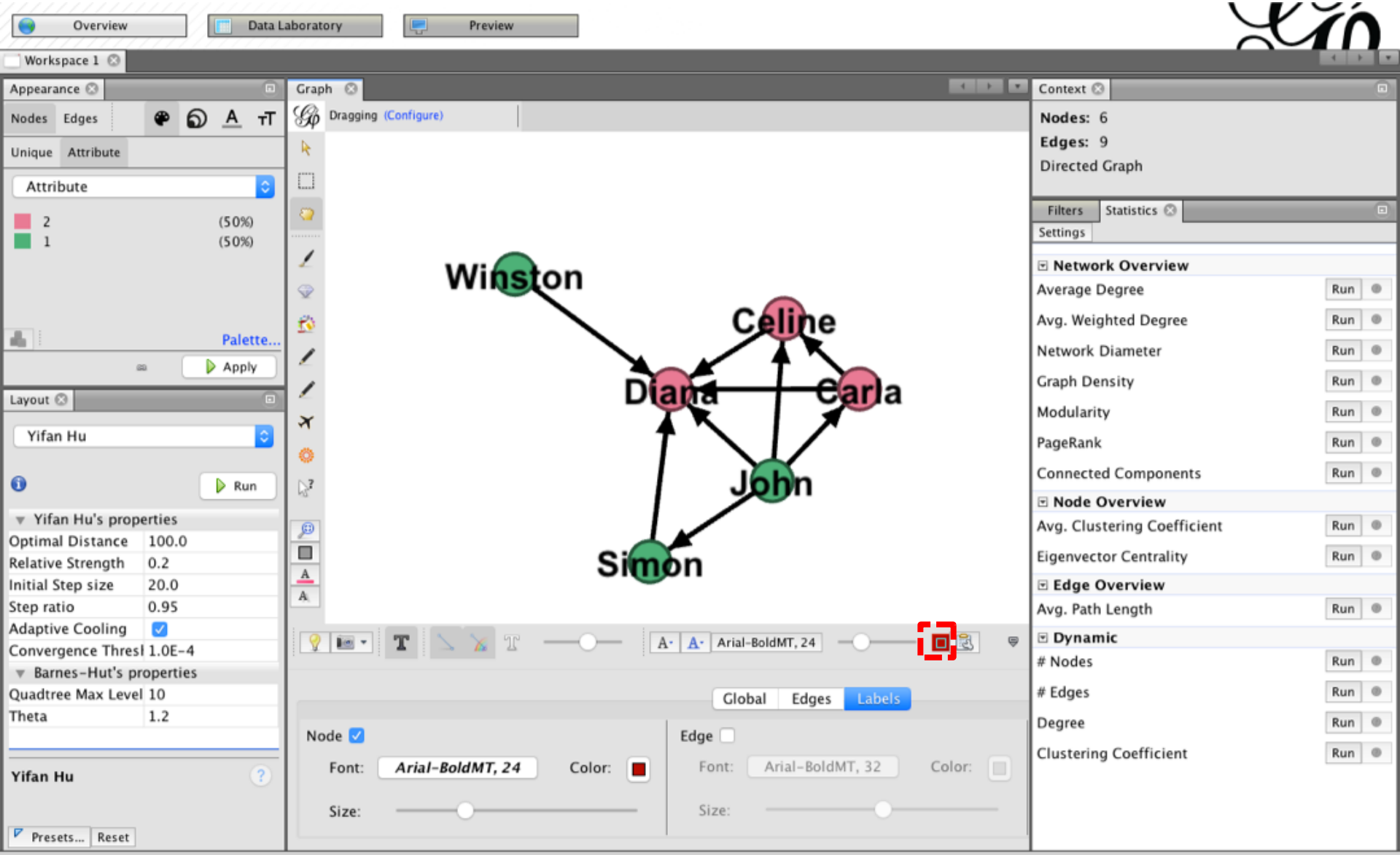
Labels Scaled



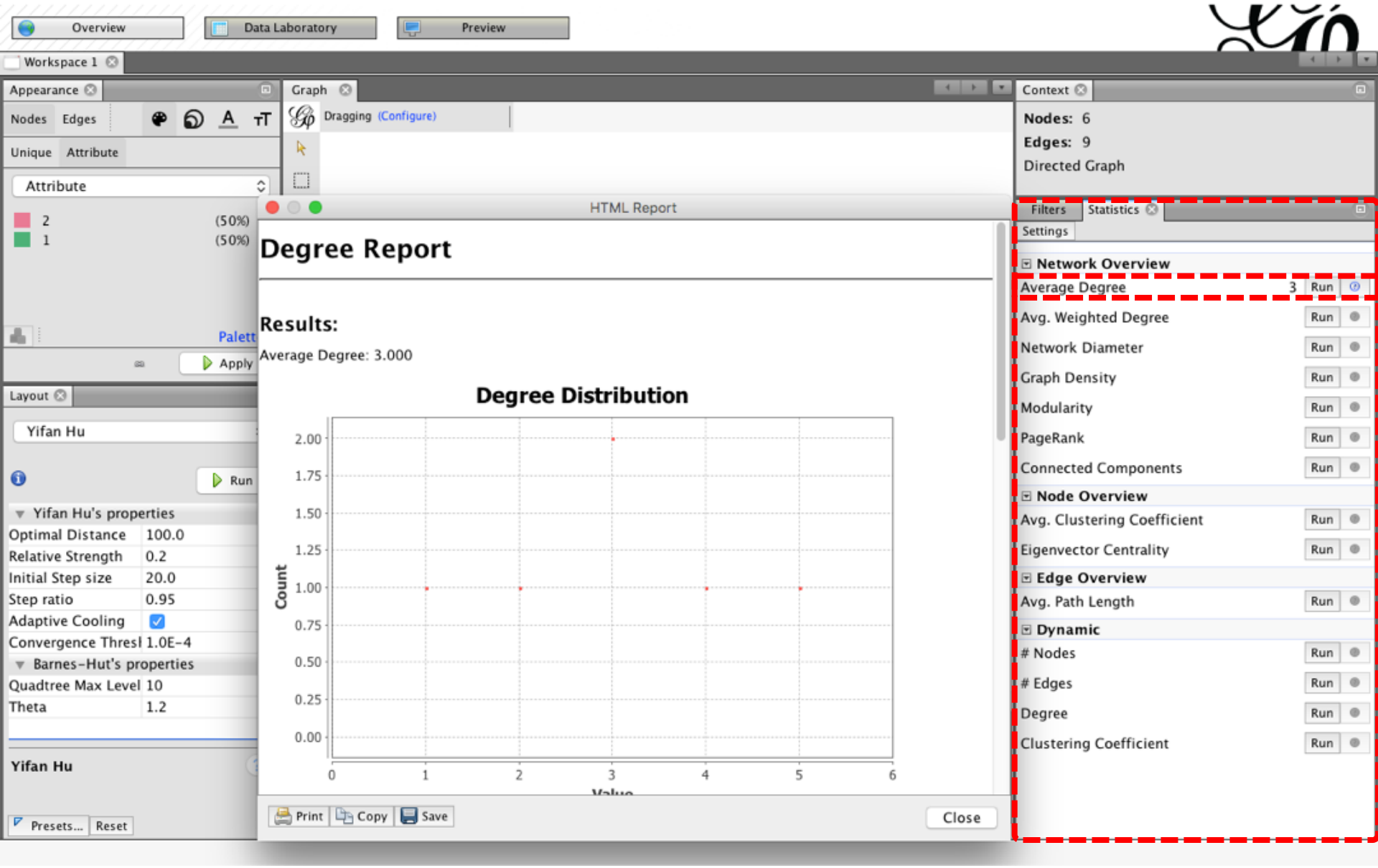
Labels Color



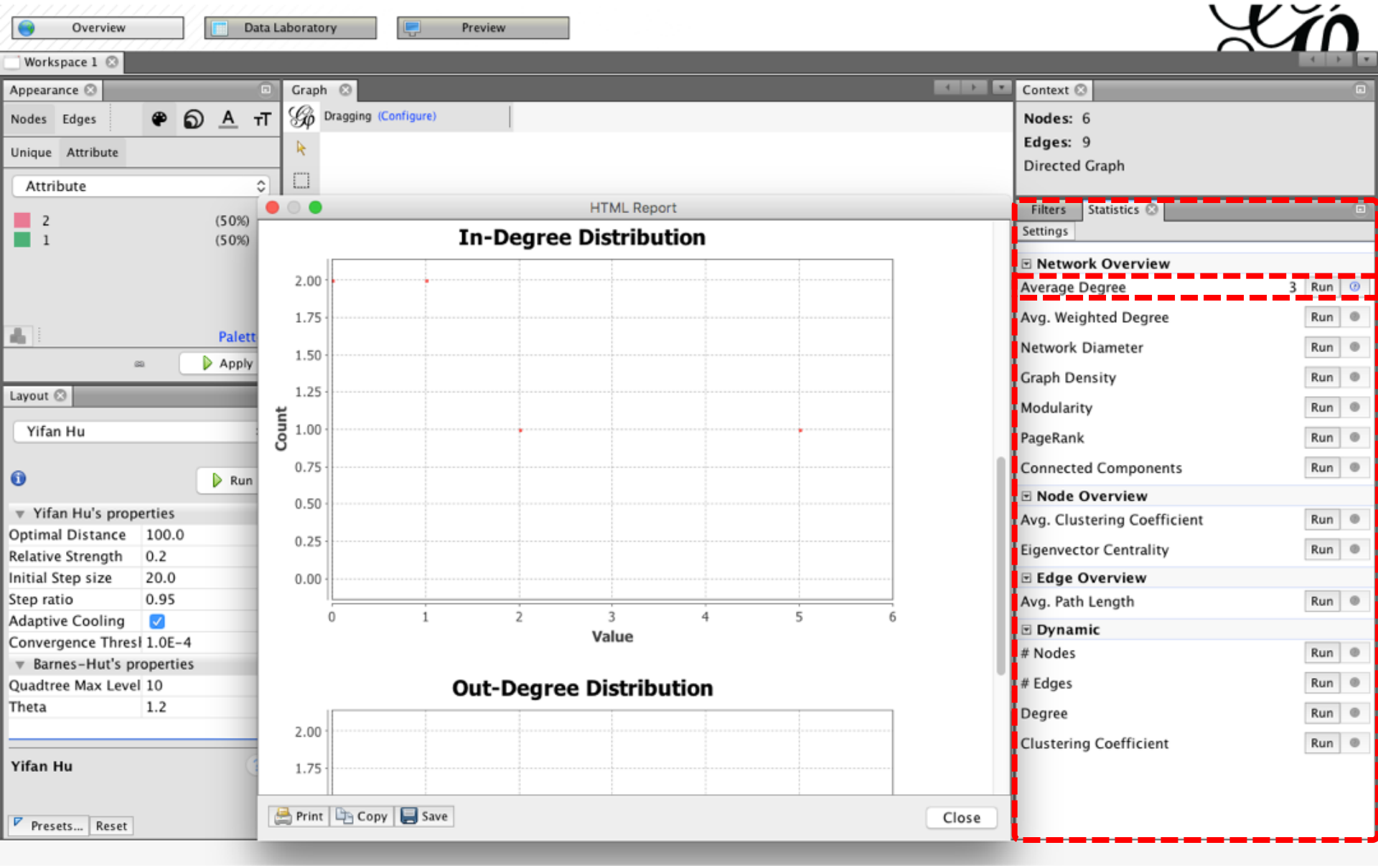
Labels Color



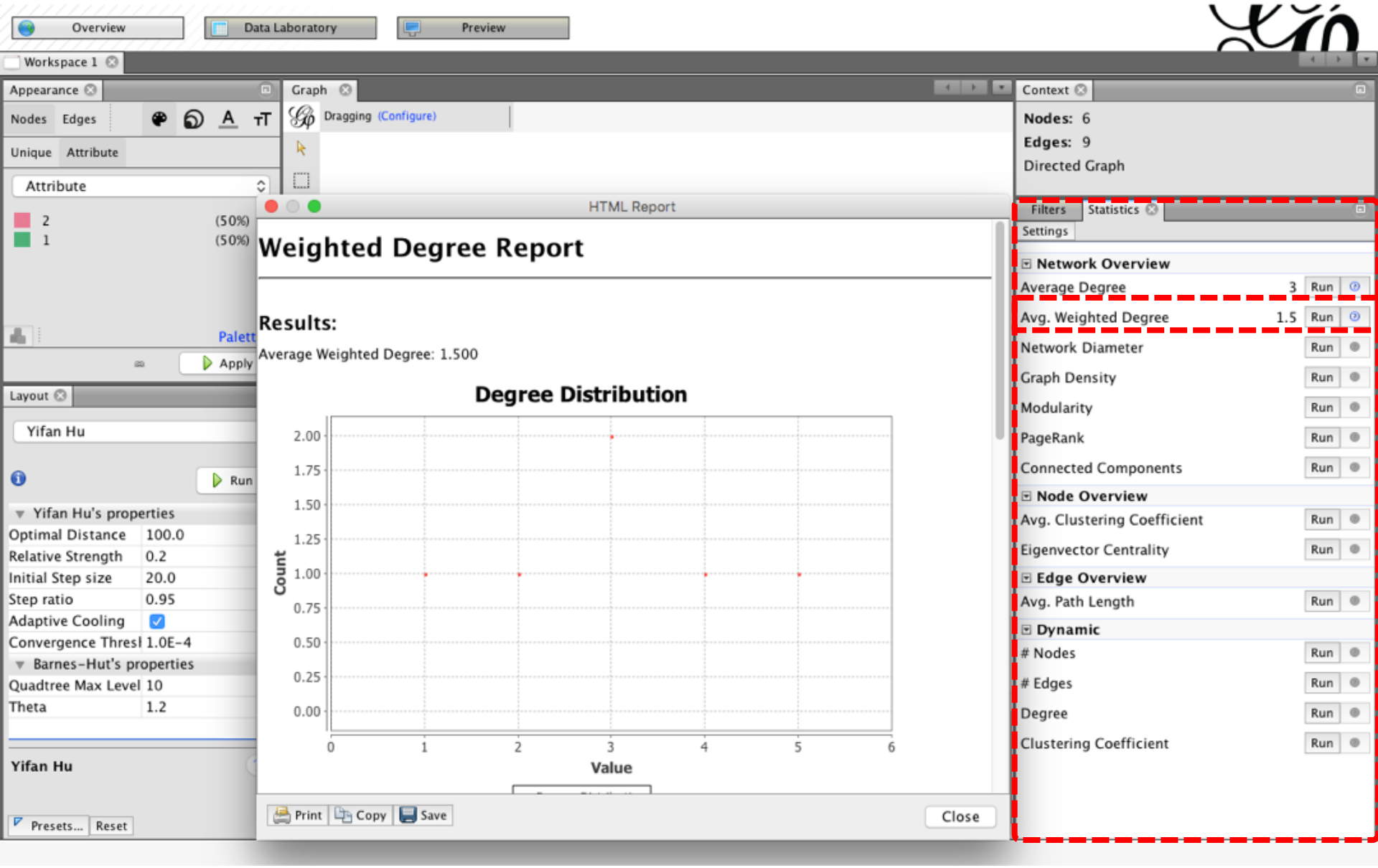
Gephi Statistics: Average Degree



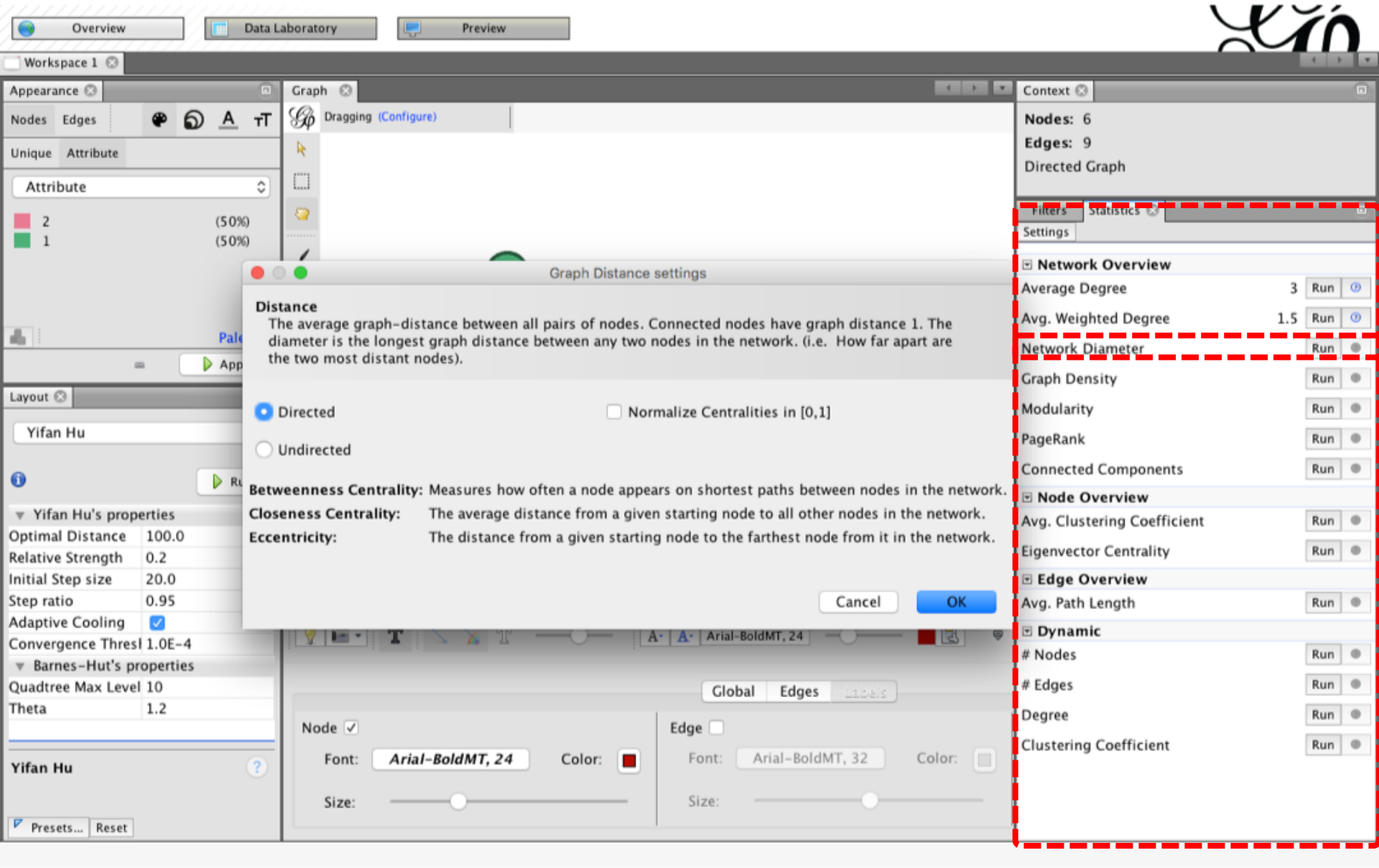
Gephi Statistics: Average Degree



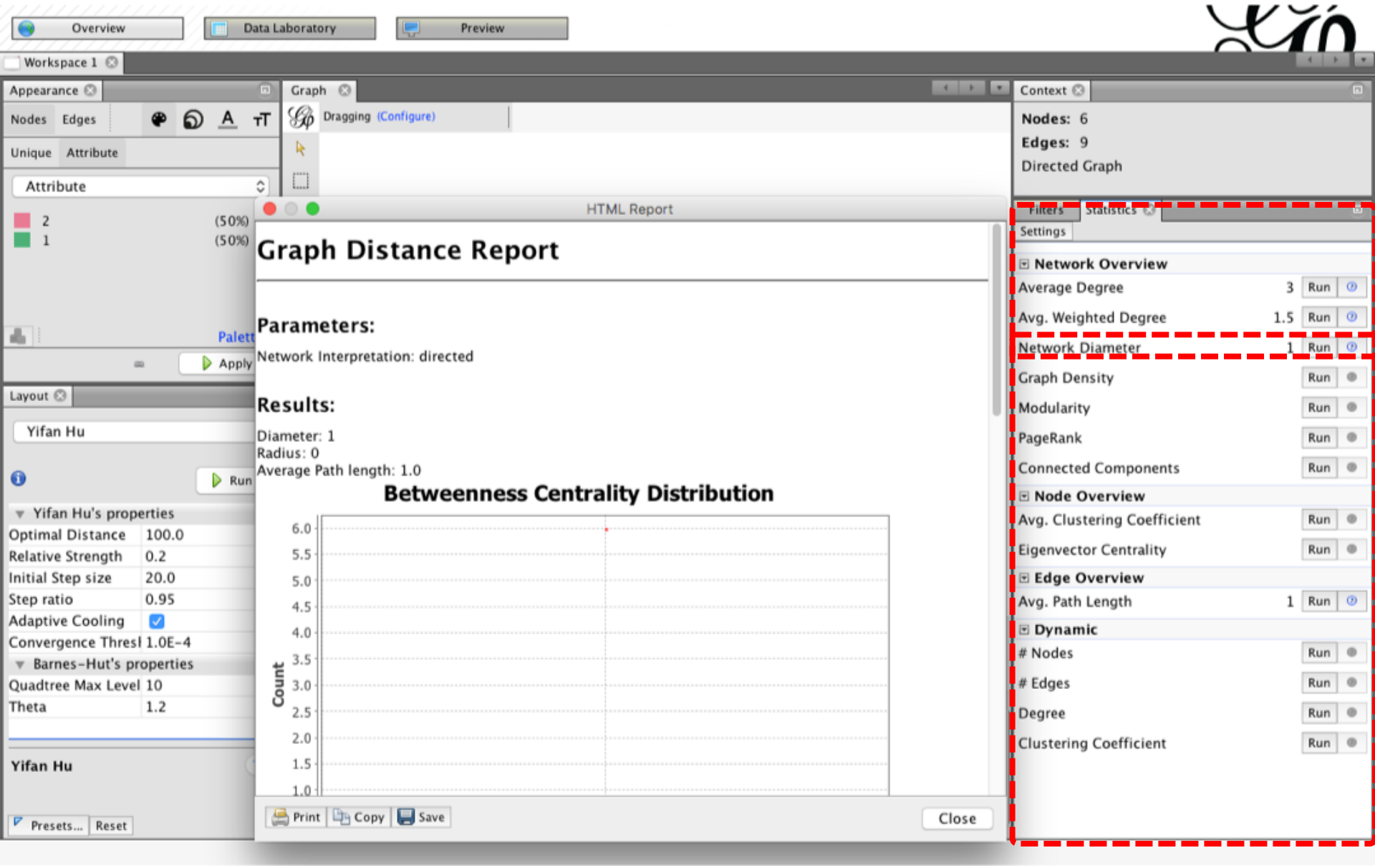
Gephi Statistics: Avg. Weighted Degree



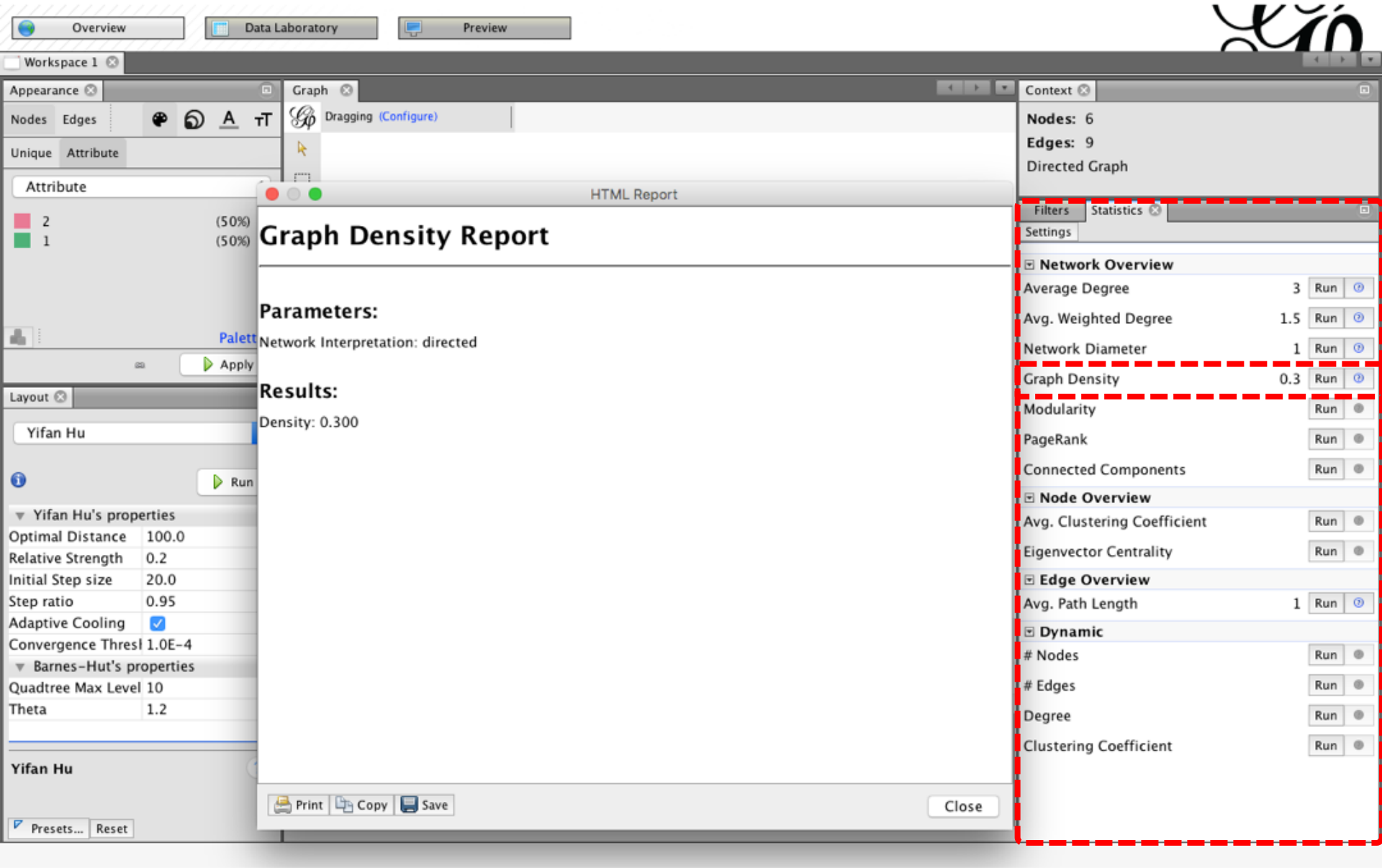
Gephi Statistics: Network Diameter



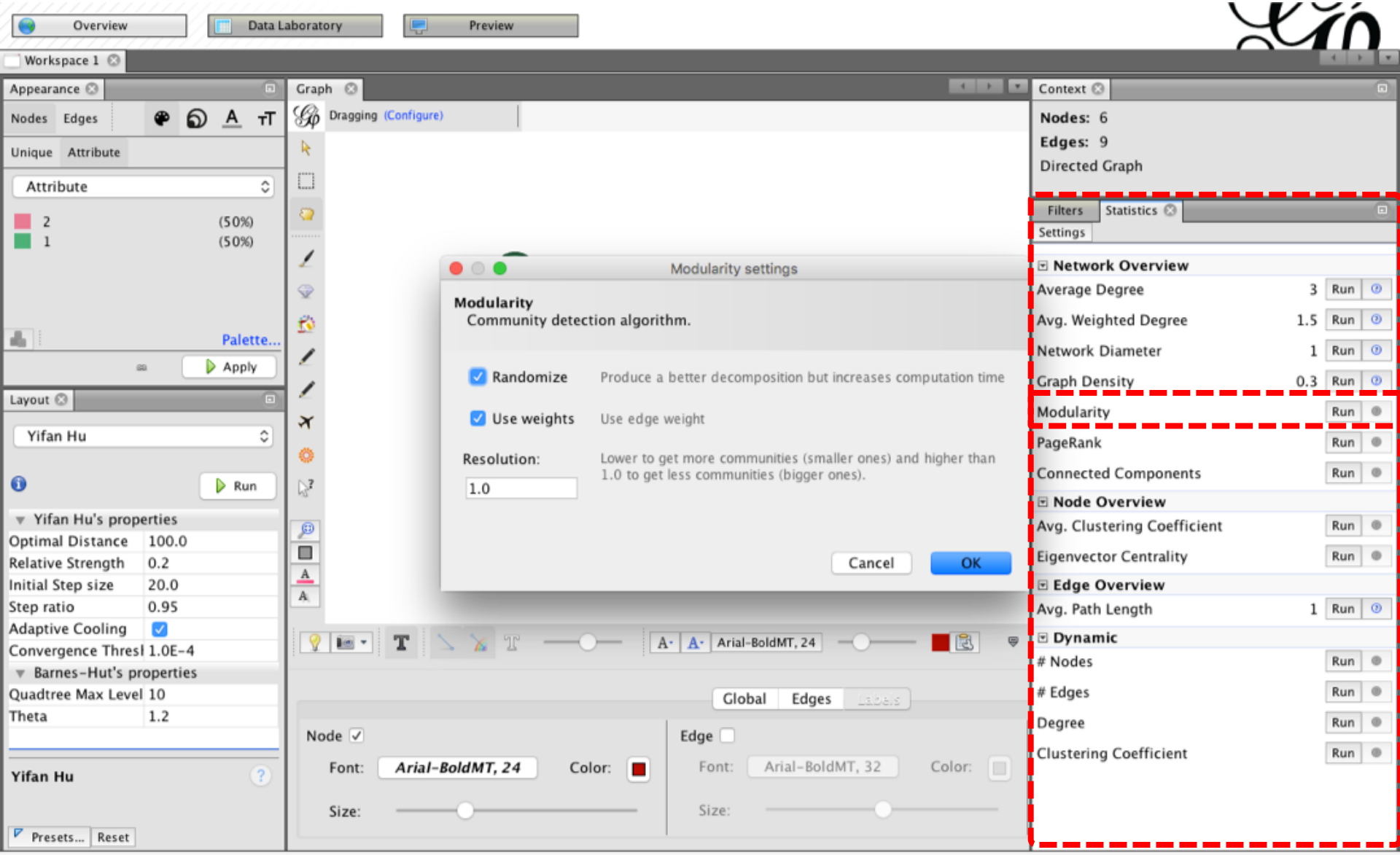
Gephi Statistics: Network Diameter



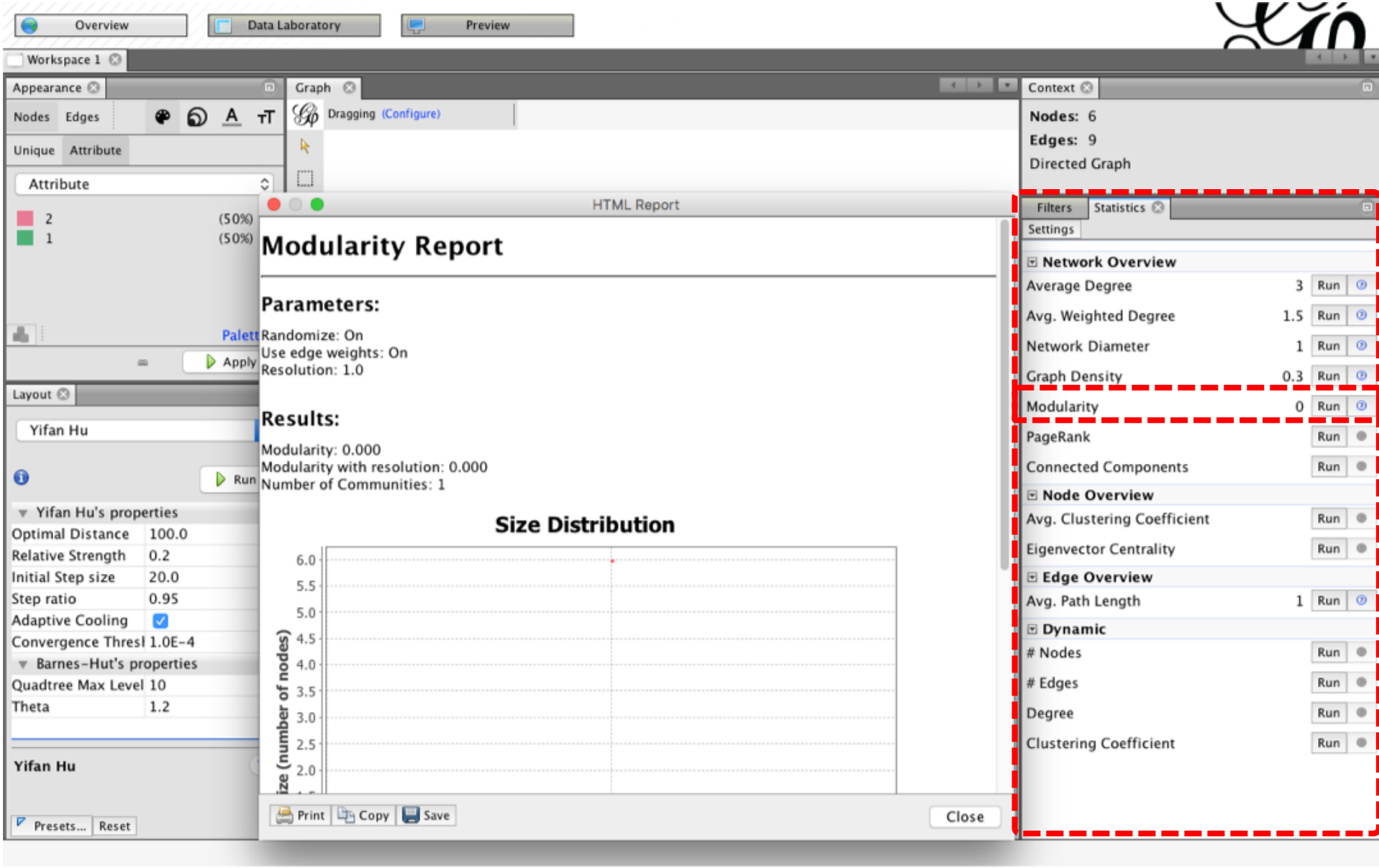
