NETWORK AND TOPICAL ANALYSIS FOR THE HUMANITIES USING NWB AND SCI2

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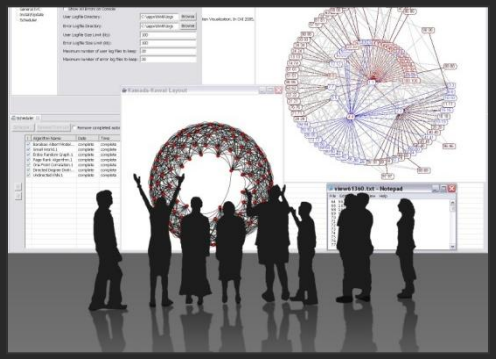
http://www.scottbot.net



With special thanks to Katy Börner, Kevin W. Boyack, Micah Linnemeier, Russell J. Duhon, Patrick Phillips, Joseph Biberstine, Chintan Tank Nianli Ma, Hanning Guo, Mark A. Price, Angela M. Zoss, and Sean Lind

Digital Humanities 2011
Meyer Library 2080E (Language Lab)
Stanford University, Stanford, CA
13:00-16:30 on June 19, 2011

Workshop Overview

1:00-1:15 Introduction to Network Analysis

1:15-1:45 Network Analysis & Visualization in the Humanities

- Theory, Applications, and Pitfalls.
- Examples In The Wild

1:45-2:15 Collecting, Cleaning & Formatting Data

2:15-2:25 Break

2:25-3:00 Sci2 Tool Basics

- Macroscope Design and Usage.
- Download and run the tool.
- Find basic statistics and run various algorithms over the network.
- Visualize the networks as either a graph or a circular hierarchy.

3:00-3:20 Sci2 Workflow Design: Padgett's Florentine Families - Prepare, load, analyze, and visualize family and business networks from 15th century Florence.

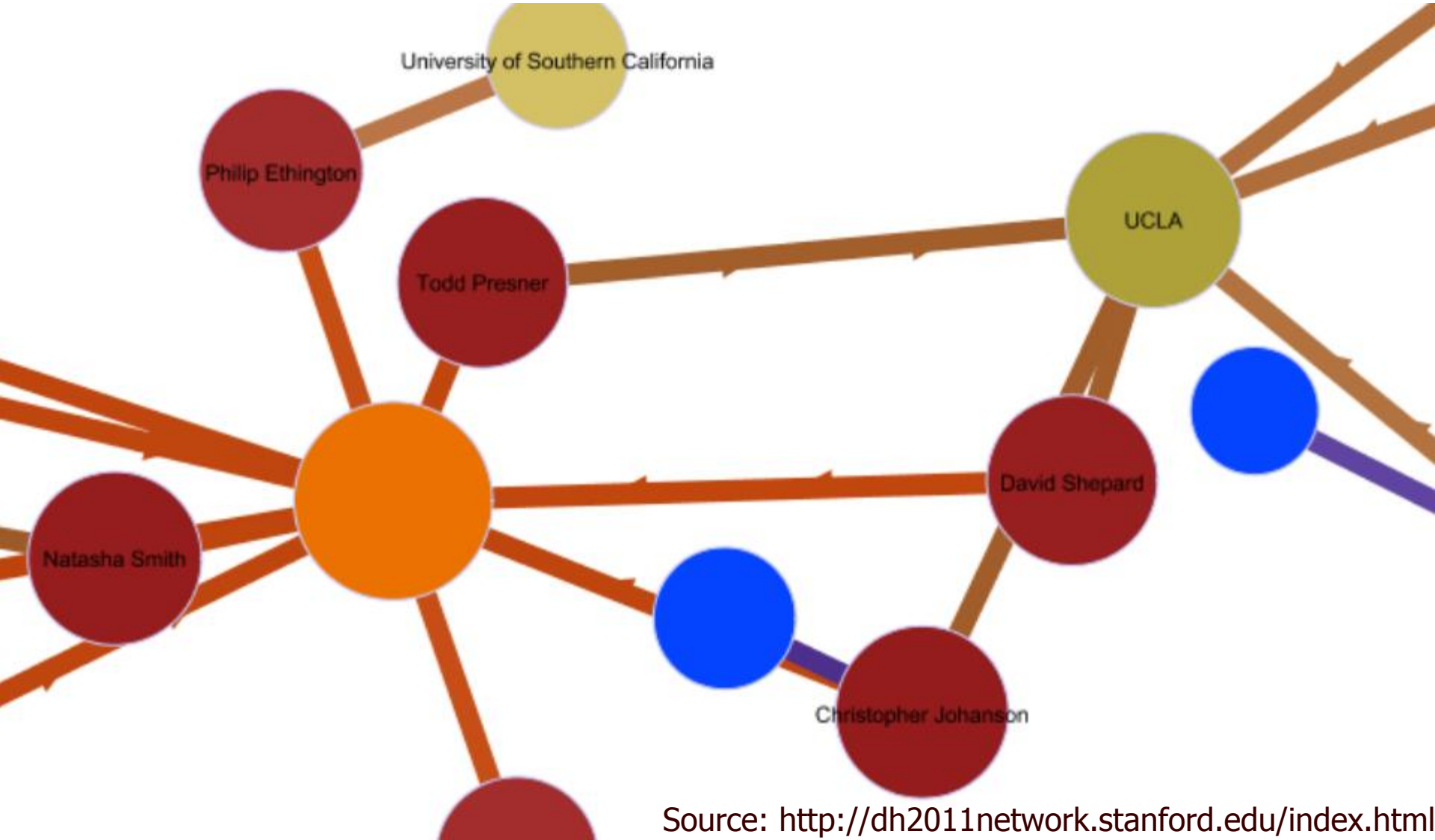
3:20-3:35 Break

3:35-4:00 Sci2 Research Demonstration: Mapping the Republic of Letters

4:00-4:30 Q&A and Technical Assistance

Network Analysis & Visualization