Gephi Statistics: Graph Density



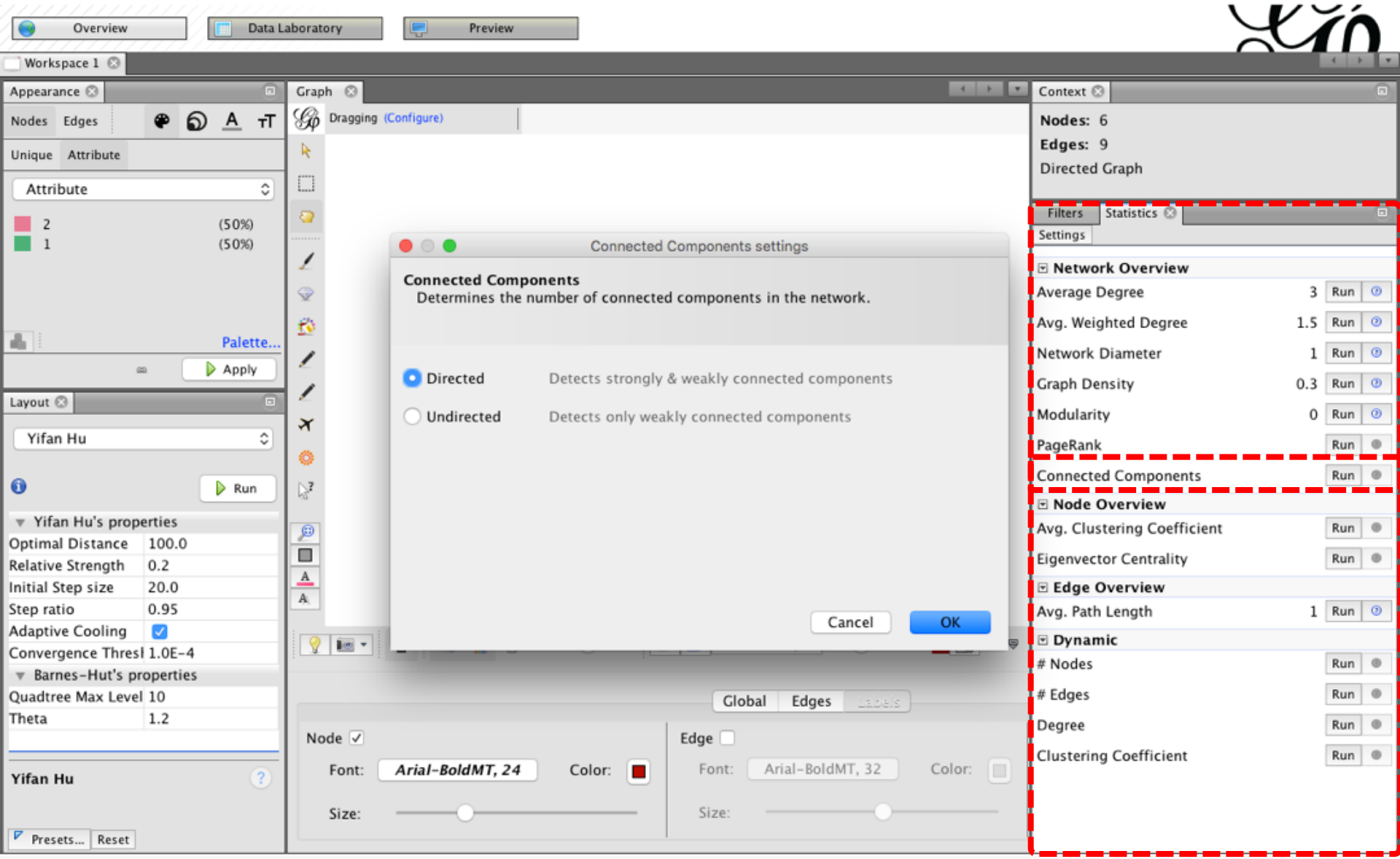
Gephi Statistics: Modularity



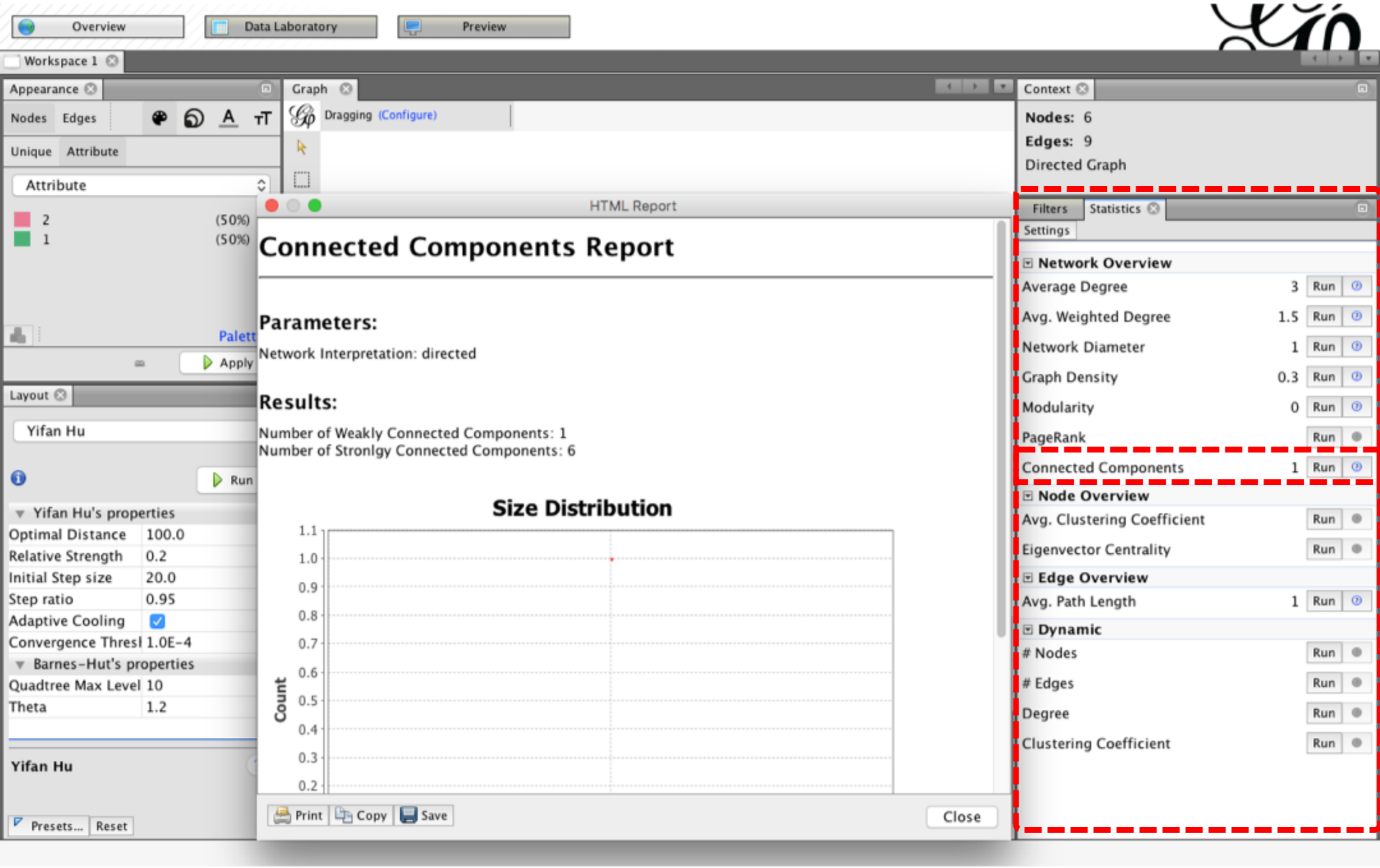
Gephi Statistics: Modularity



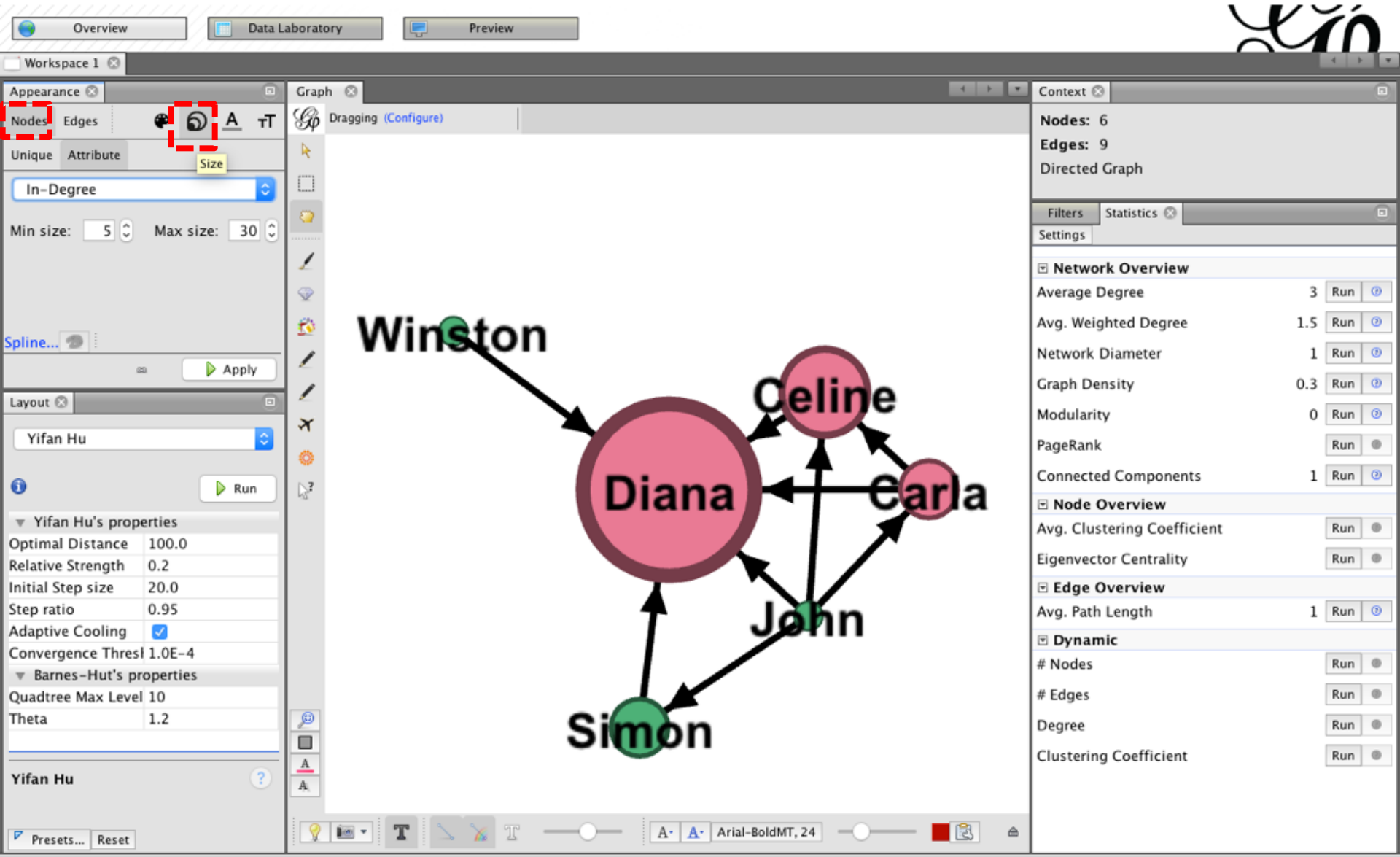
Gephi Statistics: Connected Components



Gephi Statistics: Connected Components

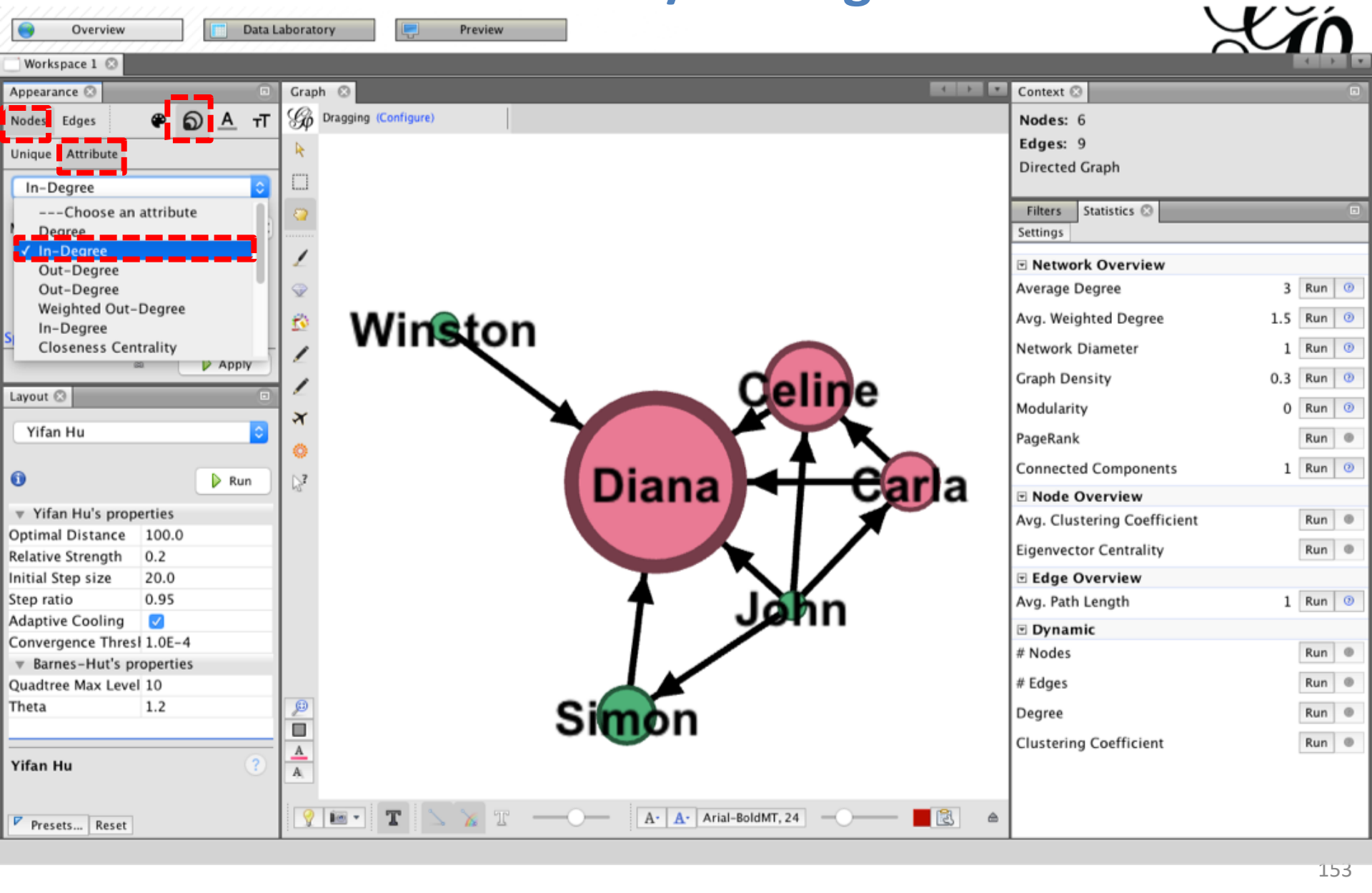


Appearance Nodes Size



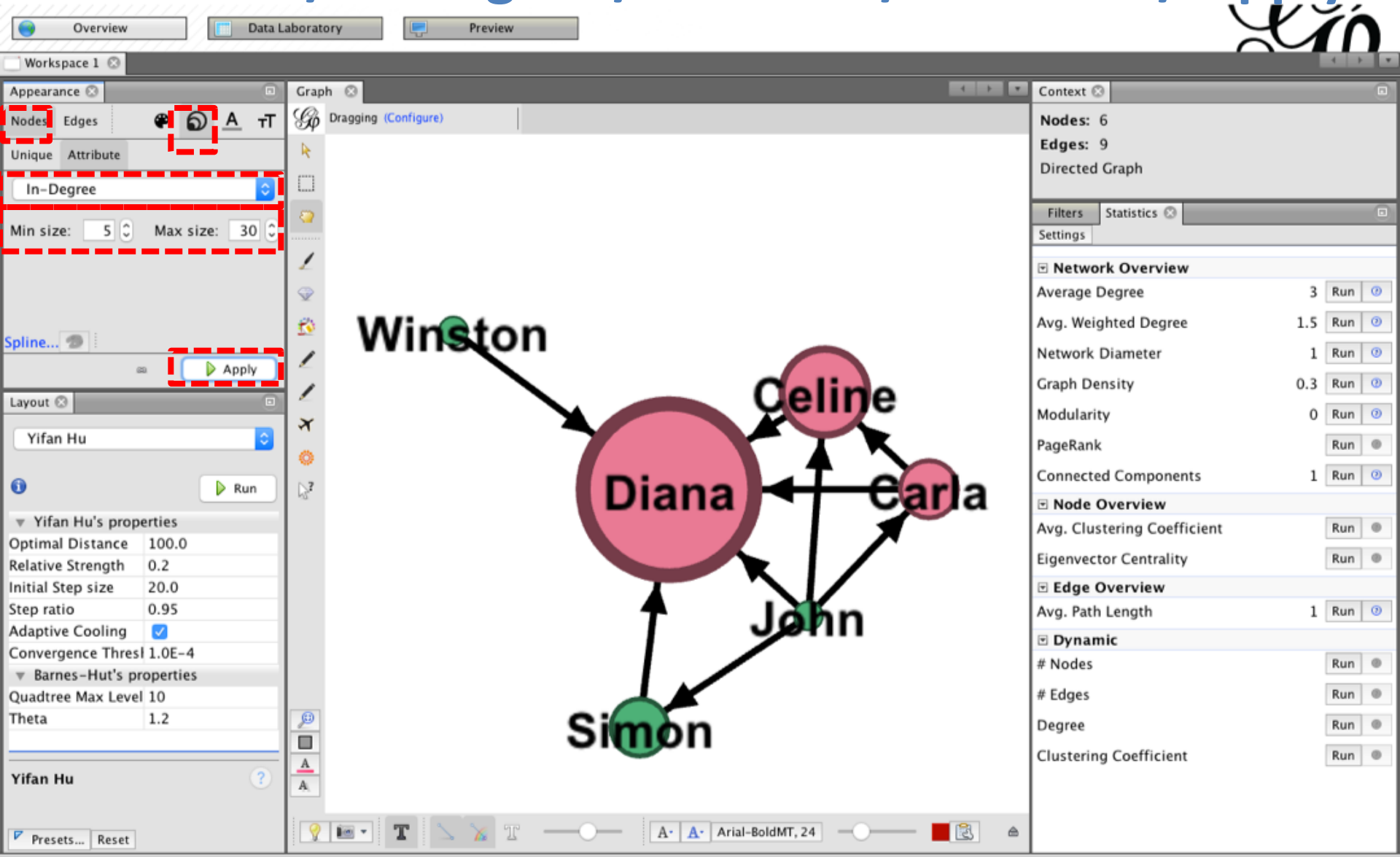
Appearance Nodes Size

Attribute / In-Degree



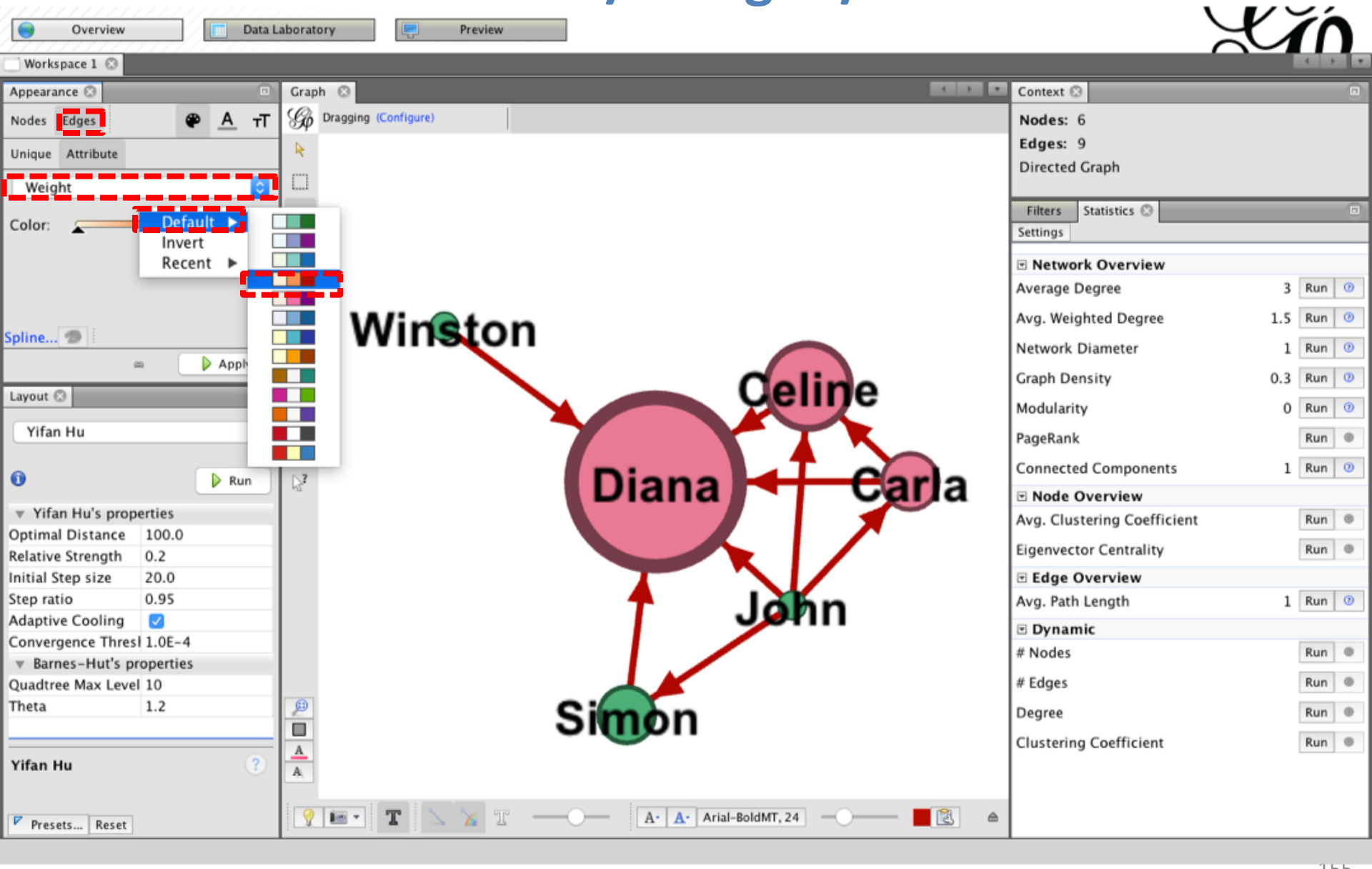
Appearance Nodes Size

Attribute / In-Degree / Min size / Max size / Apply



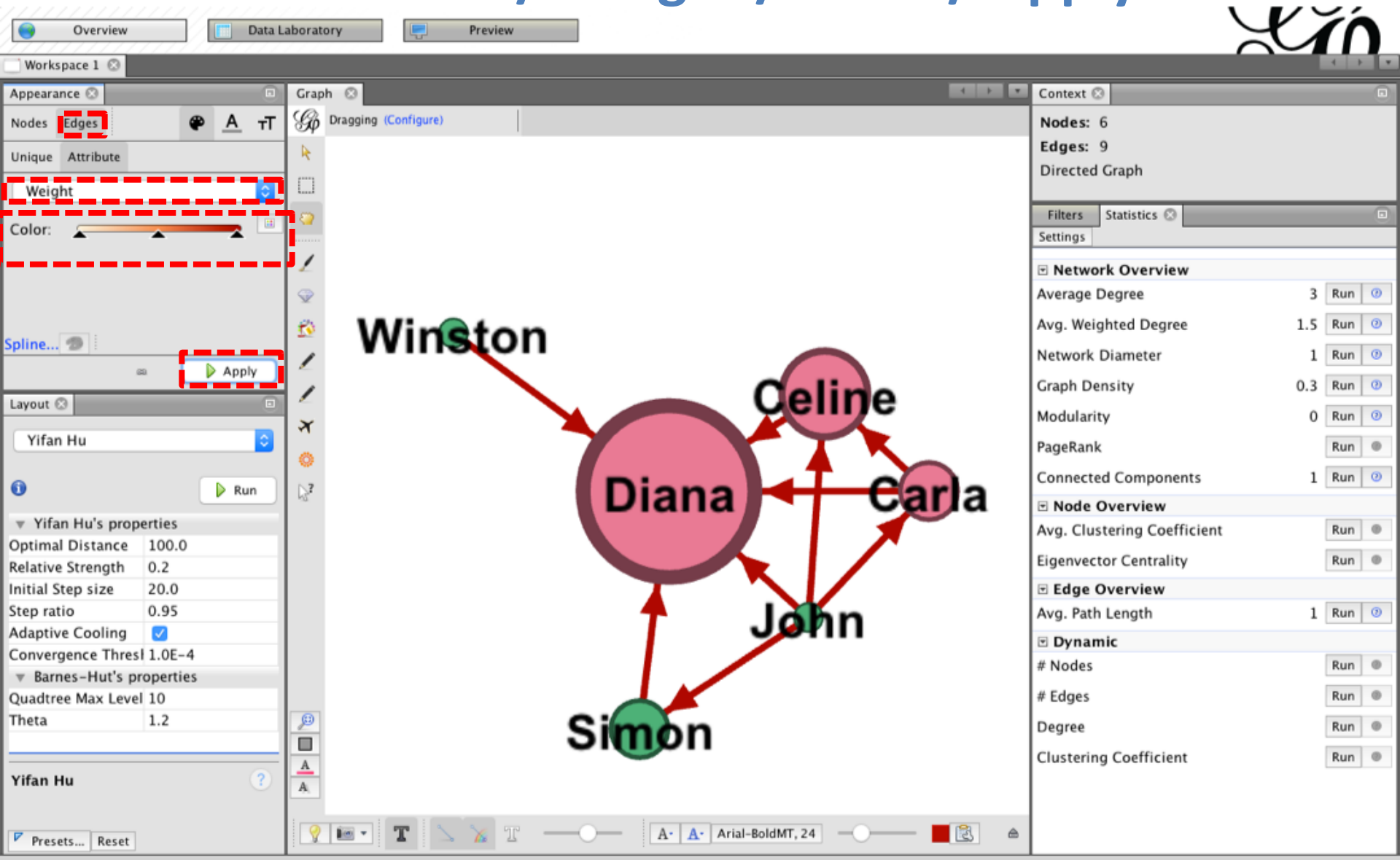
Appearance Edges

Attribute / Weight / Color

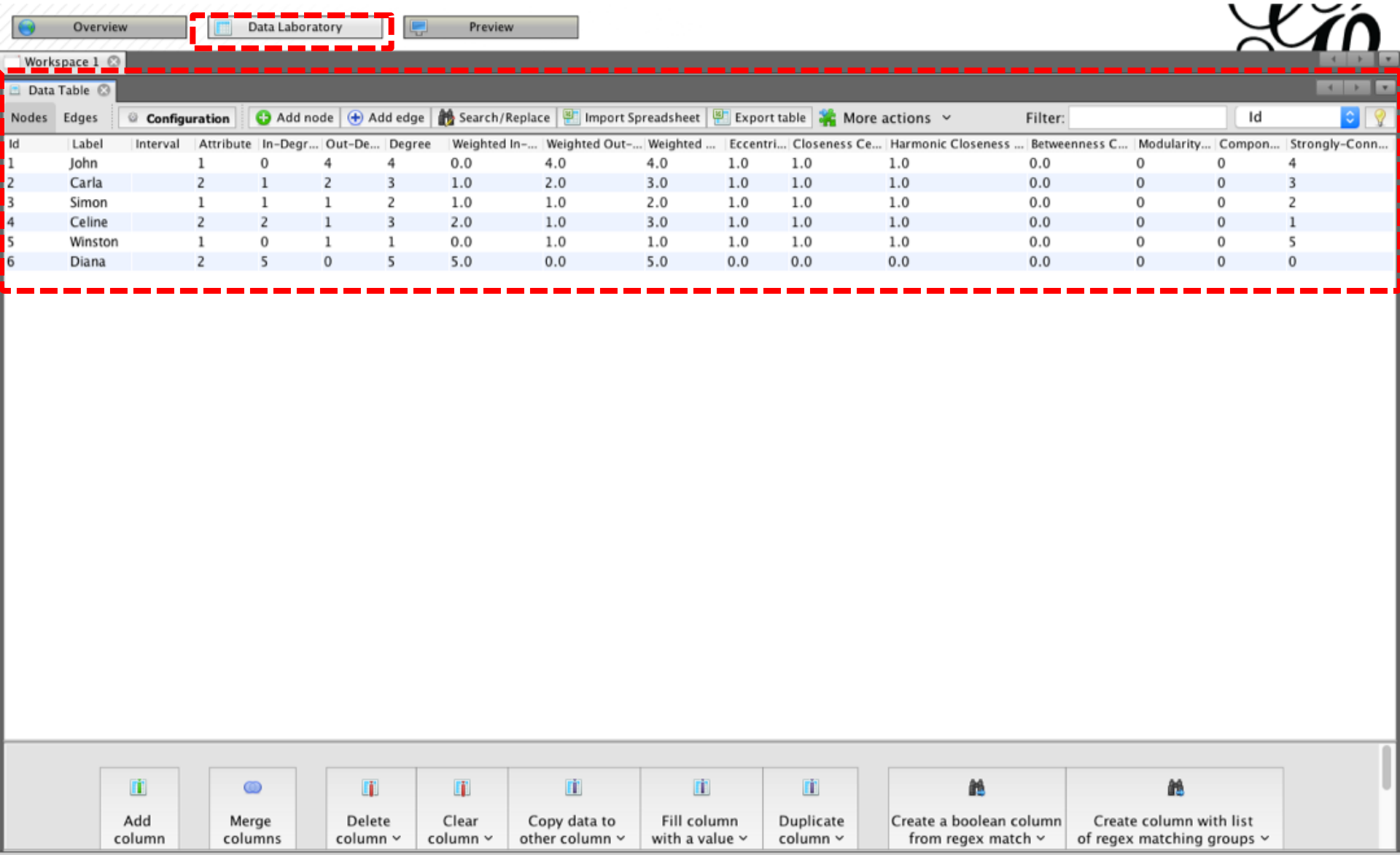


Appearance Edges

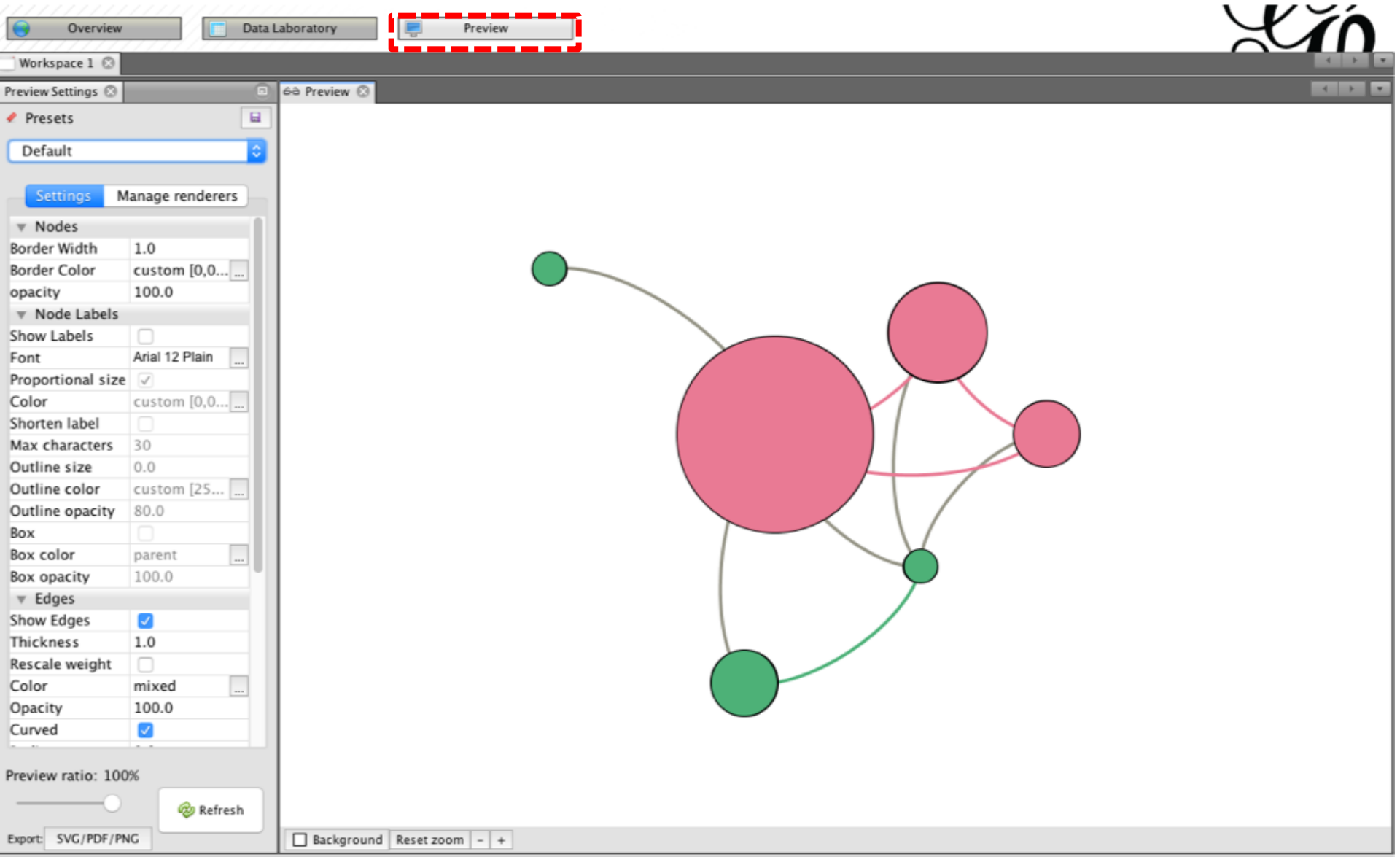
Attribute / Weight / Color / Apply



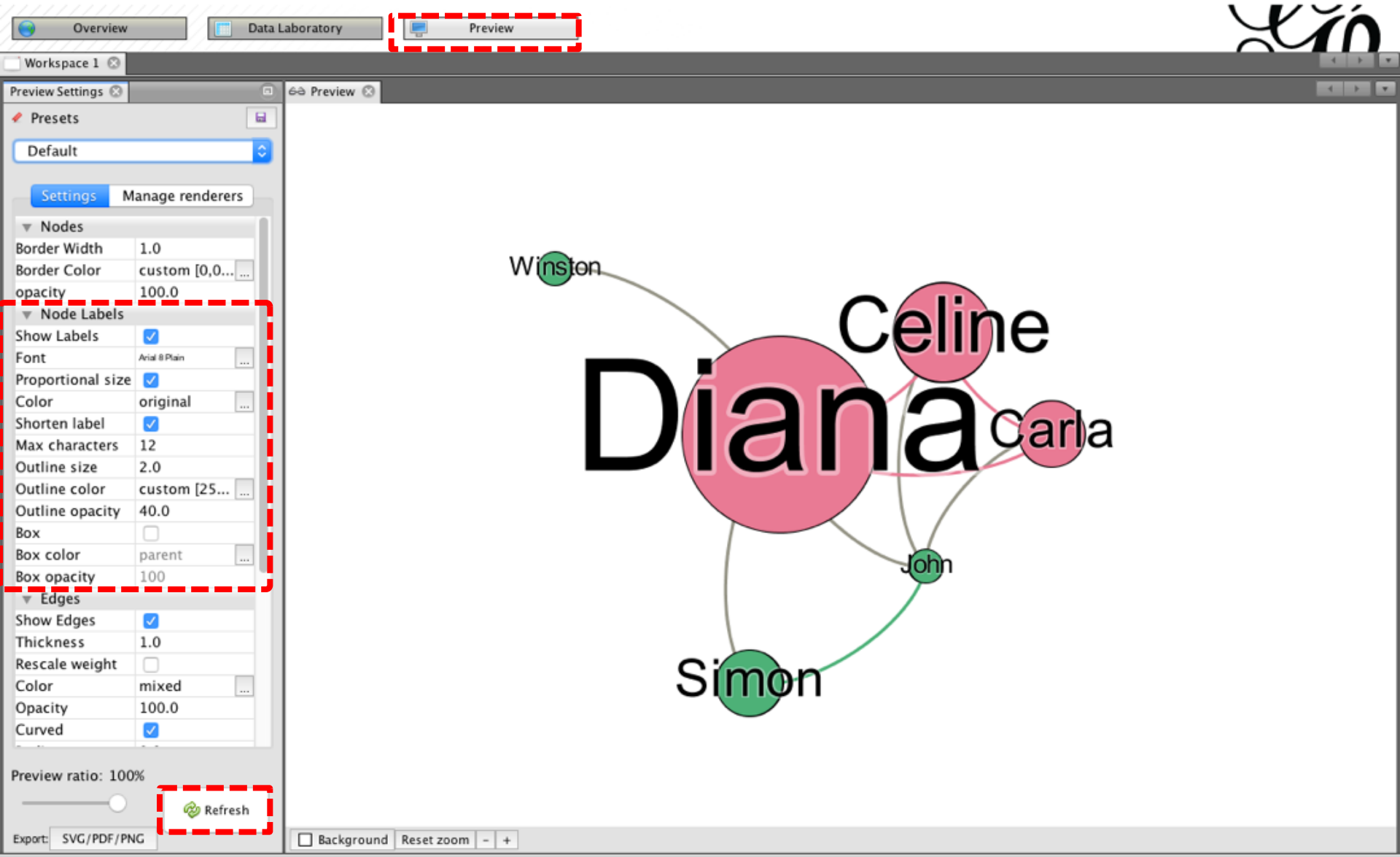
Gephi Data Laboratory



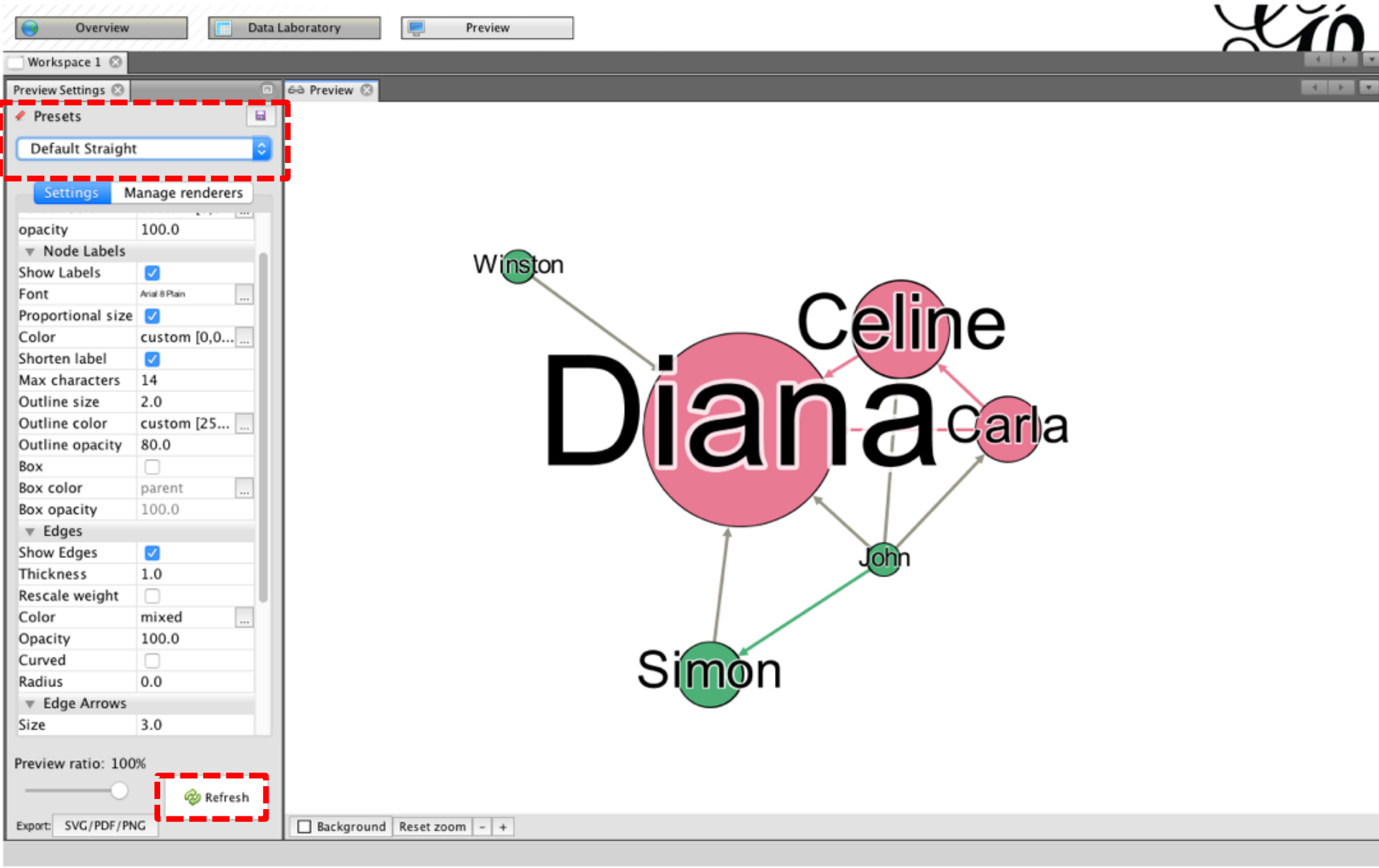
Gephi Preview



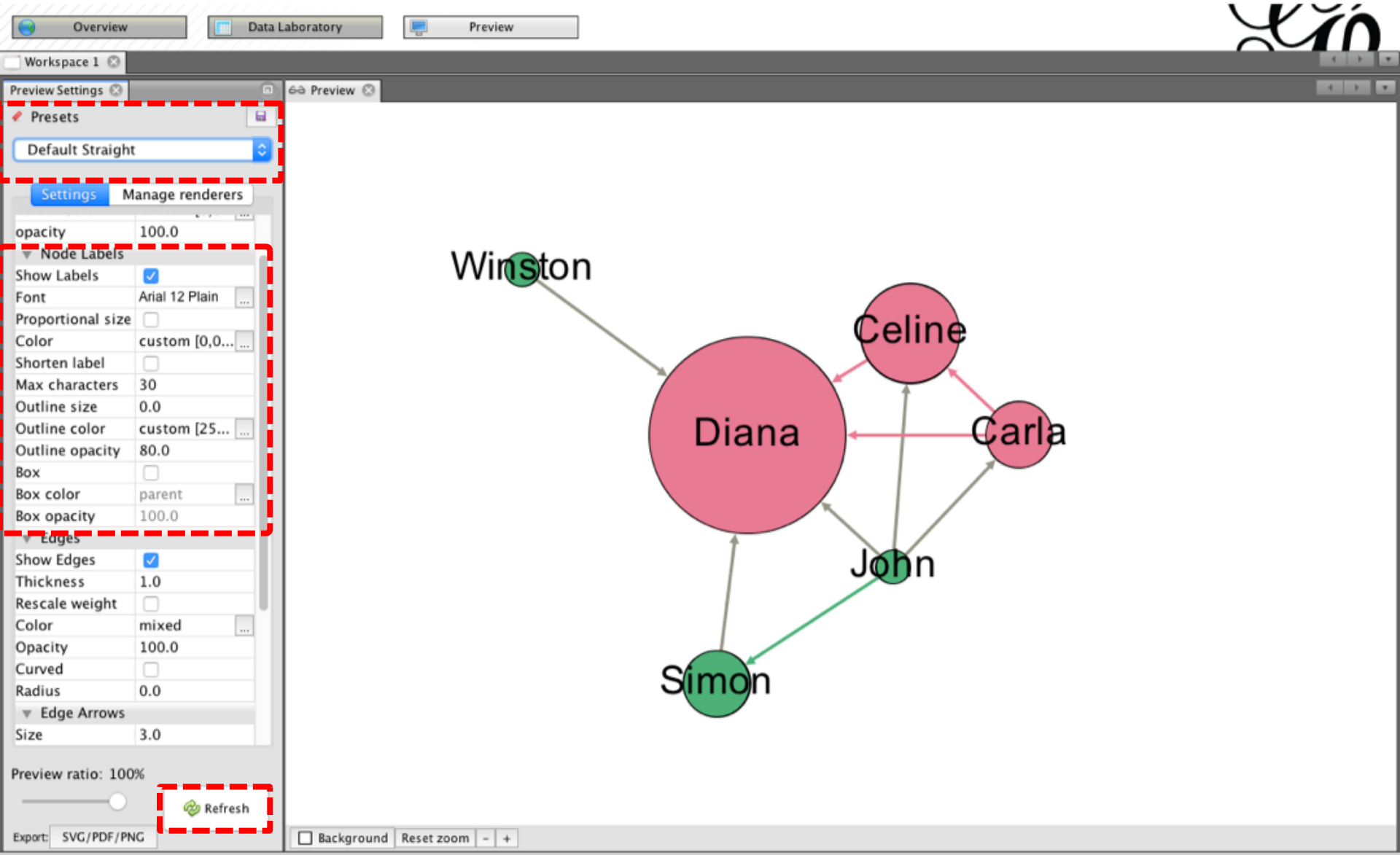
Gephi Preview: Show Labels



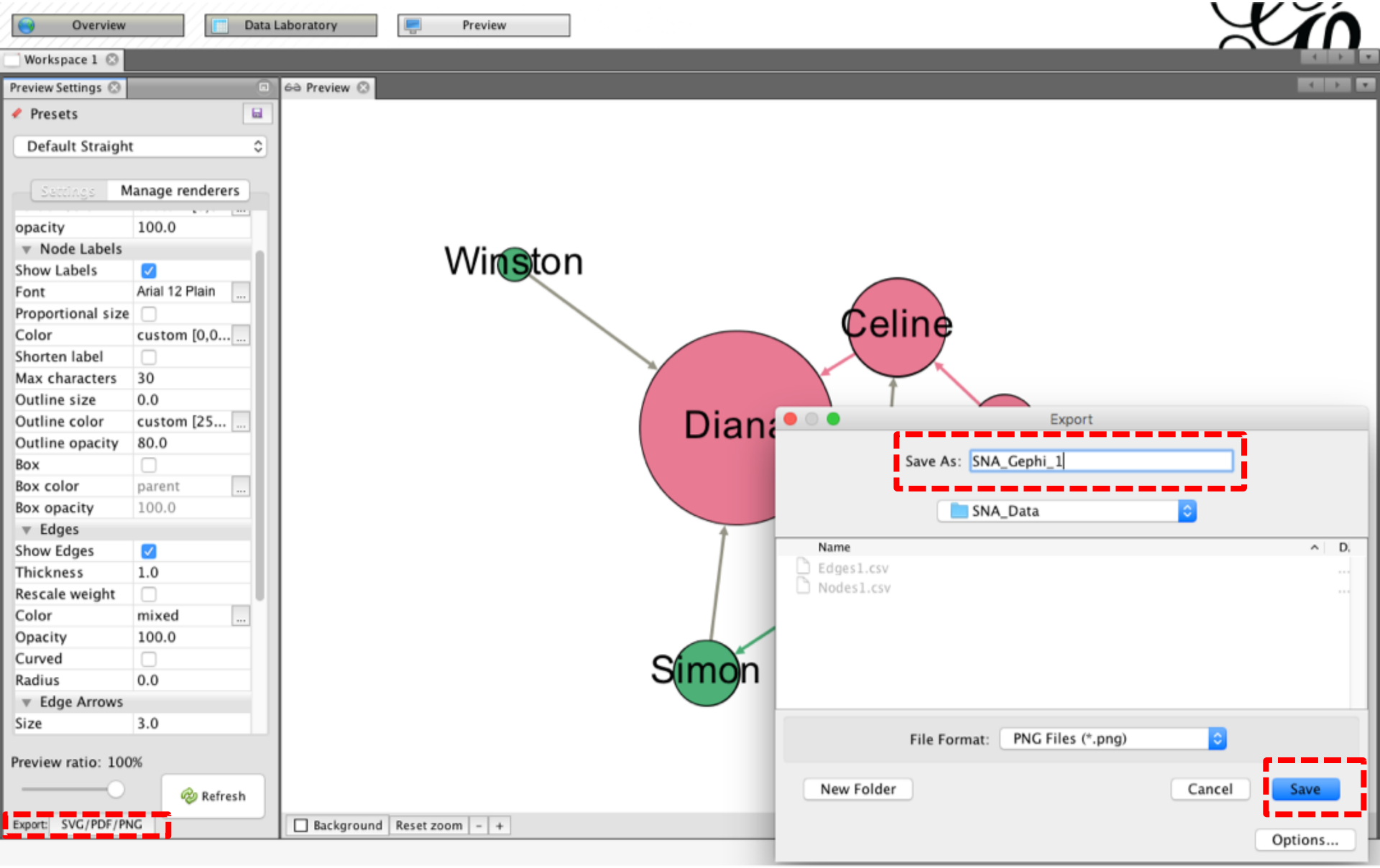
Gephi Preview: Default Straight



Gephi Preview: Default Straight

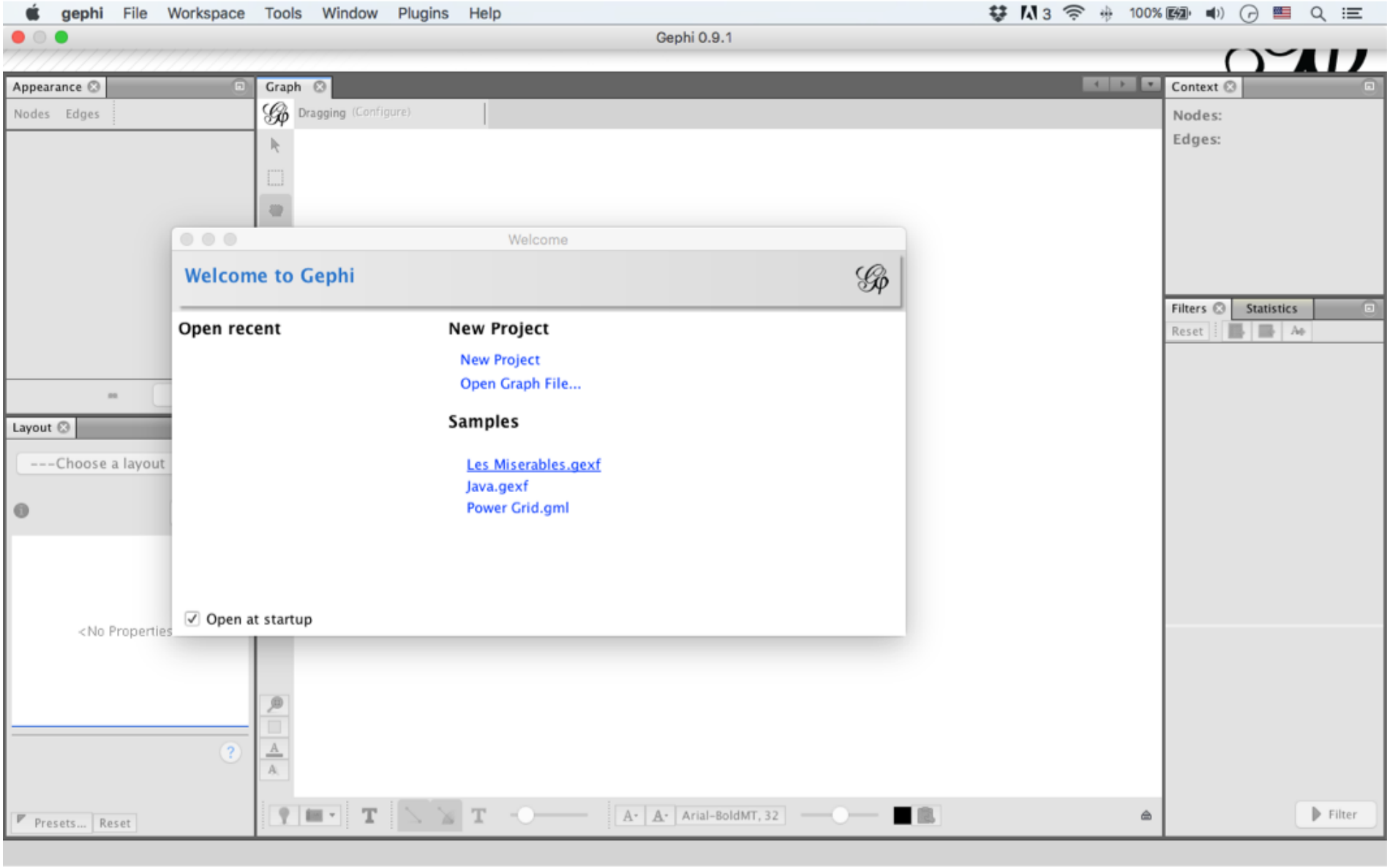


Gephi Preview: Export SVG/PDF/PNG

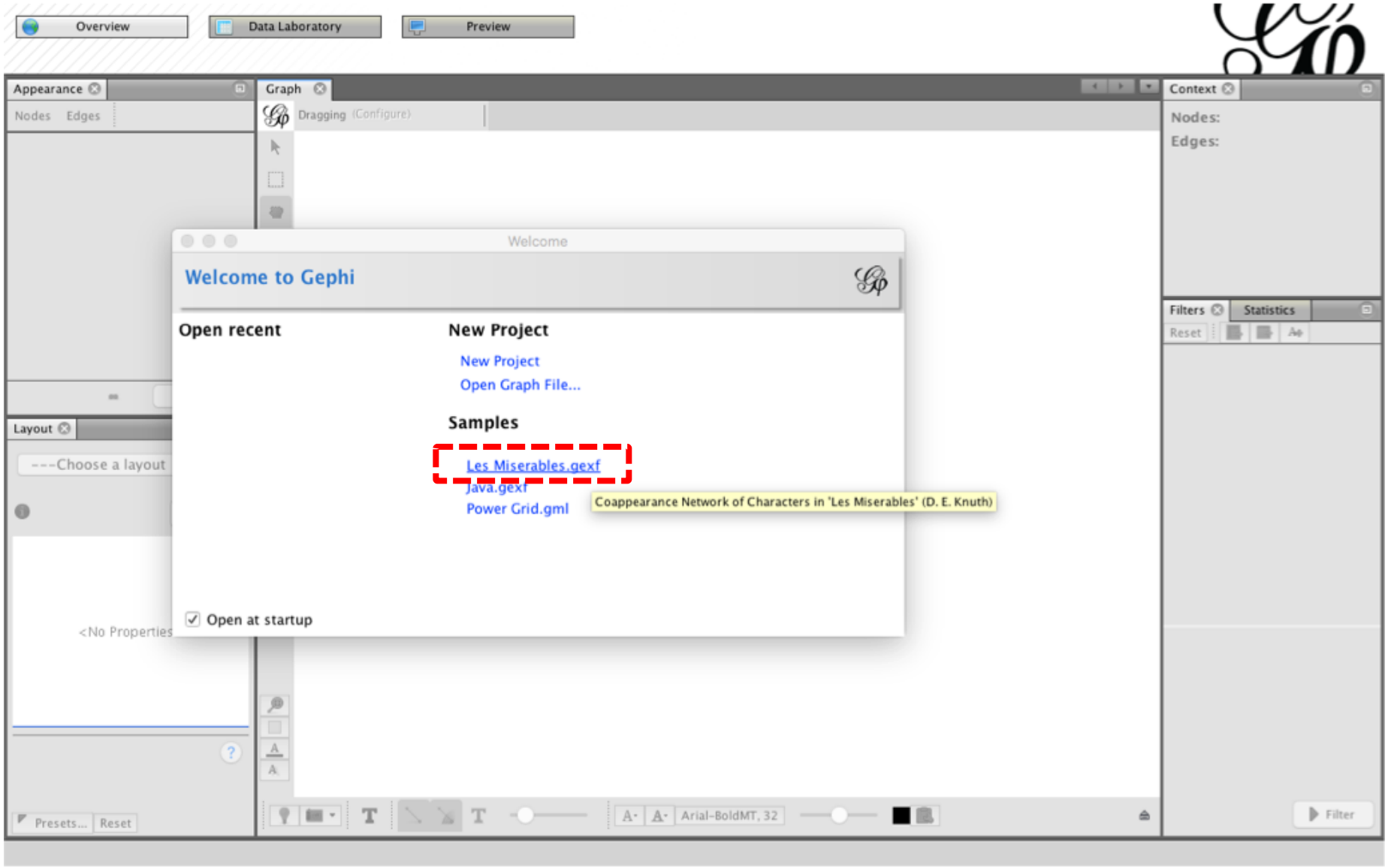


Open Gephi Samples

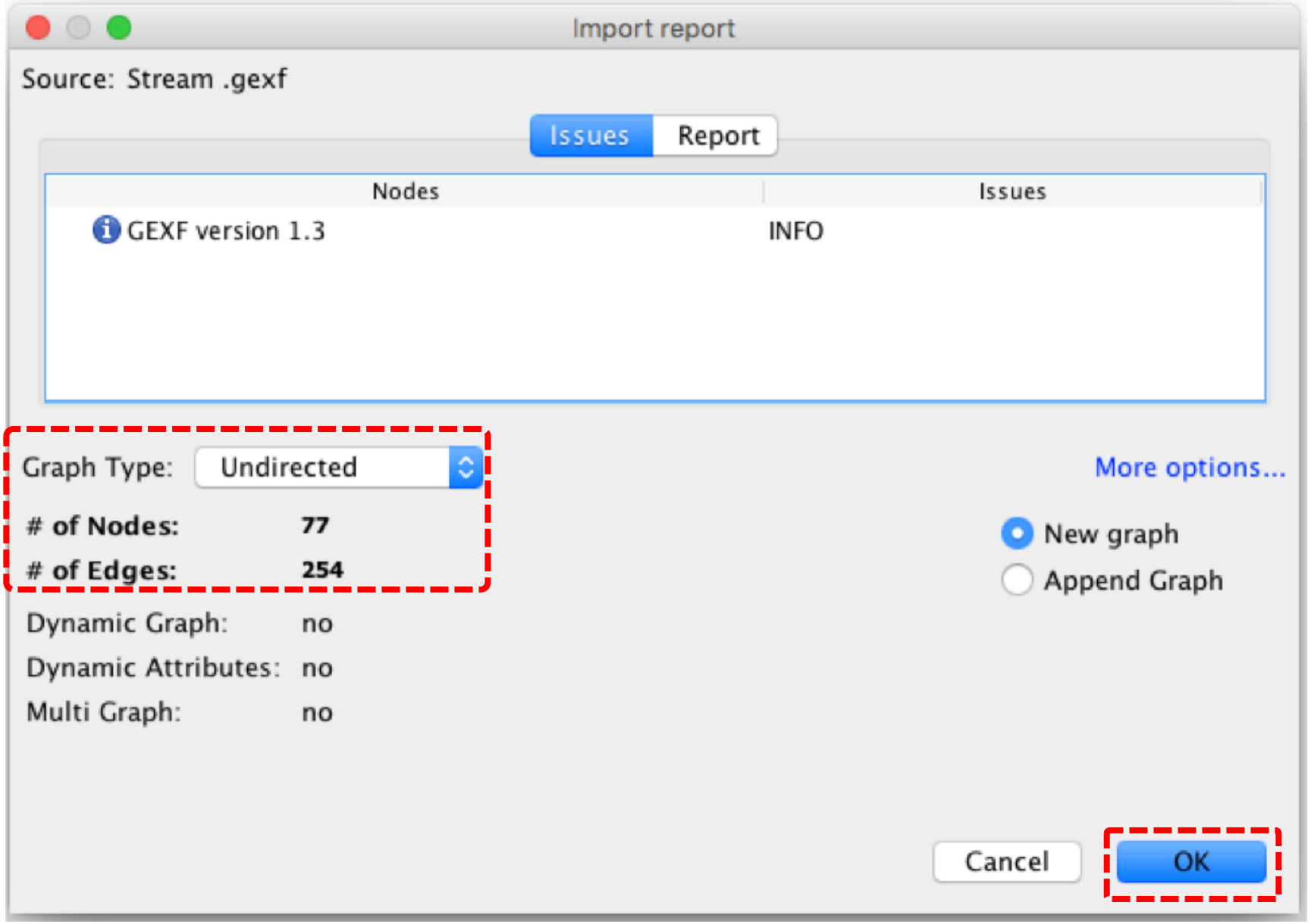
Gephi Samples



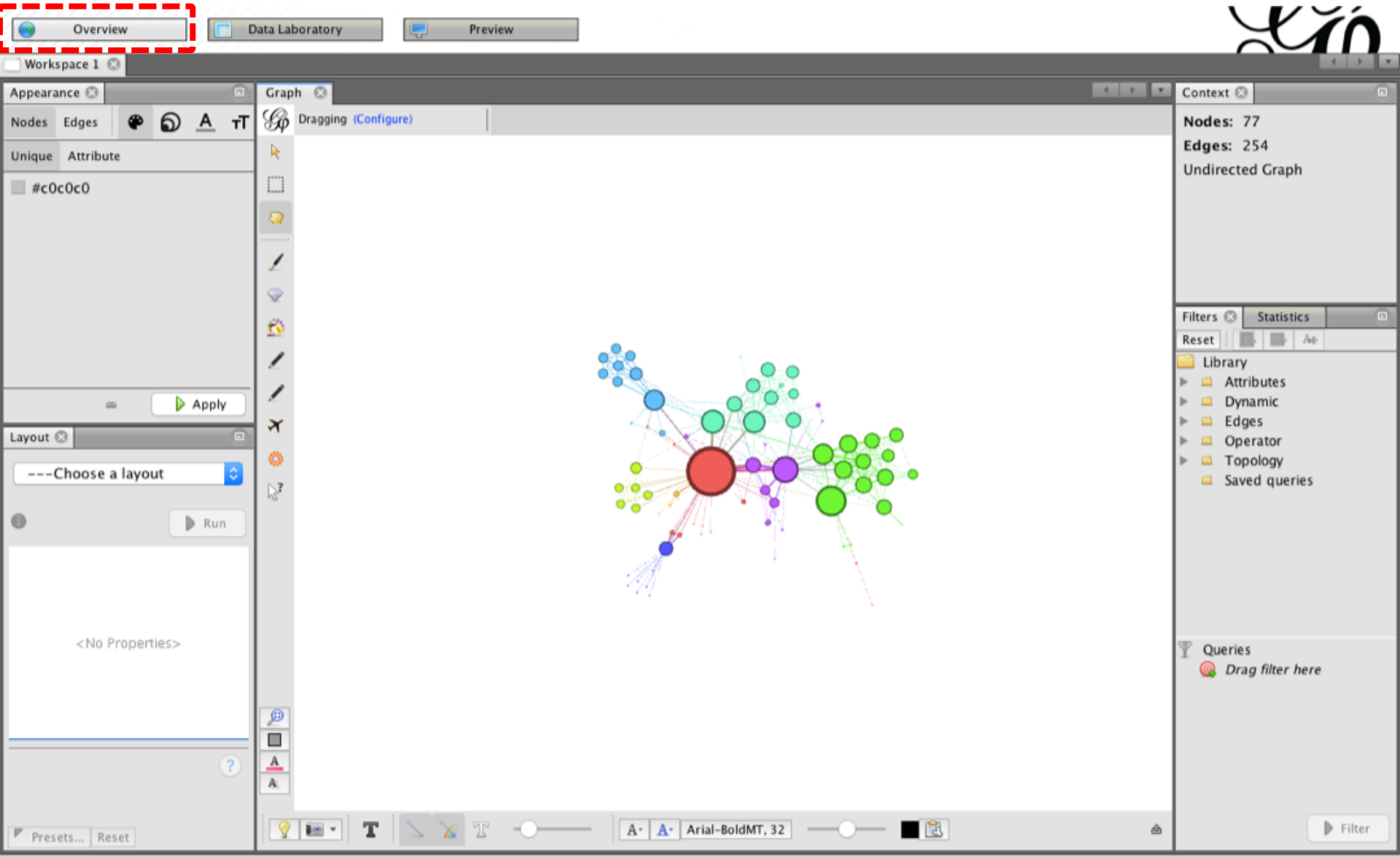
Gephi Samples
Les Miserables.gexf



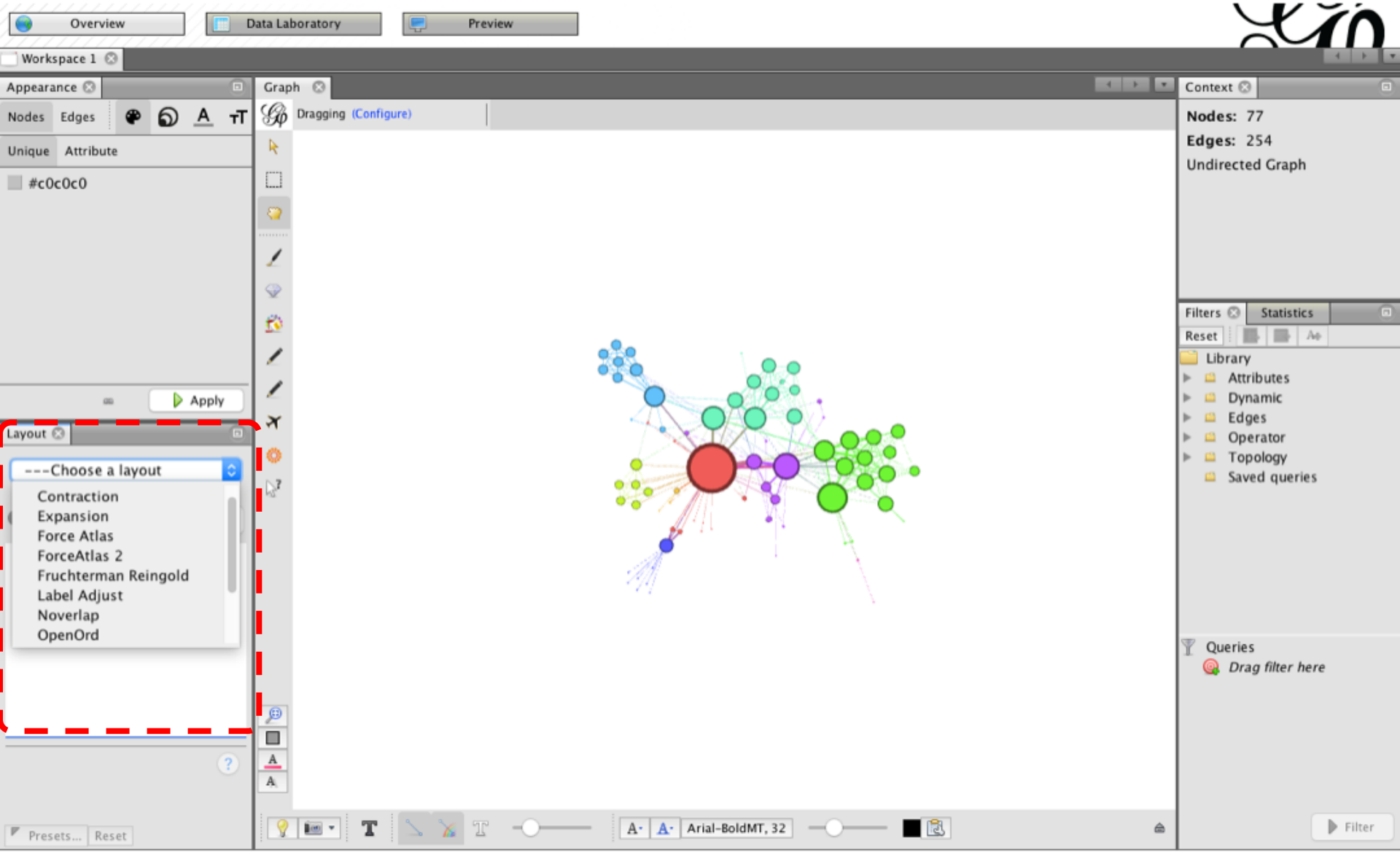
Gephi Import Report



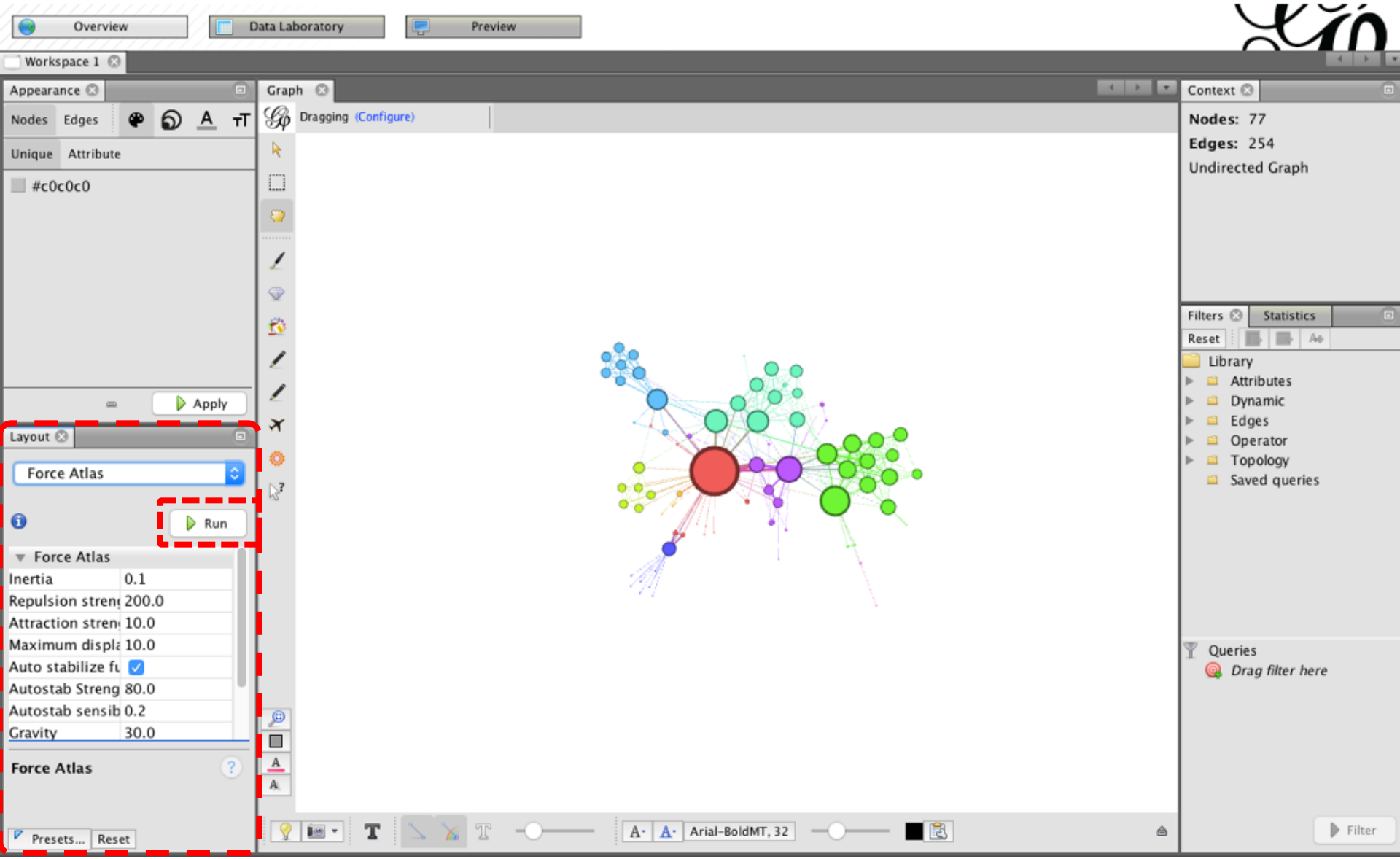
Gephi Overview



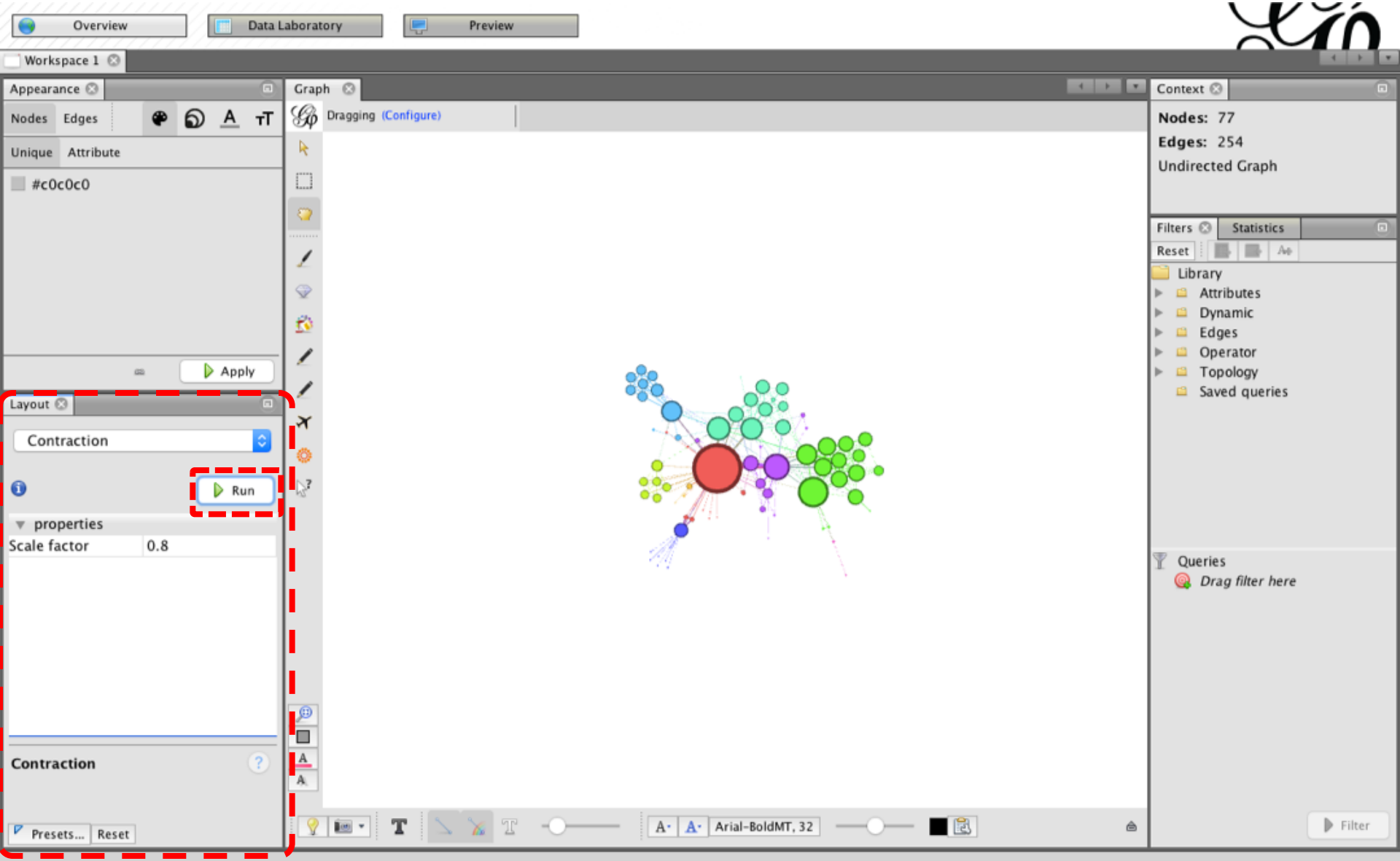
Gephi Layout



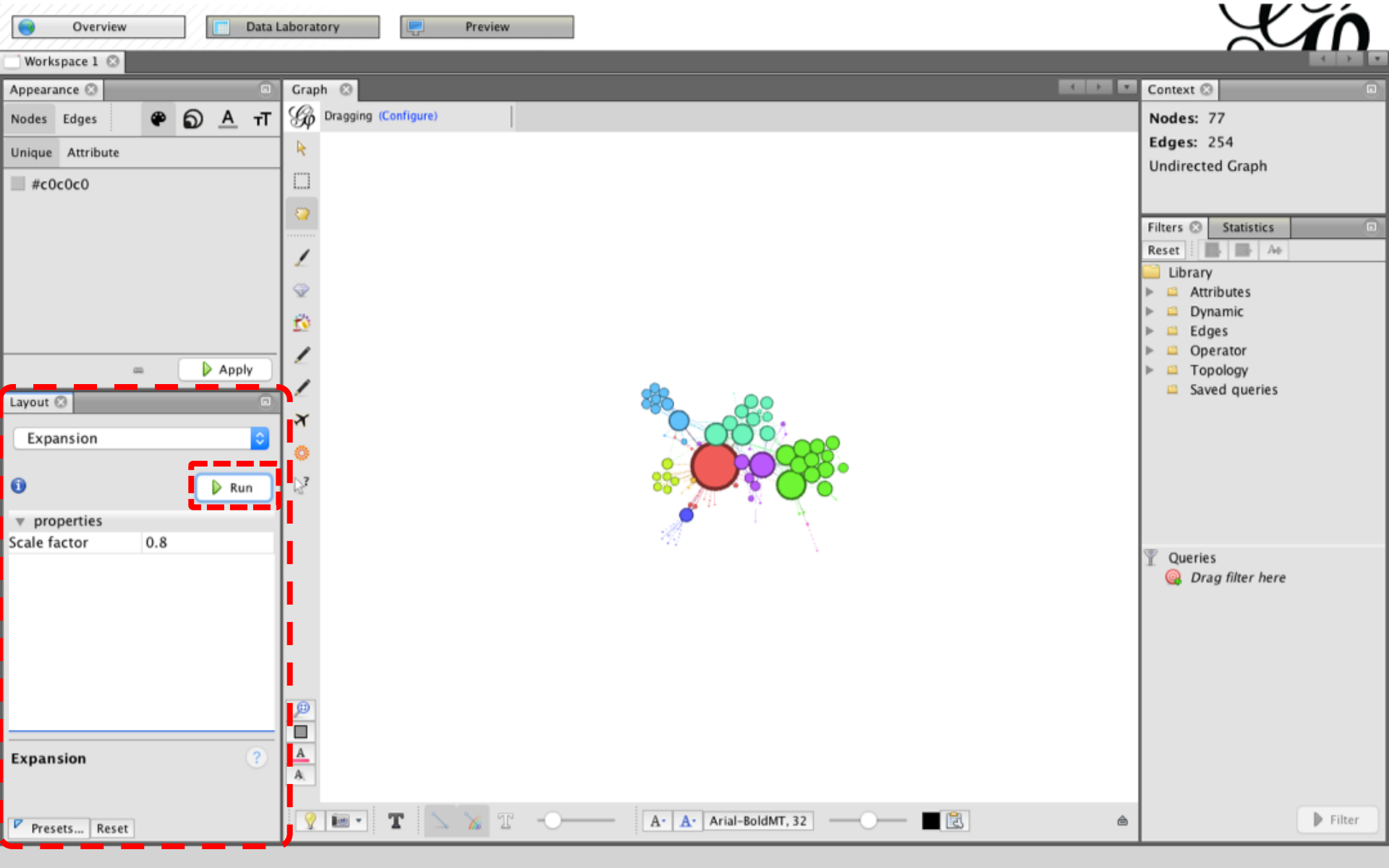
Gephi Layout: Force Atlas



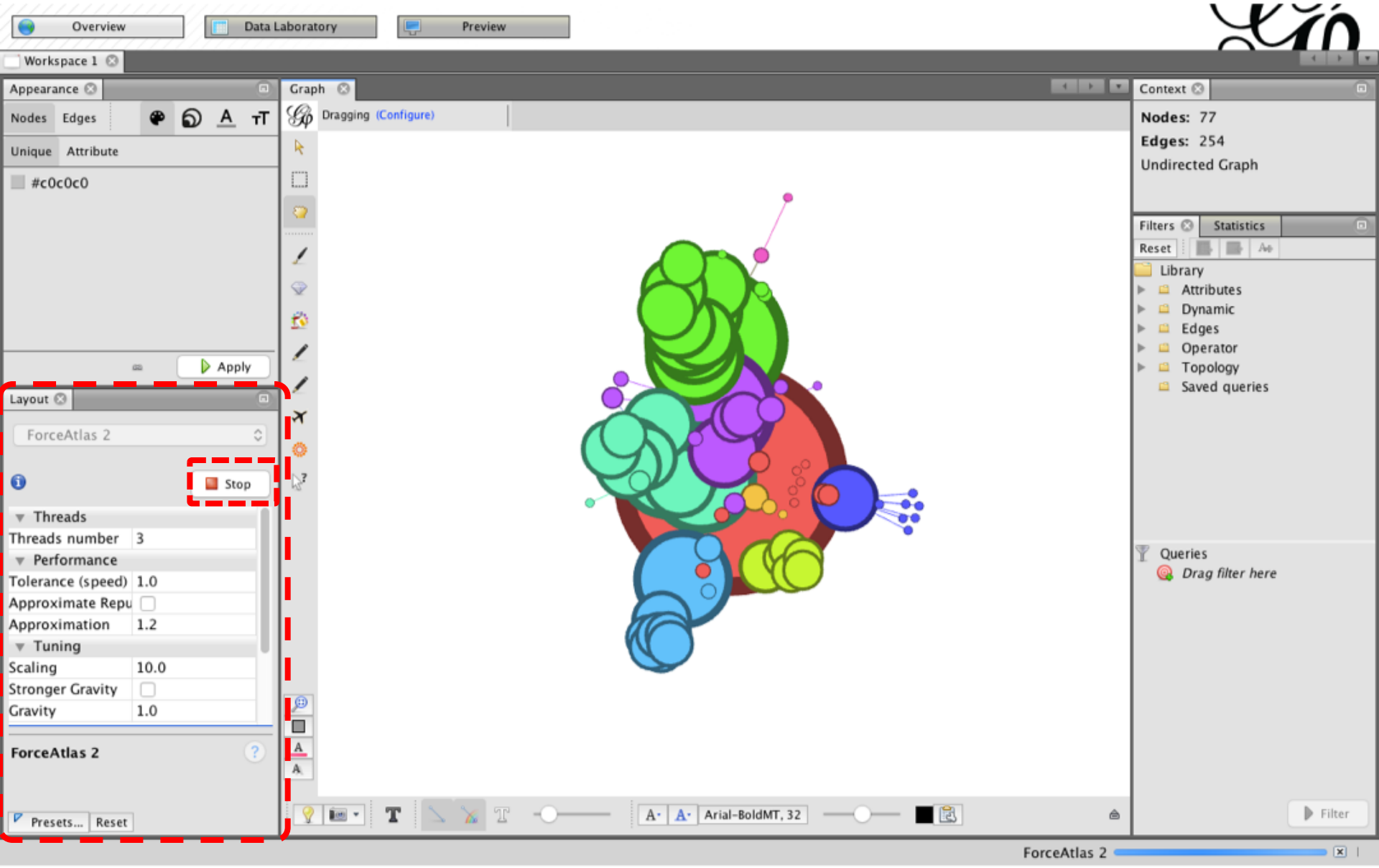
Gephi Layout: Contraction



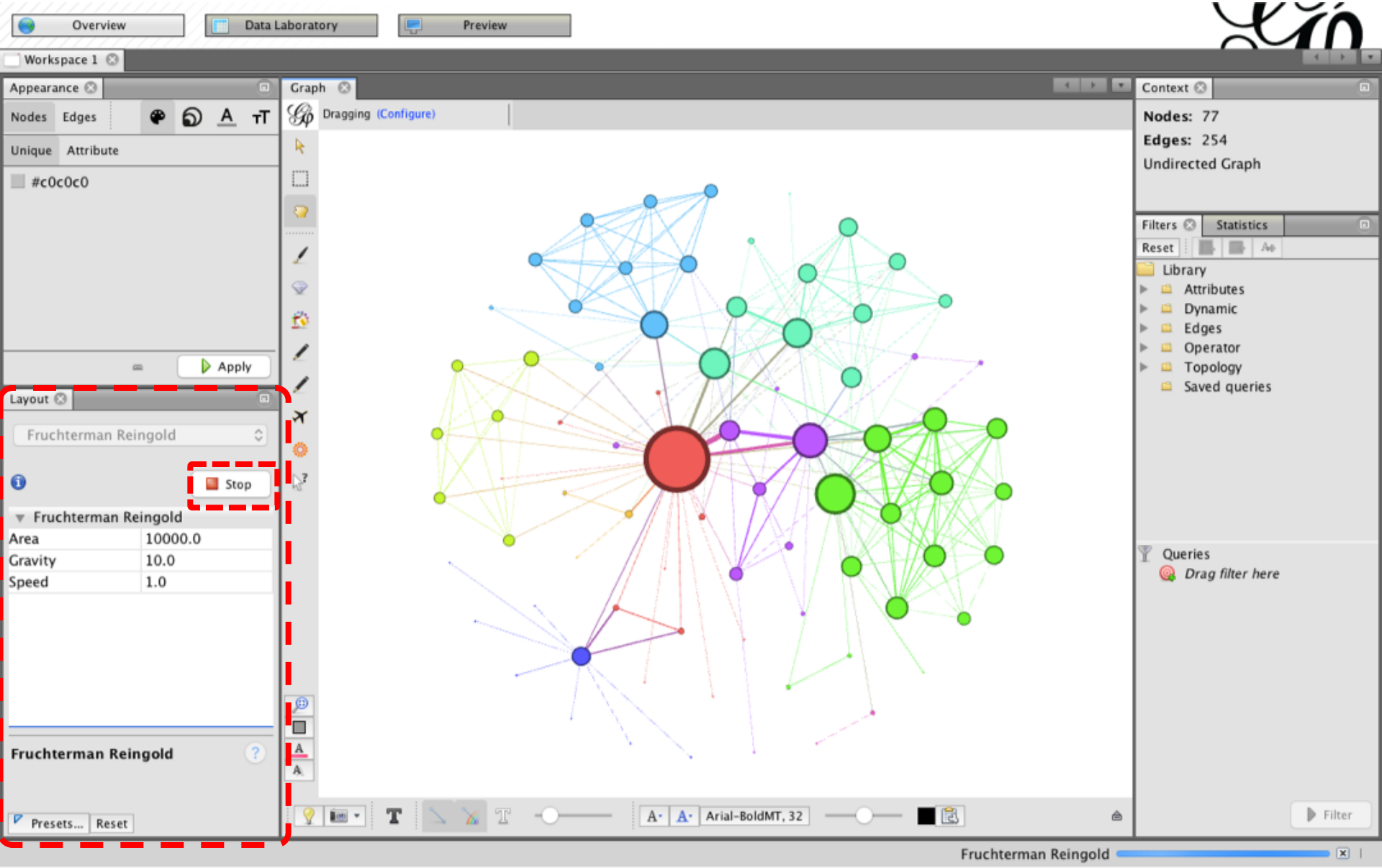
Gephi Layout: Expansion



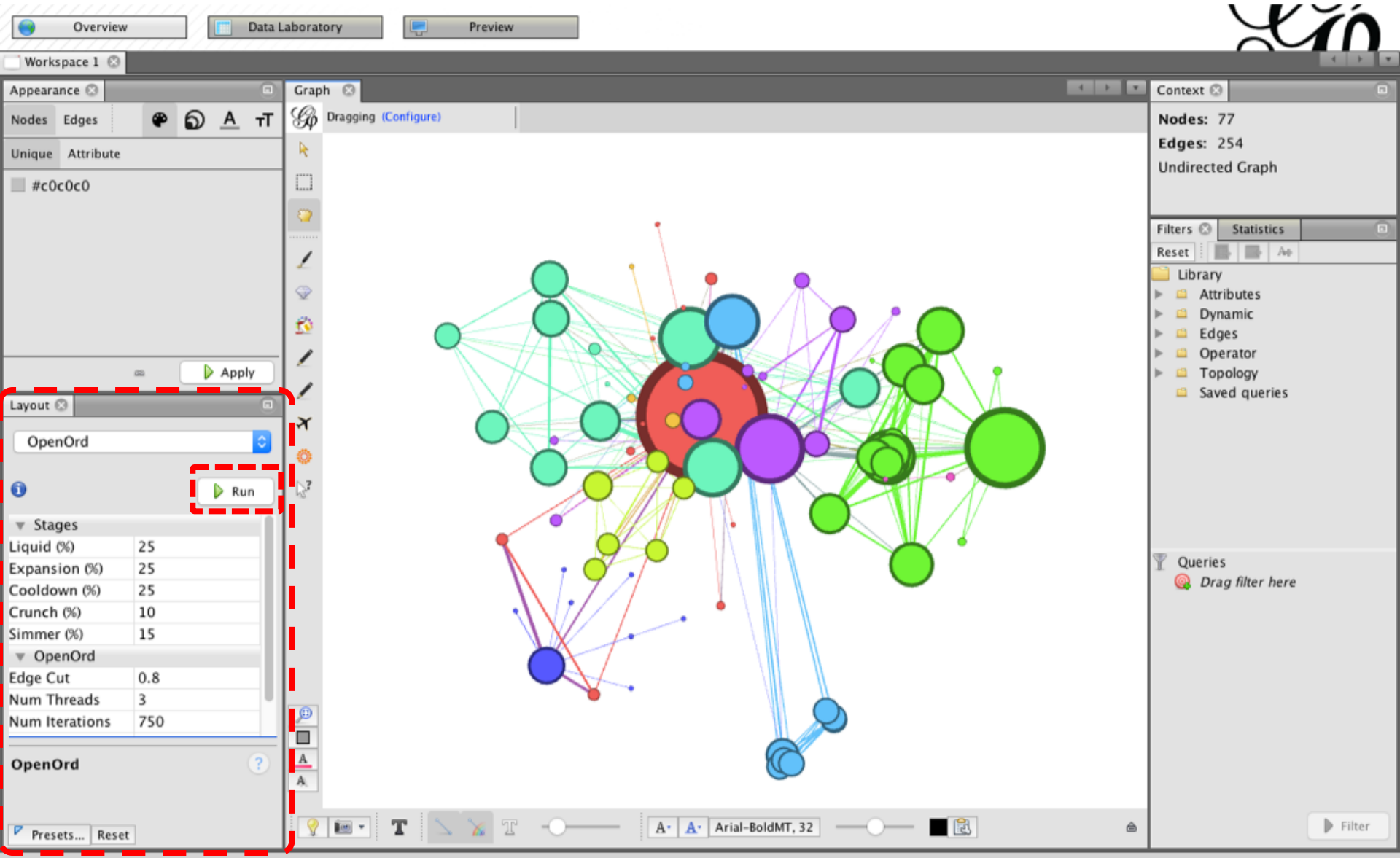
Gephi Layout: ForceAtlas 2



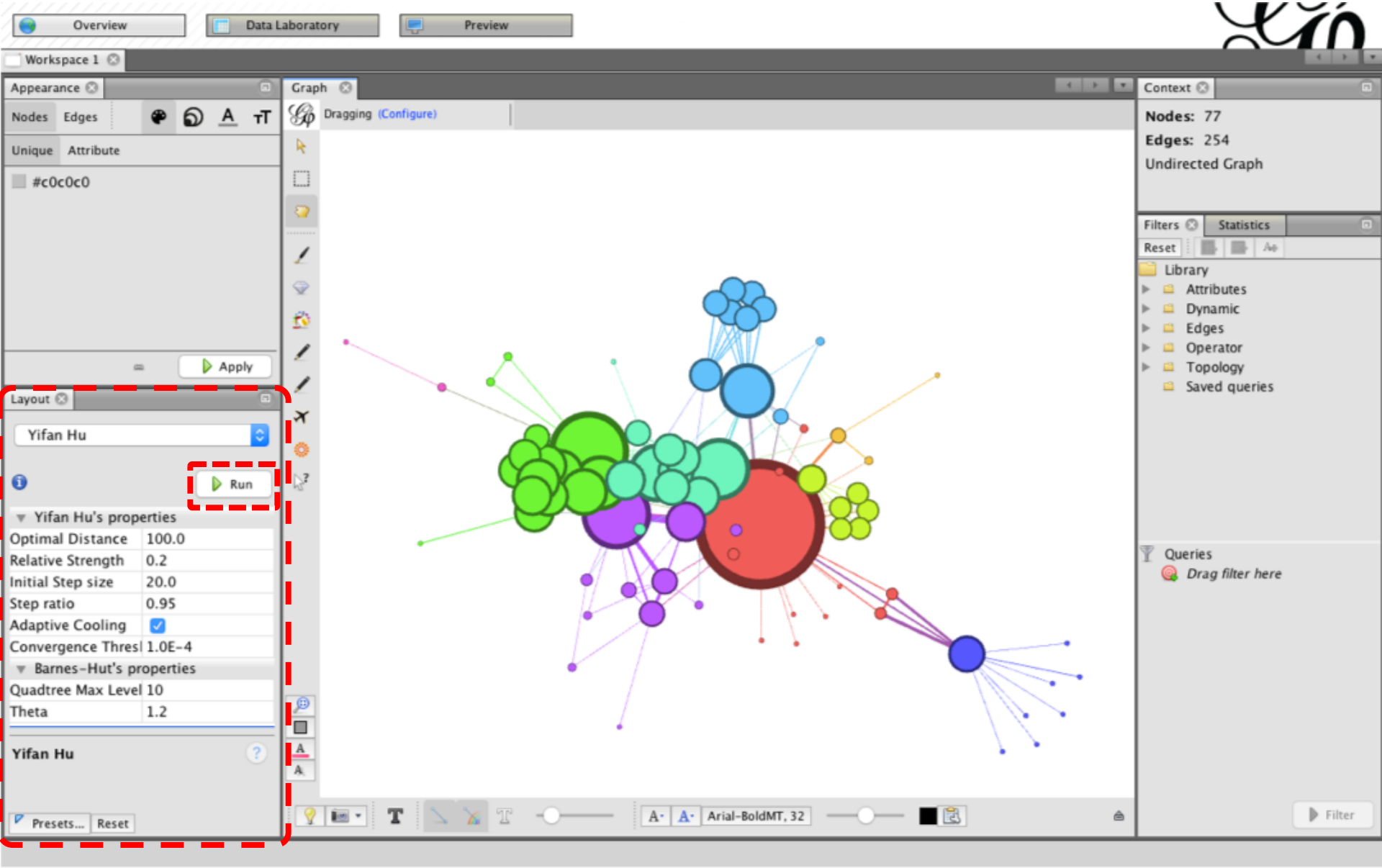
Gephi Layout: Fruchterman Reingold



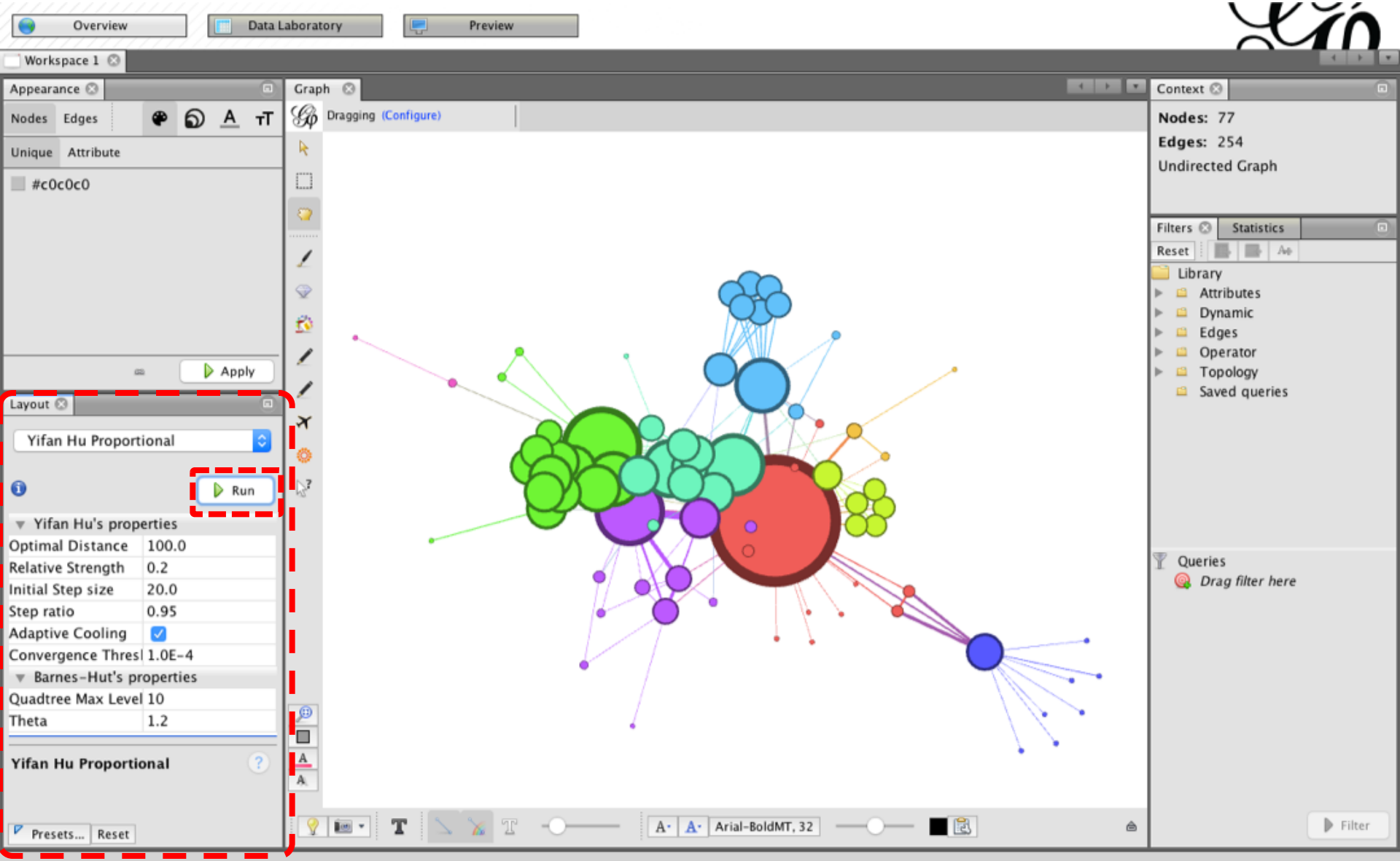
Gephi Layout: OpenOrd



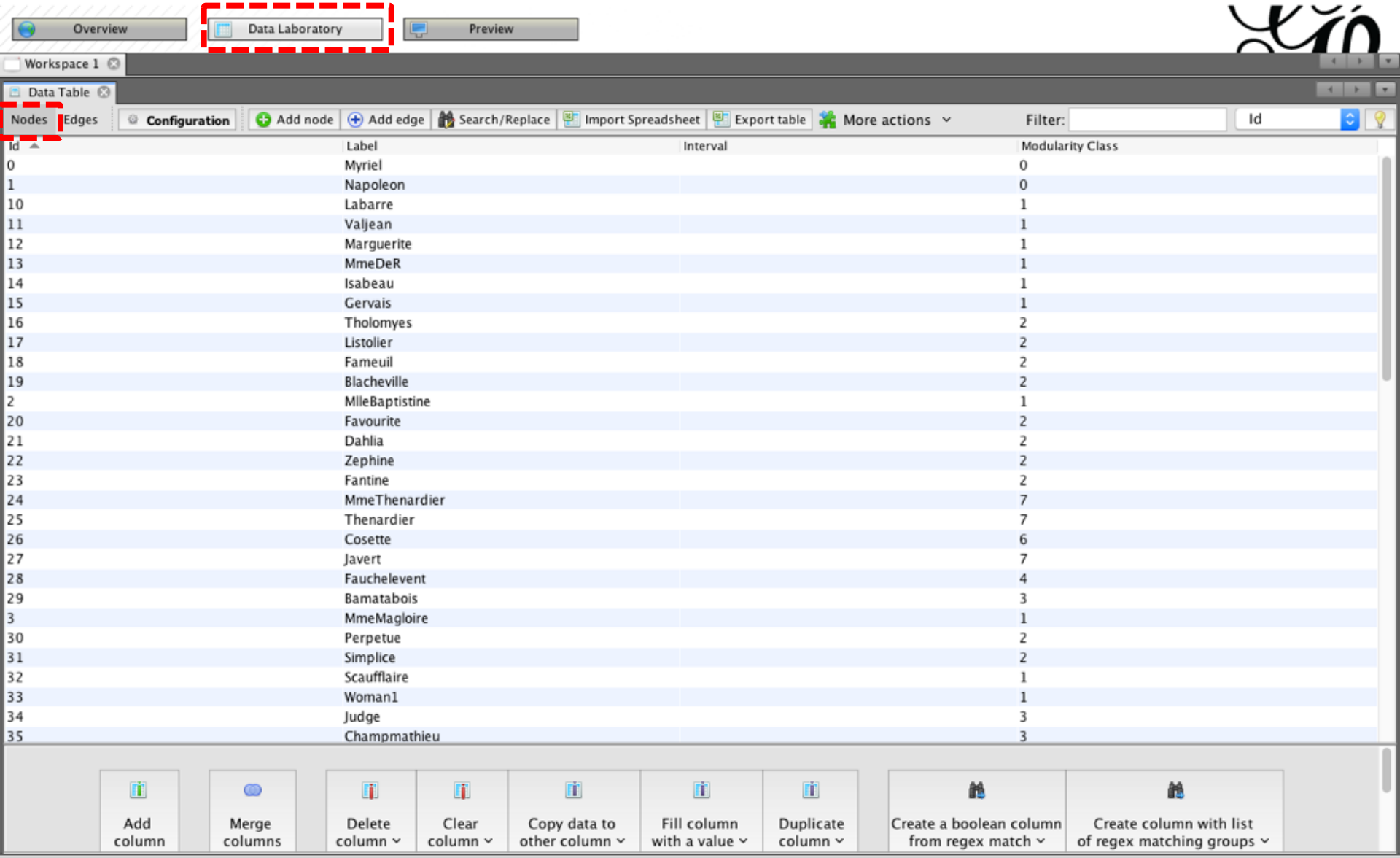
Gephi Layout: Yifan Hu



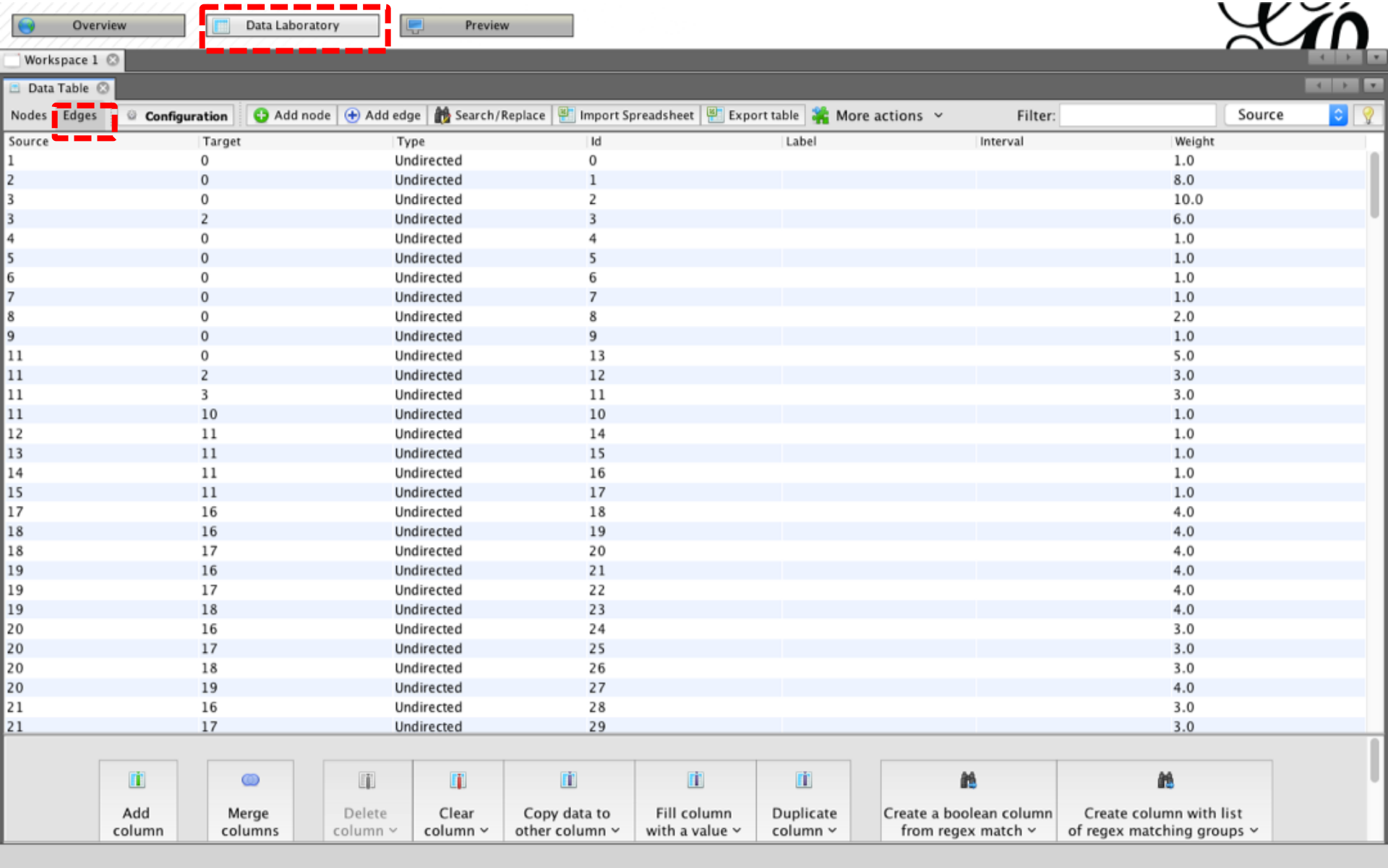
Gephi Layout: Yifan Hu Proportional



Gephi Data Laboratory: Nodes



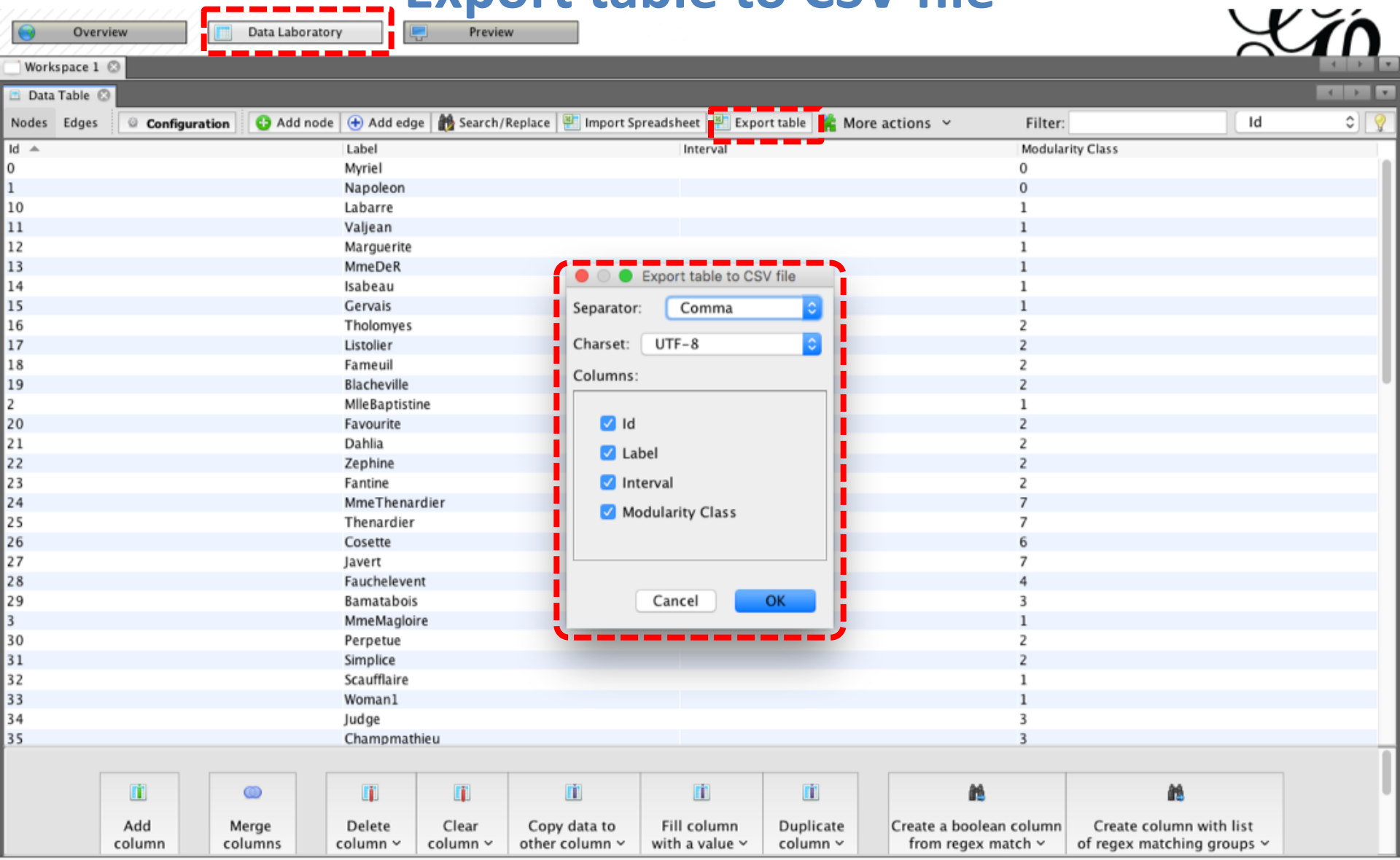
Gephi Data Laboratory: Edges



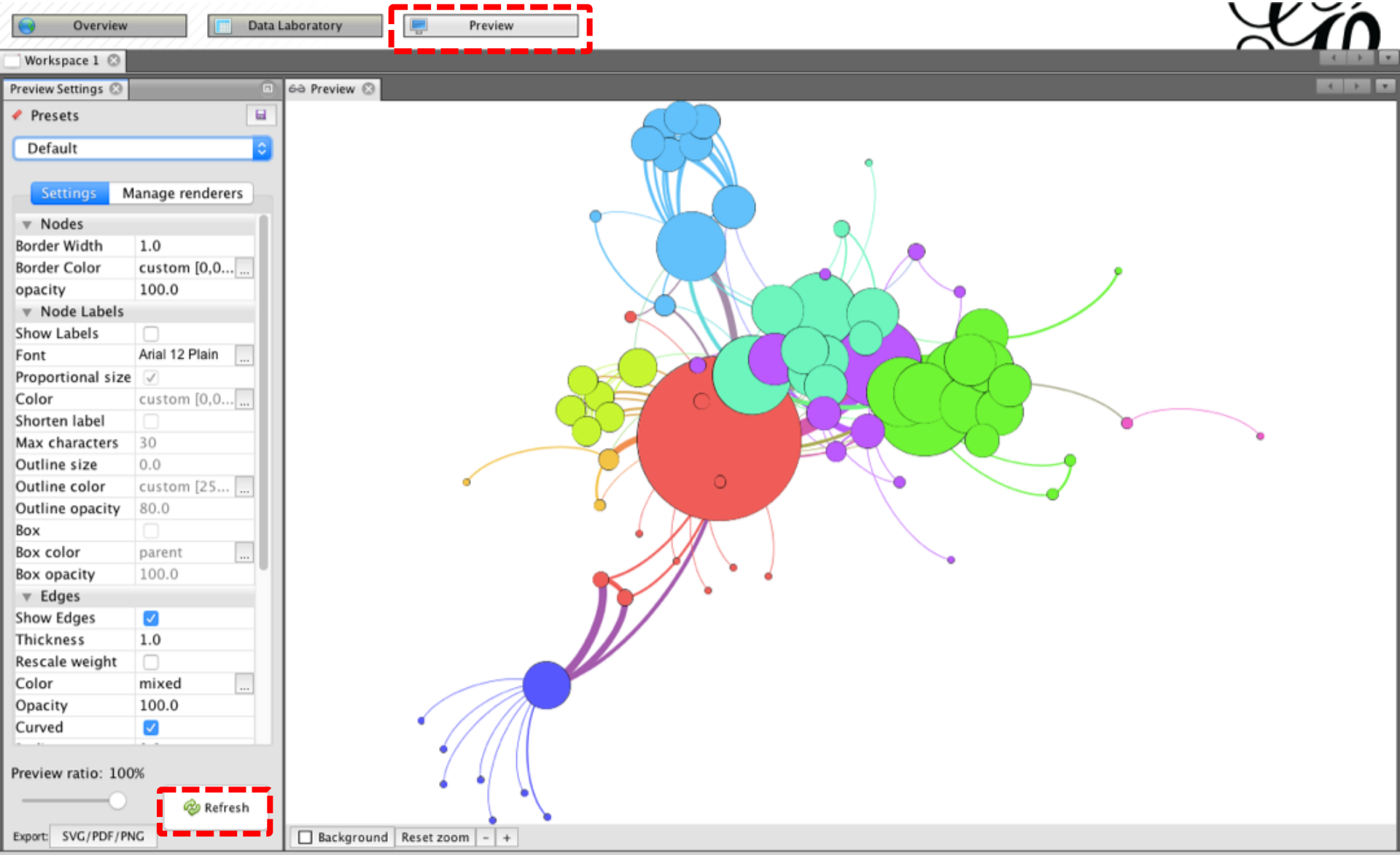
Source	Target	Type	Id	Label	Interval	Weight
1	0	Undirected	0			1.0
2	0	Undirected	1			8.0
3	0	Undirected	2			10.0
3	2	Undirected	3			6.0
4	0	Undirected	4			1.0
5	0	Undirected	5			1.0
6	0	Undirected	6			1.0
7	0	Undirected	7			1.0
8	0	Undirected	8			2.0
9	0	Undirected	9			1.0
11	0	Undirected	13			5.0
11	2	Undirected	12			3.0
11	3	Undirected	11			3.0
11	10	Undirected	10			1.0
12	11	Undirected	14			1.0
13	11	Undirected	15			1.0
14	11	Undirected	16			1.0
15	11	Undirected	17			1.0
17	16	Undirected	18			4.0
18	16	Undirected	19			4.0
18	17	Undirected	20			4.0
19	16	Undirected	21			4.0
19	17	Undirected	22			4.0
19	18	Undirected	23			4.0
20	16	Undirected	24			3.0
20	17	Undirected	25			3.0
20	18	Undirected	26			3.0
20	19	Undirected	27			4.0
21	16	Undirected	28			3.0
21	17	Undirected	29			3.0

Gephi Data Laboratory:

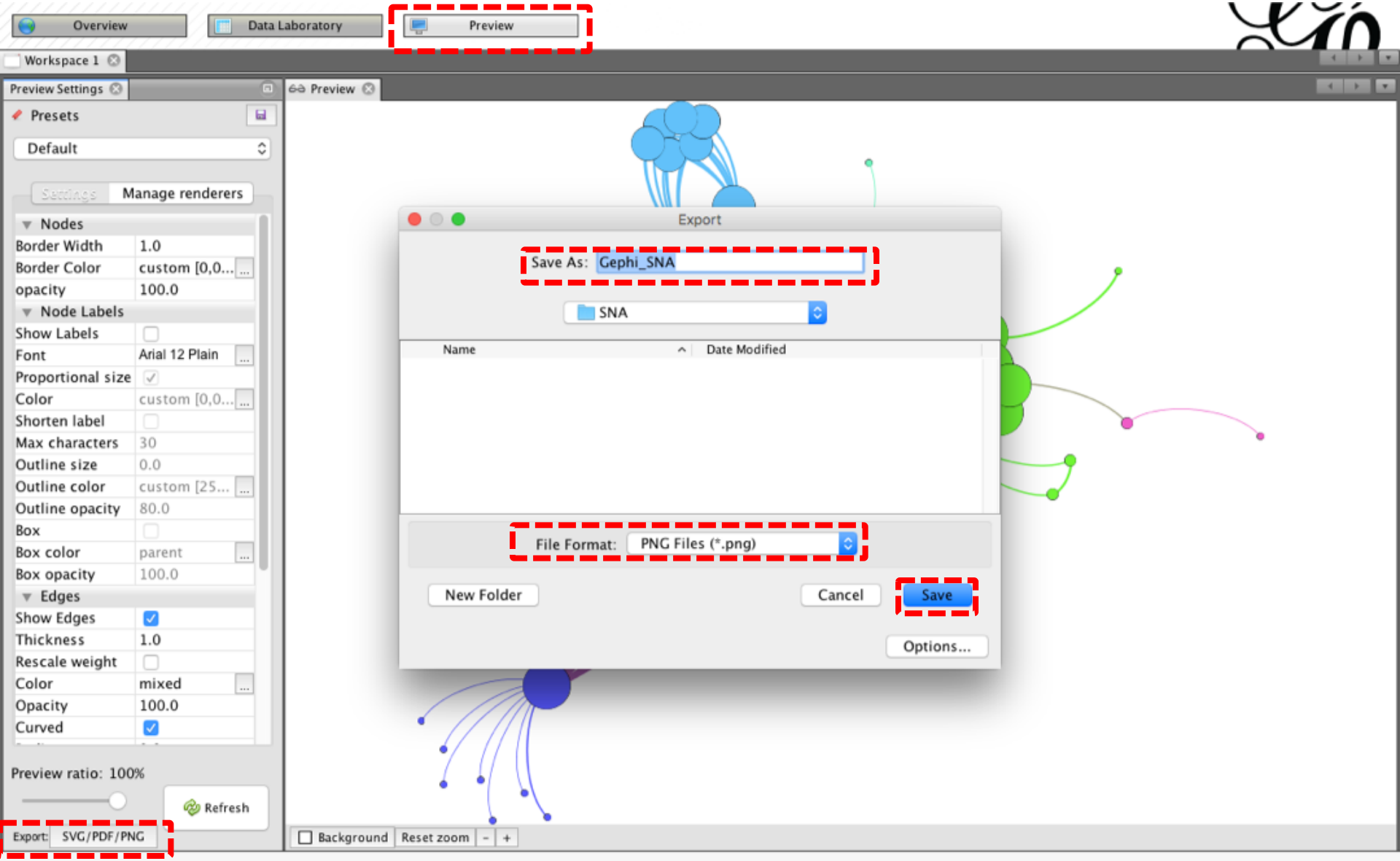
Export table to CSV file



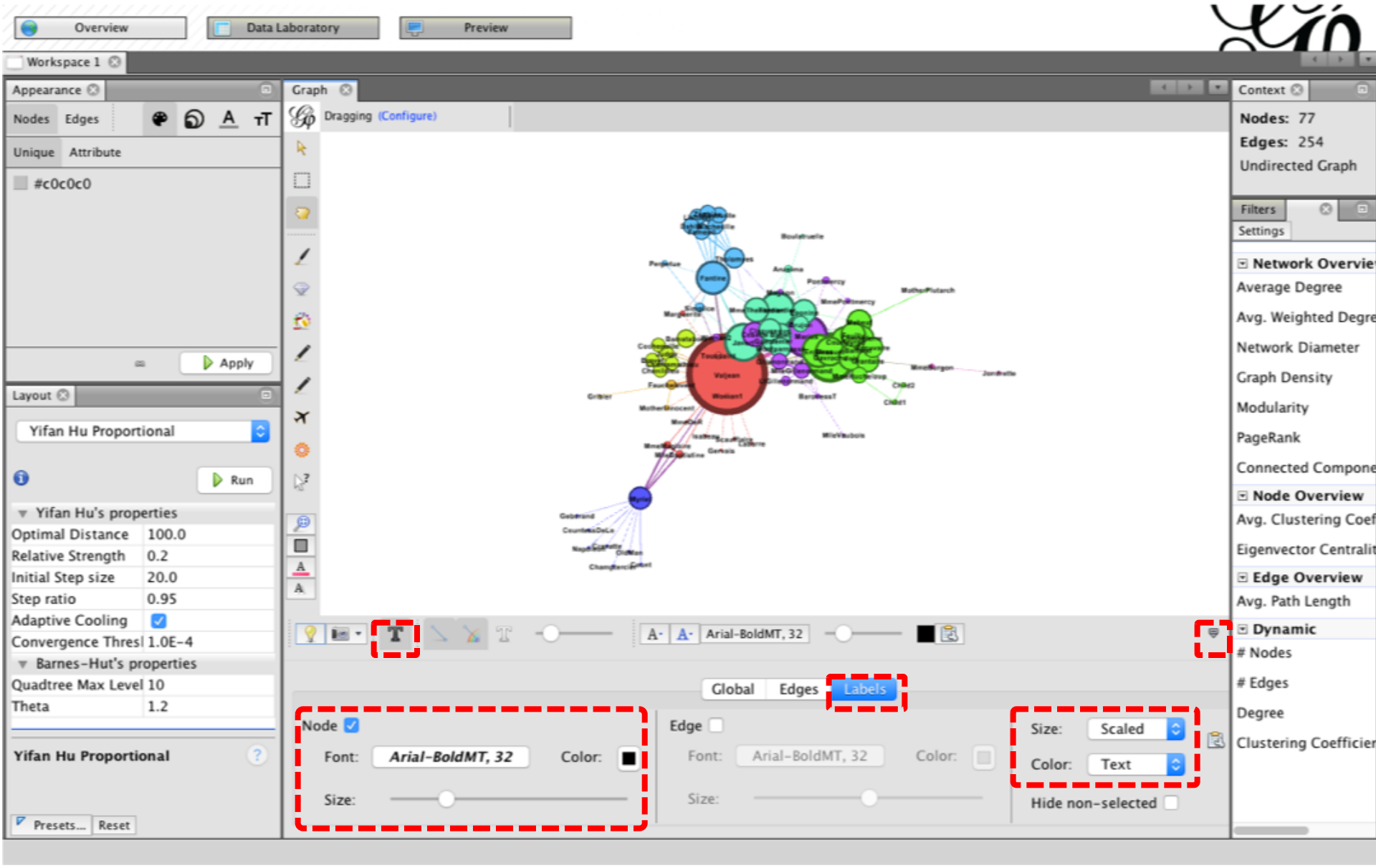
Gephi Preview



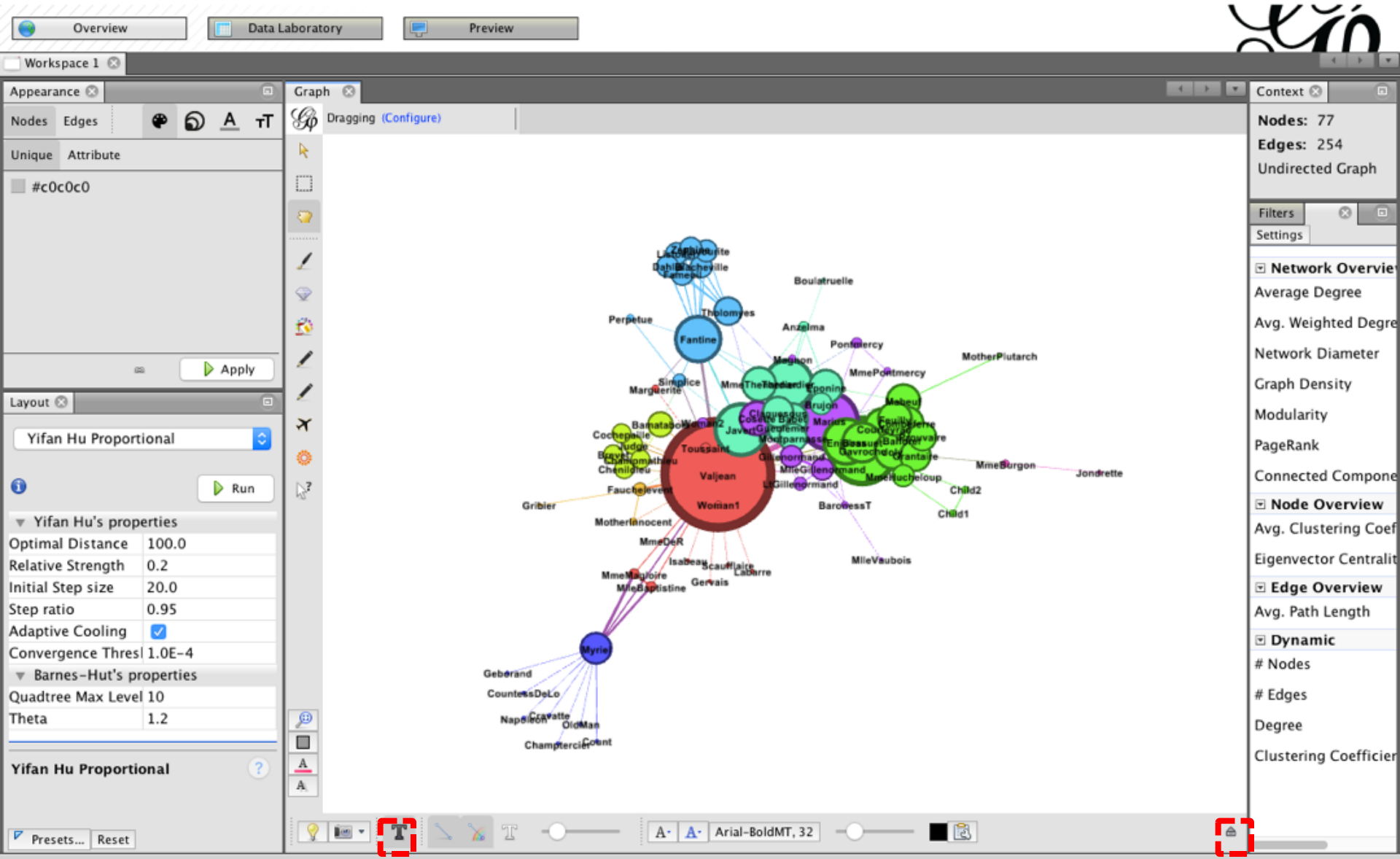
Gephi Preview: Export SVG/PDF/PNG



Gephi Overview: Text Labels



Gephi Overview: Text Labels



Comparison of Social Network Analysis (SNA) Tools

General Comparison of SNA Tools

Software	NETWORKX	IGRAPH	GEPHI	PAJEK
TYPE	LIBRARY	LIBRARY	STAND ALONE	STAND ALONE
PLATFORM	PYTHON	PYTHON\R\C LIBRARY	WINDOWS	WINDOWS
COMPUTATIONAL TIME	FAST	FAST	FAST	MEDIUM
NO. OF NODES	1 MILLION	1 MILLION	0.15 MILLION	1 MILLION

Naheed Akhtar (2014)

Source: Naheed Akhtar (2014), "Social network analysis tools." In 2014 Fourth International Conference on Communication Systems and Network Technologies (CSNT)

Network Types Supported by SNA Tools

Graph type	Networkx	IGraph	Gephi	Pajek
1-Mode network	Yes	Yes	Yes	Yes
2-Mode network Graph	Yes	Yes	Yes	Yes
Multirelational network Graph	No	No	No	Yes
Temporarily network Graph	Yes	No	No	Yes

Naheed Akhtar (2014)

Source: Naheed Akhtar (2014), "Social network analysis tools." In 2014 Fourth International Conference on Communication Systems and Network Technologies (CSNT)

Graph Layout Supported by SNA Tools

Layout	Networkx	IGraph	Pajek	Gephi
Circular layout	Yes	Yes	Yes	Yes
Random layout	Yes	Yes	Yes	No
Spectral layout	Yes	No	No	No
Spring layout	Yes	Yes	Ye s	Yes
Graphviz layout	Yes	No	No	No
Kamanda kawai	No	Yes	Yes	No
Fruchterman reingold	No	Yes	Yes	No
Force Atlas layout	No	No	Yes	No

Naheed Akhtar (2014)

Source: Naheed Akhtar (2014), "Social network analysis tools." In 2014 Fourth International Conference on Communication Systems and Network Technologies (CSNT)

Execution Time for SNA Features

SNA Features	Networkx	IGraph	Gephi	Pajek
Load time	54.67 sec.	3.707 sec	29 sec	3 sec
Degree centrality	58.57 sec	6.199 sec	4 sec	2 sec
Graph degree	60.87 sec	6.22 sec	4 sec	2 sec
Page rank	120.78 sec	9.81 sec	10 sec	No
Hits	57.23 sec	15.43	8 sec	No
Cliques	66.98 sec	9.35 sec	Na	No
Density	58.94 sec	3.302 sec	4 sec	No
Modularity	81 .4 sec	9 sec	30 sec	6 sec
Network diameter	35 sec	3.51 sec	120 sec	No
Core	65.84 sec	6.532 sec	No	1 sec
Cohesion	No	8.943 sec	No	No
Clustering coefficient	3303.99 sec	1800 sec	1200 sec	108 sec
Hub	76.57	5.831 sec	3 sec	No
Authority	Array is to big	6.783 sec	3 sec	No

Naheed Akhtar (2014)

Source: Naheed Akhtar (2014), "Social network analysis tools." In 2014 Fourth International Conference on Communication Systems and Network Technologies (CSNT)

Comparative analysis of Social Networking Analysis tools

Software	Pajek	Gephi	Social Network Visualizer	Netlytic	Graphviz
Version	1.26	0.7 alpha	1.56 Beta	Tier 1,2,3	2.38.0
Type	Stand-alone software	Stand-alone software	Stand-alone software	Stand-alone software	Stand-alone software
Platform	Windows	Java	Windows	Windows	Windows
License	Free	GNU GPL	Free	Tier 1,2 (Free) Tier 3 (CS)	Free
Expectable Computing Time	Fast(C)	Medium(JAVA)	Fast(C)	Medium(JAVA)	Fast(C)
Tractable number of nodes	500000 nodes	150000 nodes	100000 nodes	300000 nodes	1400000 nodes
Time to load 10^5 nodes and 10^6 edges	24 seconds	40 seconds	46 seconds	50 seconds	34 seconds
File formats					
GML	No	Yes	Yes	Yes	No
Pajek(.net)	No	Important Only	No	No	No
GraphML	Export only	Yes	Yes	Yes	No
DL	Yes	Yes	Yes	Yes	No
GEXF	No	Yes	Yes	Yes	No
Graph types					
Two-mode graphs	Yes	No	No	No	Yes
Multi-relational graphs	Yes	No	No	Yes	Yes
Temporality	Yes	No	No	Yes	Yes
Visualization layouts					
FruchtermanReingold	Yes	Yes	Yes	Yes	No
Kamada Kawai	Yes	Yes	No	No	Yes
Other spring layouts	No	Yes	Yes	No	Yes
Indicators					
Degree centrality	Yes	Yes	Yes	Yes	Yes
Betweenness centrality	Yes	Yes	Yes	Yes	Yes
Closeness centrality	Yes	Yes	Yes	Yes	Yes
Dyad census	No	No	No	No	No
Triad census	Yes	No	No	No	No
HITS	No	Yes	Yes	No	No
Page Rank	No	Yes	Yes	Yes	No
Clustering Algorithms					
Edge Betweenness	No	No	No	Yes	No
Walktrap	No	No	No	Yes	No
Spinglass	No	No	No	Yes	No
Dendogram Display	Yes	Yes	Yes	Yes	Yes

Source: Agrawal, H., Thakur, A., Slathia, R., & Sumangali, K. (2015). A Comparative Analysis of Social Networking Analysis Tools. J Inform Tech Softw Eng, 5(157),

Comparative analysis of Social Networking Analysis tools

Software	**Pajek**	**Gephi**
Version	1.26	0.7 alpha
Type	Stand-alone software	Stand-alone software
Platform	Windows	Java
License	Free	GNU GPL
Expectable Computing Time	Fast(C)	Medium(JAVA)
Tractable number of nodes	500000 nodes	150000 nodes
Time to load 10^5 nodes and 10^6 edges	24 seconds	40 seconds
File formats		
GML	No	Yes
Pajek(.net)	No	Important Only
GraphML	Export only	Yes
DL	Yes	Yes
GEXF	No	Yes
Graph types		
Two-mode graphs	Yes	No
Multi-relational graphs	Yes	No
Temporality	Yes	No

Source: Agrawal, H., Thakur, A., Slathia, R., & Sumangali, K. (2015). A Comparative Analysis of Social Networking Analysis Tools. J Inform Tech Softw Eng, 5(157),

Comparative analysis of Social Networking Analysis tools

Software	Pajek	Gephi
Visualization layouts		
FruchtermanReingold	Yes	Yes
Kamada Kawai	Yes	Yes
Other spring layouts	No	Yes
Indicators		
Degree centrality	Yes	Yes
Betweenness centrality	Yes	Yes
Closeness centrality	Yes	Yes
Dyad census	No	No
Triad census	Yes	No
HITS	No	Yes
Page Rank	No	Yes
Clustering Algorithms		
Edge Betweenness	No	No
Walktrap	No	No
Spinglass	No	No
Dendogram Display	Yes	Yes

Source: Agrawal, H., Thakur, A., Slathia, R., & Sumangali, K. (2015). A Comparative Analysis of Social Networking Analysis Tools. J Inform Tech Softw Eng, 5(157),

A Survey of Tools for Community Detection and Mining in Social Networks

(Maivizhi et al., 2016)

Tools	Pajek	Gephi	igraph
Version	4.1	0.9.1	1.0.1
Website	vlado.fmf.uni-lj.si/pub/networks/pajek/	gephi.org	igraph.org
Type	Software	Software	Library
Platform	Windows	Windows, Mac OS X, Linux	R, Python, C/C++
License	Free and Commercial	Open source and free	Open source and free
Number of nodes	1 Billion	0.6 Million	>1 Million
Computing Time	Medium	Fast	Fast

Source: Maivizhi, R., S. Sendhilkumar, and G. S. Mahalakshmi. "A Survey of Tools for Community Detection and Mining in Social Networks." In *Proceedings of the International Conference on Informatics and Analytics*, p. 71. ACM, 2016.

A Survey of Tools for Community Detection and Mining in Social Networks

(Maivizhi et al., 2016)

Network Type	Pajek	Gephi	igraph
1-mode network	Yes	Yes	Yes
2-mode network	Yes	Yes	Yes
Multi-relational network	Yes	No	No
Temporal (dynamic) network	Yes	No	No

Source: Maivizhi, R., S. Sendhilkumar, and G. S. Mahalakshmi. "A Survey of Tools for Community Detection and Mining in Social Networks." In *Proceedings of the International Conference on Informatics and Analytics*, p. 71. ACM, 2016.

A Survey of Tools for Community Detection and Mining in Social Networks

(Maivizhi et al., 2016)

File Format	Pajek	Gephi	igraph
.net	Yes	Yes	No
.gml	No	Yes	Yes
.graphml	No	Yes	Yes
.txt	No	No	Yes
.csv	No	Yes	Yes
.pajek	Yes	Import only	Yes
.dl	No	Yes	Import only
.graphdb	No	No	Yes
.dot	No	Yes	Export only

Source: Maivizhi, R., S. Sendhilkumar, and G. S. Mahalakshmi. "A Survey of Tools for Community Detection and Mining in Social Networks." In *Proceedings of the International Conference on Informatics and Analytics*, p. 71. ACM, 2016.

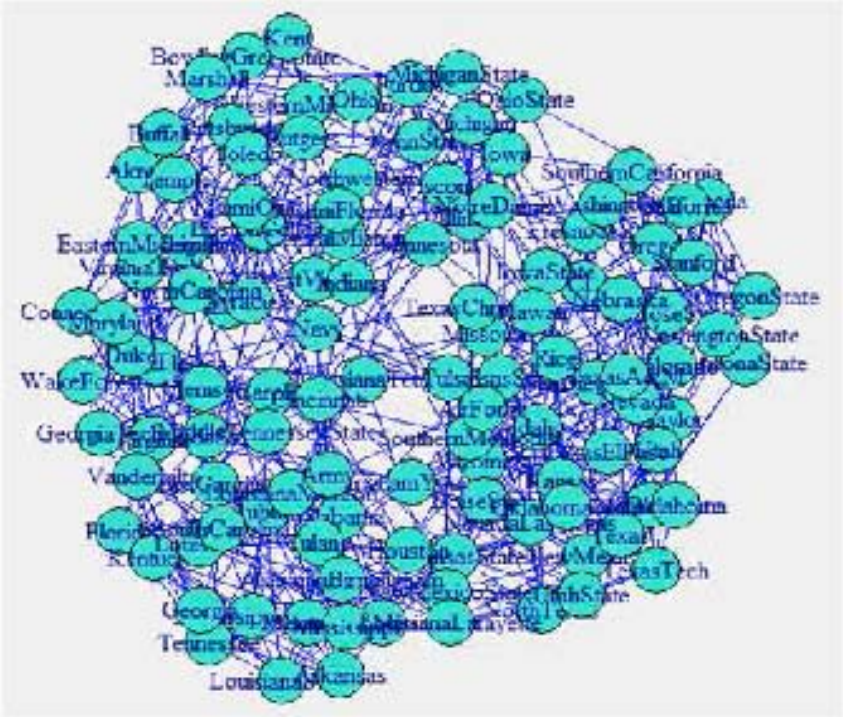
A Survey of Tools for Community Detection and Mining in Social Networks

(Maivizhi et al., 2016)

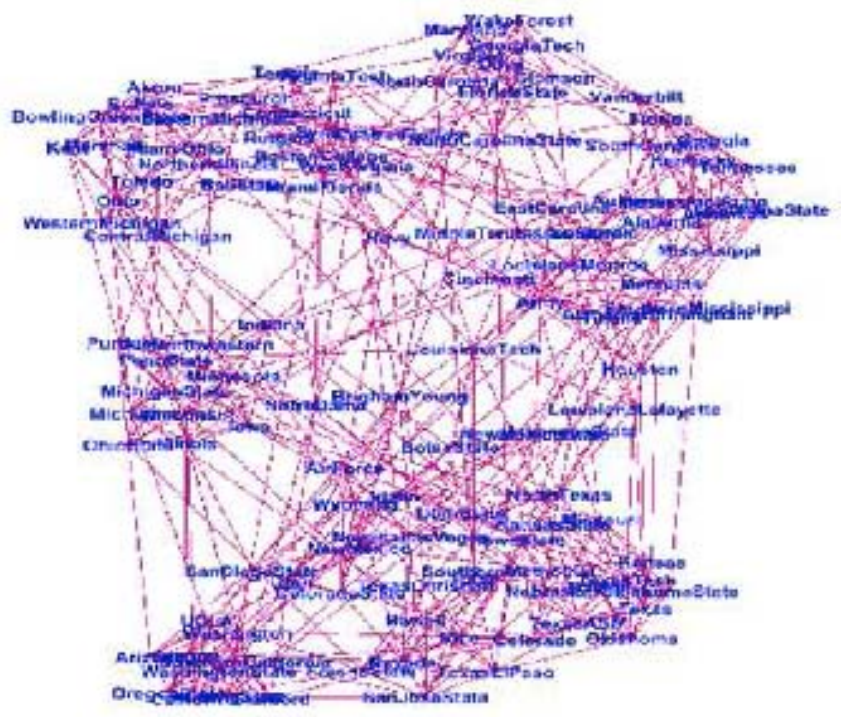
Visualization Layout	Pajek	Gephi	igraph
Kamada-kawai	Yes	No	Yes
Fruchterman-Reingold	Yes	Yes	Yes
Other spring layout	Yes	No	Yes
Circular layout	Yes	No	Yes
Random layout	Yes	Yes	Yes
Force atlas layout	Yes	Yes	Yes
Spectral layout	No	No	No
Tree layout	No	No	Yes

Source: Maivizhi, R., S. Sendhilkumar, and G. S. Mahalakshmi. "A Survey of Tools for Community Detection and Mining in Social Networks." In *Proceedings of the International Conference on Informatics and Analytics*, p. 71. ACM, 2016.

Visualization using igraph and Gephi



Visualization of American College Football using igraph with kamada-kawai layout.



Visualization of American College Football using Gephi with force-directed layout.

Source: Maivizhi, R., S. Sendhilkumar, and G. S. Mahalakshmi. "A Survey of Tools for Community Detection and Mining in Social Networks." In *Proceedings of the International Conference on Informatics and Analytics*, p. 71. ACM, 2016.

A Survey of Tools for Community Detection and Mining in Social Networks

(Maivizhi et al., 2016)

Network Metrics	Pajek	Gephi	igraph
Degree Centrality	Yes	Yes	Yes
Betweenness Centrality	Yes	Yes	Yes
Closeness Centrality	Yes	Yes	Yes
Network Diameter	Yes	Yes	Yes
Dyad Census	No	No	Yes
Triad Census	Yes	No	Yes
HITS	No	No	Yes
Page Rank	No	Yes	Yes

Source: Maivizhi, R., S. Sendhilkumar, and G. S. Mahalakshmi. "A Survey of Tools for Community Detection and Mining in Social Networks." In *Proceedings of the International Conference on Informatics and Analytics*, p. 71. ACM, 2016.

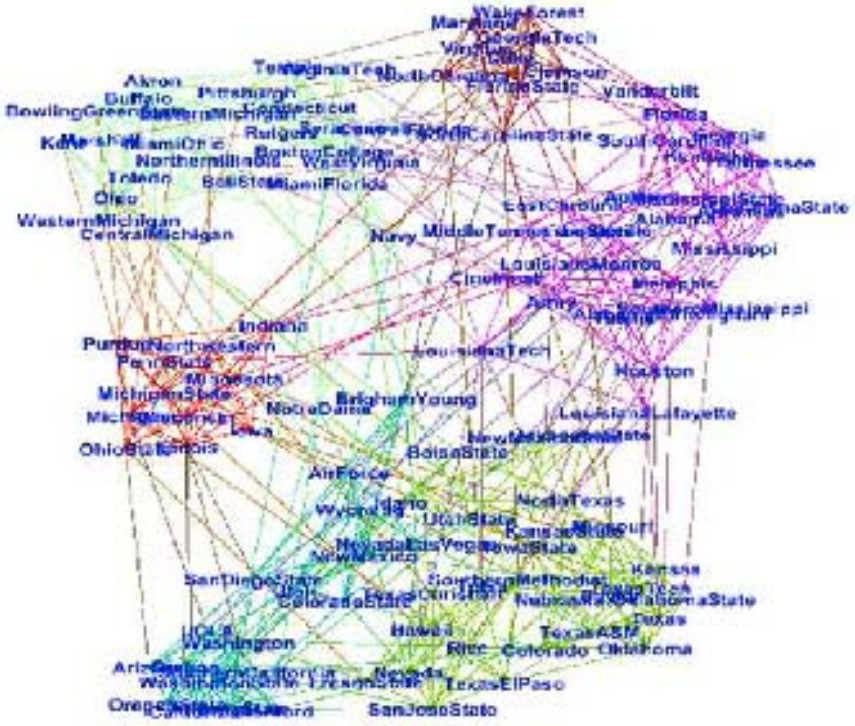
A Survey of Tools for Community Detection and Mining in Social Networks

(Maivizhi et al., 2016)

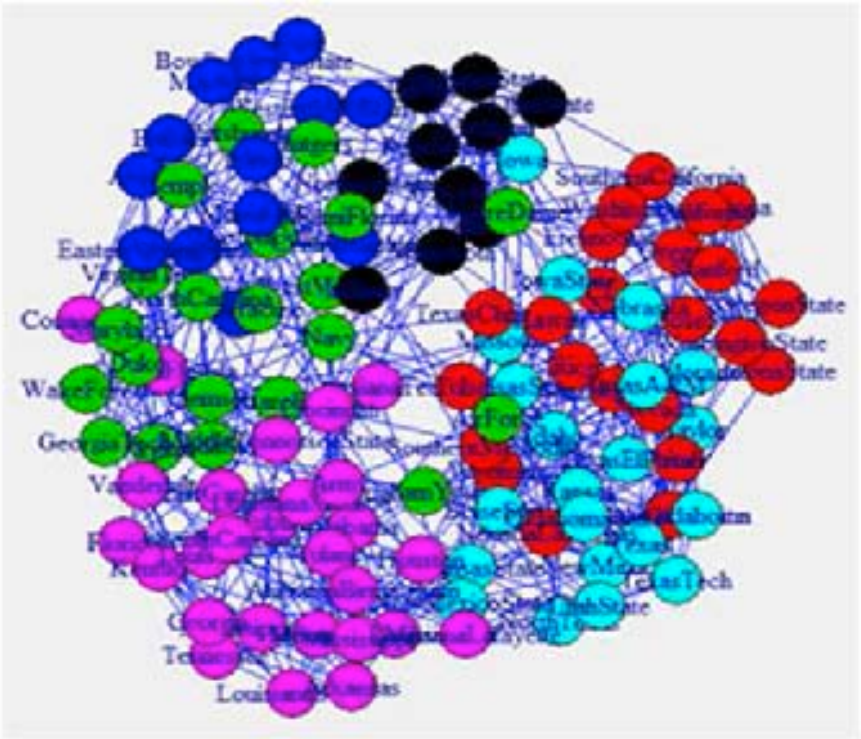
Community Algorithms	Pajek	Gephi	igraph
Louvain Method	Yes	Yes	Yes
Edge Betweenness	No	No	Yes
Greedy Method	No	No	Yes
Modularity Method	No	No	No
Clique Percolation Method	No	No	No
Label Propagation	No	No	Yes
Eigen Vector	No	No	Yes
Random Walk	No	No	Yes
Statistical Method	No	No	Yes

Source: Maivizhi, R., S. Sendhilkumar, and G. S. Mahalakshmi. "A Survey of Tools for Community Detection and Mining in Social Networks." In *Proceedings of the International Conference on Informatics and Analytics*, p. 71. ACM, 2016.

Community Detection using Gephi and igraph



Community detection using Gephi with Louvain method.



Community detection using igraph with Fast Greedy Algorithm.

Source: Maivizhi, R., S. Sendhilkumar, and G. S. Mahalakshmi. "A Survey of Tools for Community Detection and Mining in Social Networks." In *Proceedings of the International Conference on Informatics and Analytics*, p. 71. ACM, 2016.

Application of SNA

Social Network Analysis of Research Collaboration in Information Reuse and Integration

Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Example of SNA Data Source

dblp
computer science bibliography

IRI 2010: Las Vegas, NV, USA

- **Proceedings of the IEEE International Conference on Information Reuse and Integration, IRI 2010, 4-6 August 2010, Las Vegas, Nevada, USA.** IEEE Systems, Man, and Cybernetics Society 2010
- Reda Alhajj, James B. D. Joshi, Mei-Ling Shyu: **Message from Program Co-Chairs.** 1
- Stuart Harvey Rubin, Shu-Ching Chen: **Forward.** 1
- Lotfi A. Zadeh: **Precisiation of meaning - toward computation with natural language.** 1-4
- Reda Alhajj, Shu-Ching Chen, Gongzhu Hu, James B. D. Joshi, Gordon K. Lee, Stuart Harvey Rubin, Mei-Ling Shyu, Lotfi A. Zadeh: **Panel title: Critical need for funding of basic and applied research in large-scale computing.** 1

Automation, Integration and Reuse across Various Apps

- László István Etesi, André Csillaghy, Lin-Ching Chang: **A message-based interoperability framework with application to astrophysics.** 1-6
- Awny Alnusair, Tian Zhao, Eric Bodden: **Effective API navigation and reuse.** 7-12
- Manabu Ohta, Ryohei Inoue, Atsuhiro Takasu: **Empirical evaluation of active sampling for CRF-based analysis of pages.** 13-18
- Qunzhi Zhou, Viktor K. Prasanna: **Workflow management of simulation based computation processes in transportation domain.** 19-24

Source: http://www.informatik.uni-trier.de/~ley/db/conf/iri/iri2010.html

Research Question

- RQ1: What are the scientific collaboration patterns in the IRI research community?

- RQ2: Who are the prominent researchers in the IRI community?

Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Methodology

- Developed a simple web focused crawler program to download literature information about all IRI papers published between 2003 and 2010 from IEEE Xplore and DBLP.
  - 767 paper
  - 1599 distinct author
- Developed a program to convert the list of coauthors into the format of a network file which can be readable by social network analysis software.
- *UCINet* and *Pajek* were used in this study for the social network analysis.

Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Top10 prolific authors (IRI 2003-2010)

1. Stuart Harvey Rubin
2. Taghi M. Khoshgoftaar
3. Shu-Ching Chen
4. Mei-Ling Shyu
5. Mohamed E. Fayad
6. Reda Alhajj
7. Du Zhang
8. Wen-Lian Hsu
9. Jason Van Hulse
10. Min-Yuh Day

Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Data Analysis and Discussion

- **Closeness Centrality**
  - Collaborated widely
- **Betweenness Centrality**
  - Collaborated diversely
- **Degree Centrality**
  - Collaborated frequently
- **Visualization of Social Network Analysis**
  - Insight into the structural characteristics of research collaboration networks

Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Top 20 authors with the highest closeness scores

Rank	ID	Closeness	Author
1	3	0.024675	Shu-Ching Chen
2	1	0.022830	Stuart Harvey Rubin
3	4	0.022207	Mei-Ling Shyu
4	6	0.020013	Reda Alhajj
5	61	0.019700	Na Zhao
6	260	0.018936	Min Chen
7	151	0.018230	Gordon K. Lee
8	19	0.017962	Chengcui Zhang
9	1043	0.017962	Isai Michel Lombera
10	1027	0.017962	Michael Armella
11	443	0.017448	James B. Law
12	157	0.017082	Keqi Zhang
13	253	0.016731	Shahid Hamid
14	1038	0.016618	Walter Z. Tang
15	959	0.016285	Chengjun Zhan
16	957	0.016285	Lin Luo
17	956	0.016285	Guo Chen
18	955	0.016285	Xin Huang
19	943	0.016285	Sneh Gulati
20	960	0.016071	Sheng-Tun Li

Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Top 20 authors with the highest betweeness scores

Rank	ID	Betweenness	Author
1	1	0.000752	Stuart Harvey Rubin
2	3	0.000741	Shu-Ching Chen
3	2	0.000406	Taghi M. Khoshgoftaar
4	66	0.000385	Xingquan Zhu
5	4	0.000376	Mei-Ling Shyu
6	6	0.000296	Reda Alhajj
7	65	0.000256	Xindong Wu
8	19	0.000194	Chengcui Zhang
9	39	0.000185	Wei Dai
10	15	0.000107	Narayan C. Debnath
11	31	0.000094	Qianhui Althea Liang
12	151	0.000094	Gordon K. Lee
13	7	0.000085	Du Zhang
14	30	0.000072	Baowen Xu
15	41	0.000067	Hongji Yang
16	270	0.000060	Zhiwei Xu
17	5	0.000043	Mohamed E. Fayad
18	110	0.000042	Abhijit S. Pandya
19	106	0.000042	Sam Hsu
20	8	0.000042	Wen-Lian Hsu

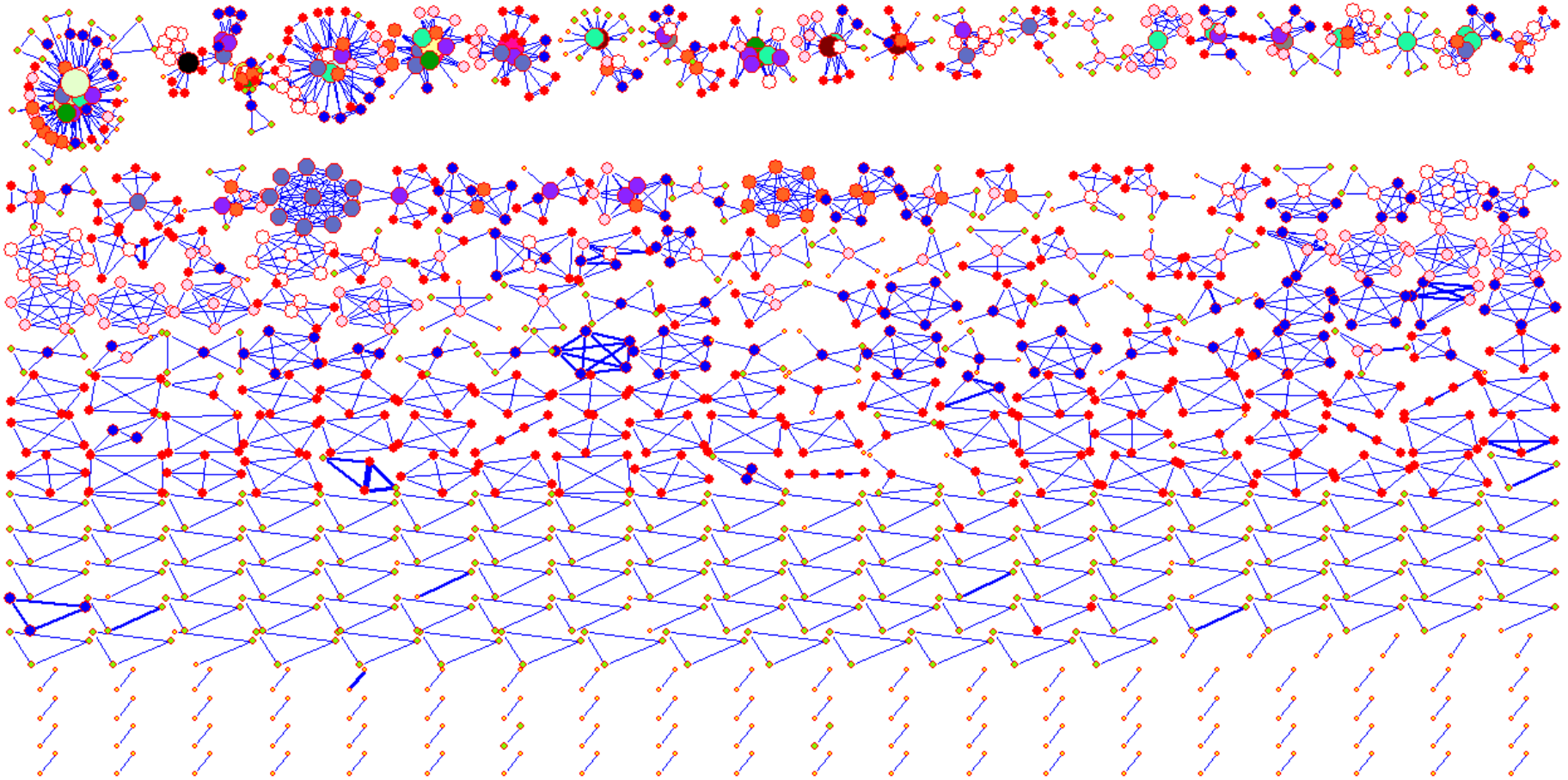
Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Top 20 authors with the highest degree scores

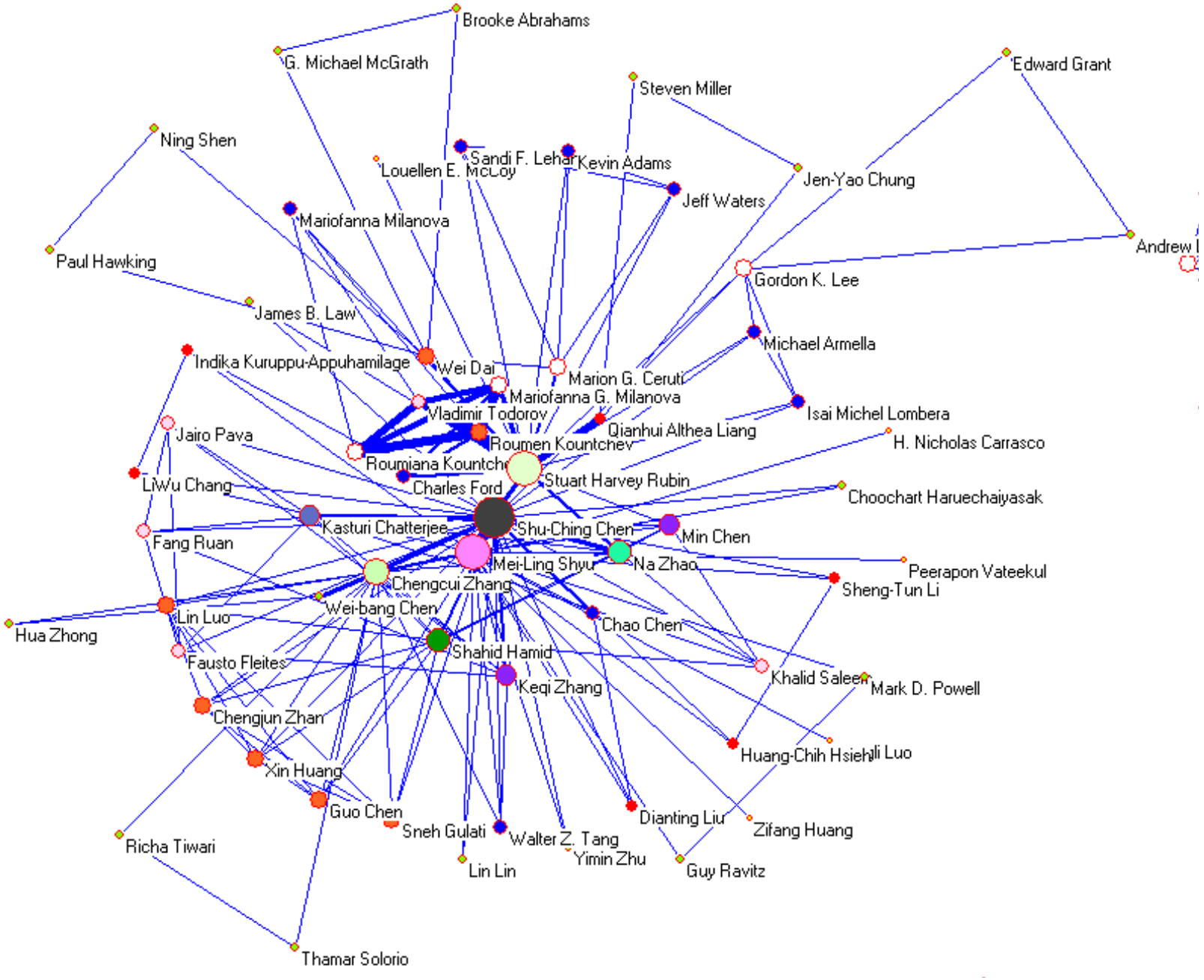
Rank	ID	Degree	Author
1	3	0.035044	Shu-Ching Chen
2	1	0.034418	Stuart Harvey Rubin
3	2	0.030663	Taghi M. Khoshgoftaar
4	6	0.028786	Reda Alhajj
5	8	0.028786	Wen-Lian Hsu
6	10	0.024406	Min-Yuh Day
7	4	0.022528	Mei-Ling Shyu
8	17	0.021277	Richard Tzong-Han Tsai
9	14	0.017522	Eduardo Santana de Almeida
10	16	0.017522	Roumen Kountchev
11	40	0.016896	Hong-Jie Dai
12	15	0.015645	Narayan C. Debnath
13	9	0.015019	Jason Van Hulse
14	25	0.013767	Roumiana Kountcheva
15	28	0.013141	Silvio Romero de Lemos Meira
16	24	0.013141	Vladimir Todorov
17	23	0.013141	Mariofanna G. Milanova
18	5	0.013141	Mohamed E. Fayad
19	19	0.012516	Chengcui Zhang
20	18	0.011890	Waleed W. Smari

Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Visualization of IRI (IEEE IRI 2003-2010) co-authorship network (global view)

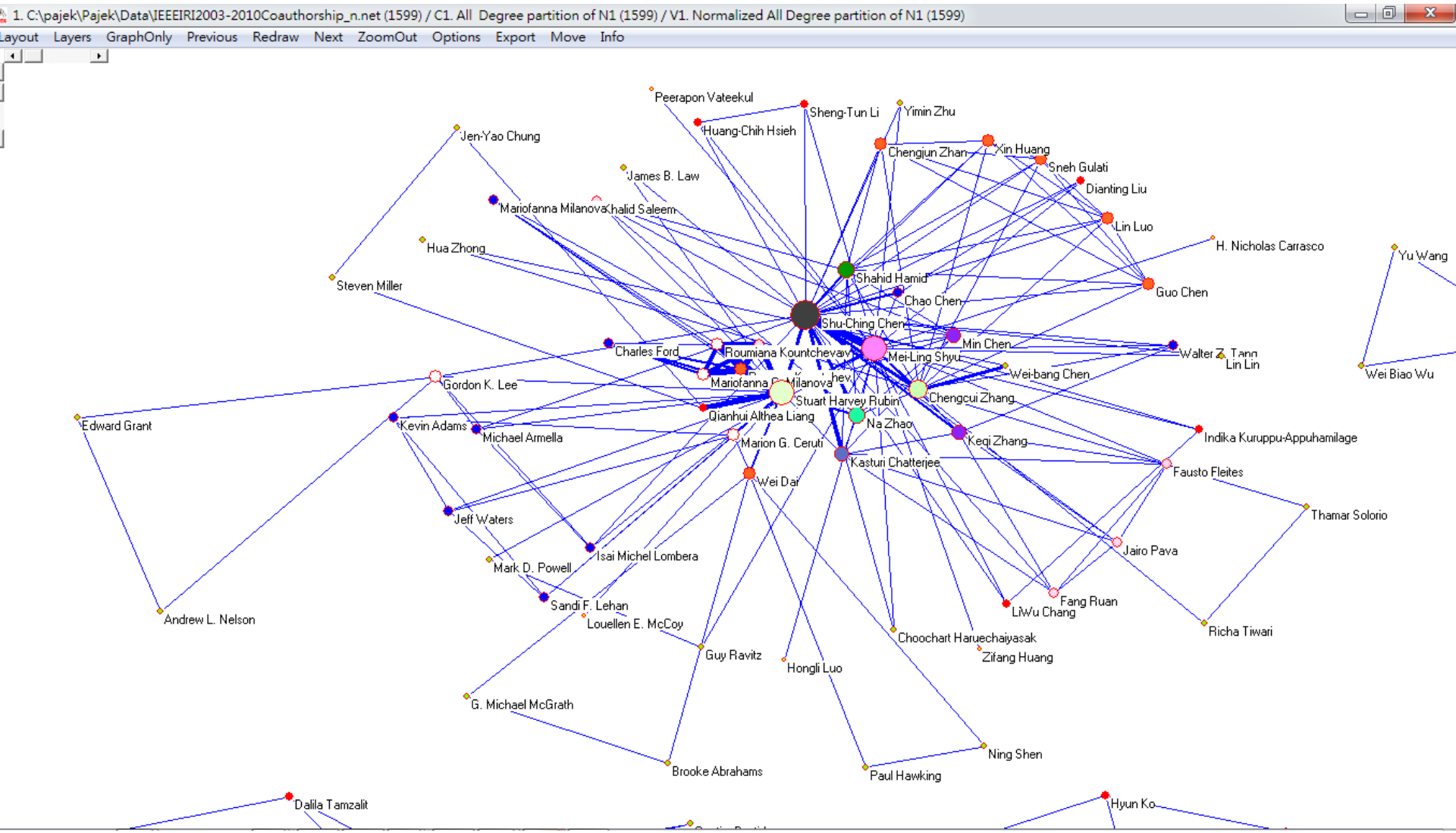


Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"



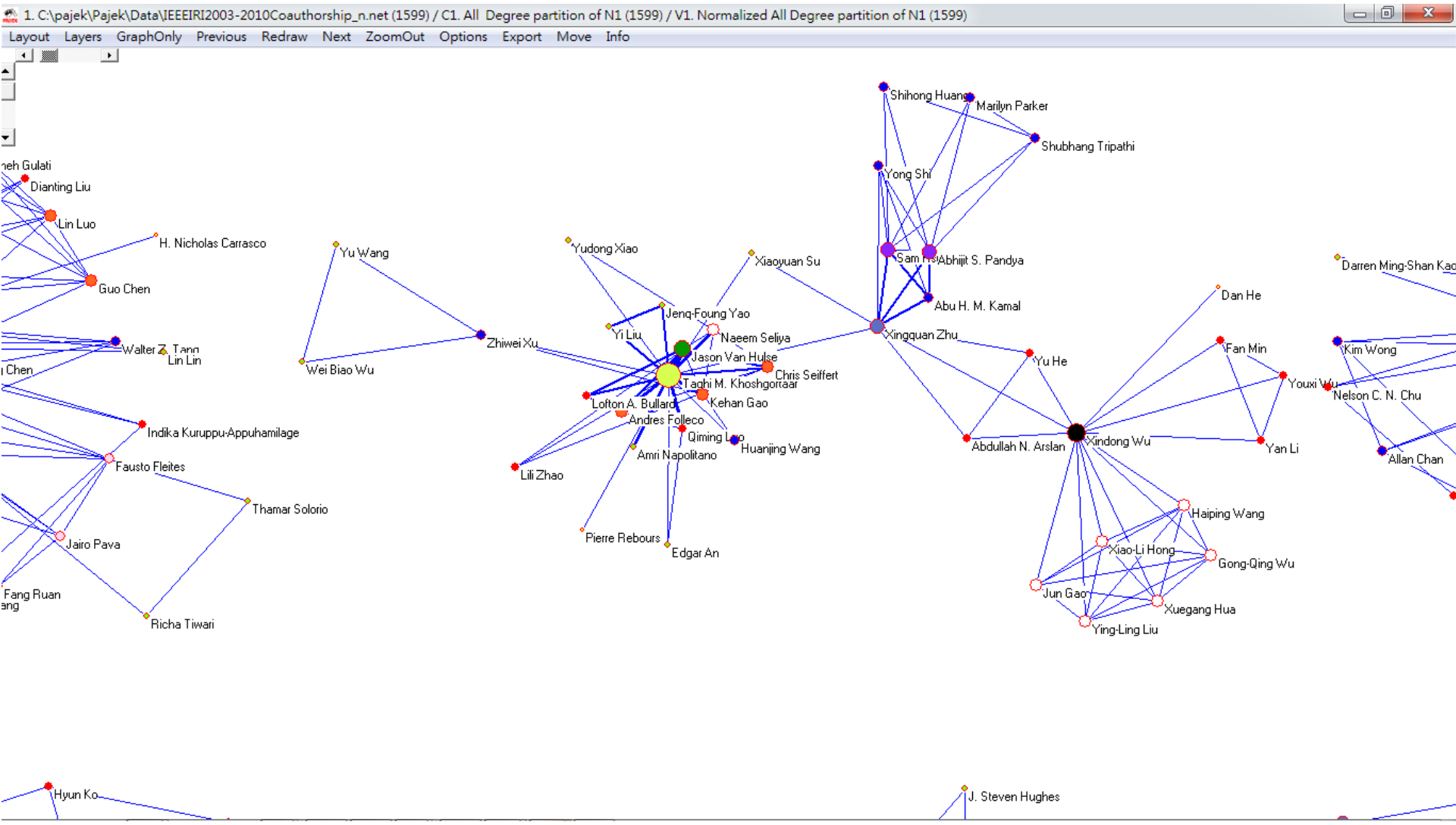
Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Visualization of Social Network Analysis



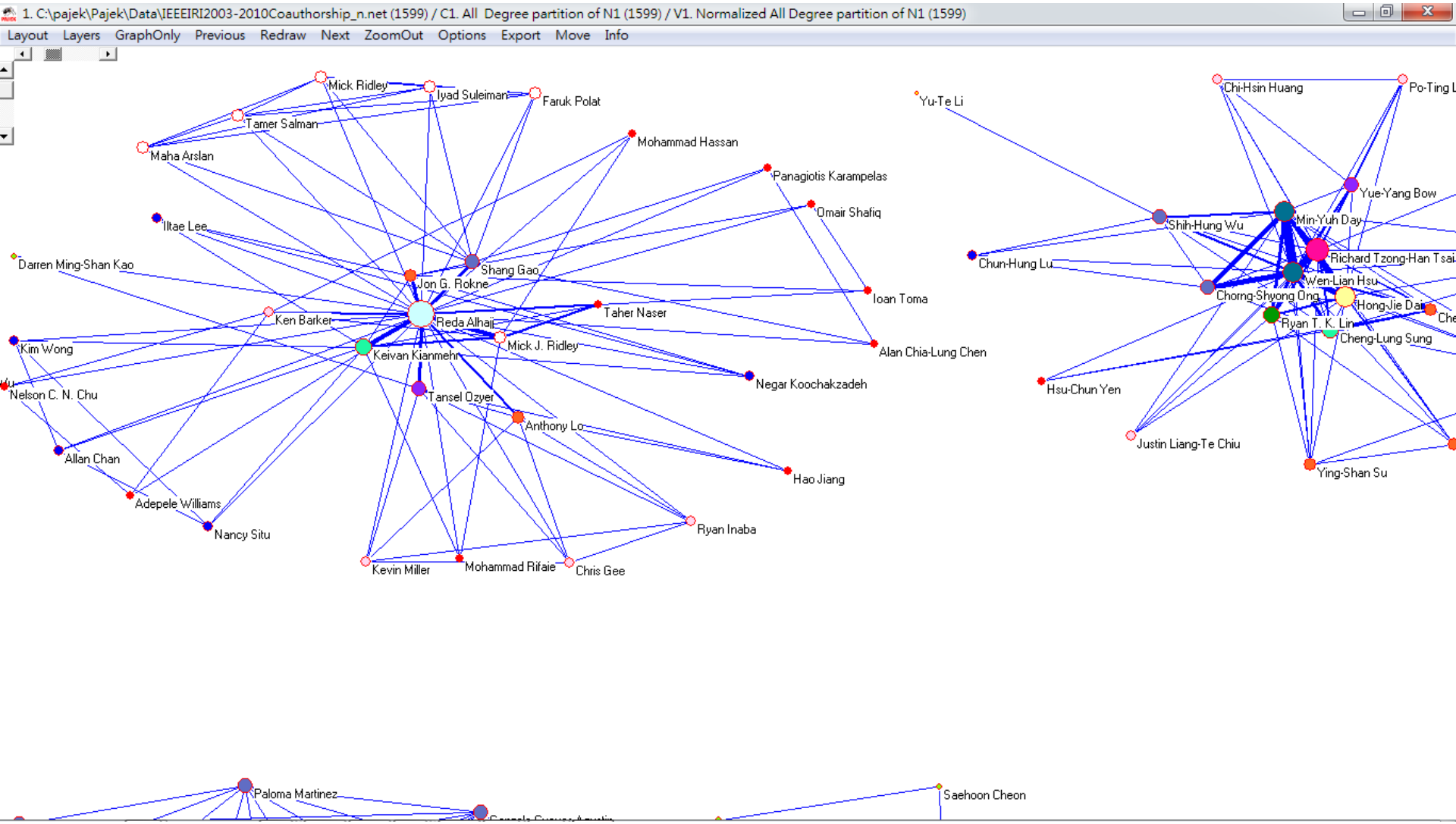
Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Visualization of Social Network Analysis



Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Visualization of Social Network Analysis



Source: Min-Yuh Day, Sheng-Pao Shih, Weide Chang (2011),
"Social Network Analysis of Research Collaboration in Information Reuse and Integration"

Summary

- Social Computing and Social Network Analysis (SNA)
- Social Network Analysis with Gephi
- Applications of SNA

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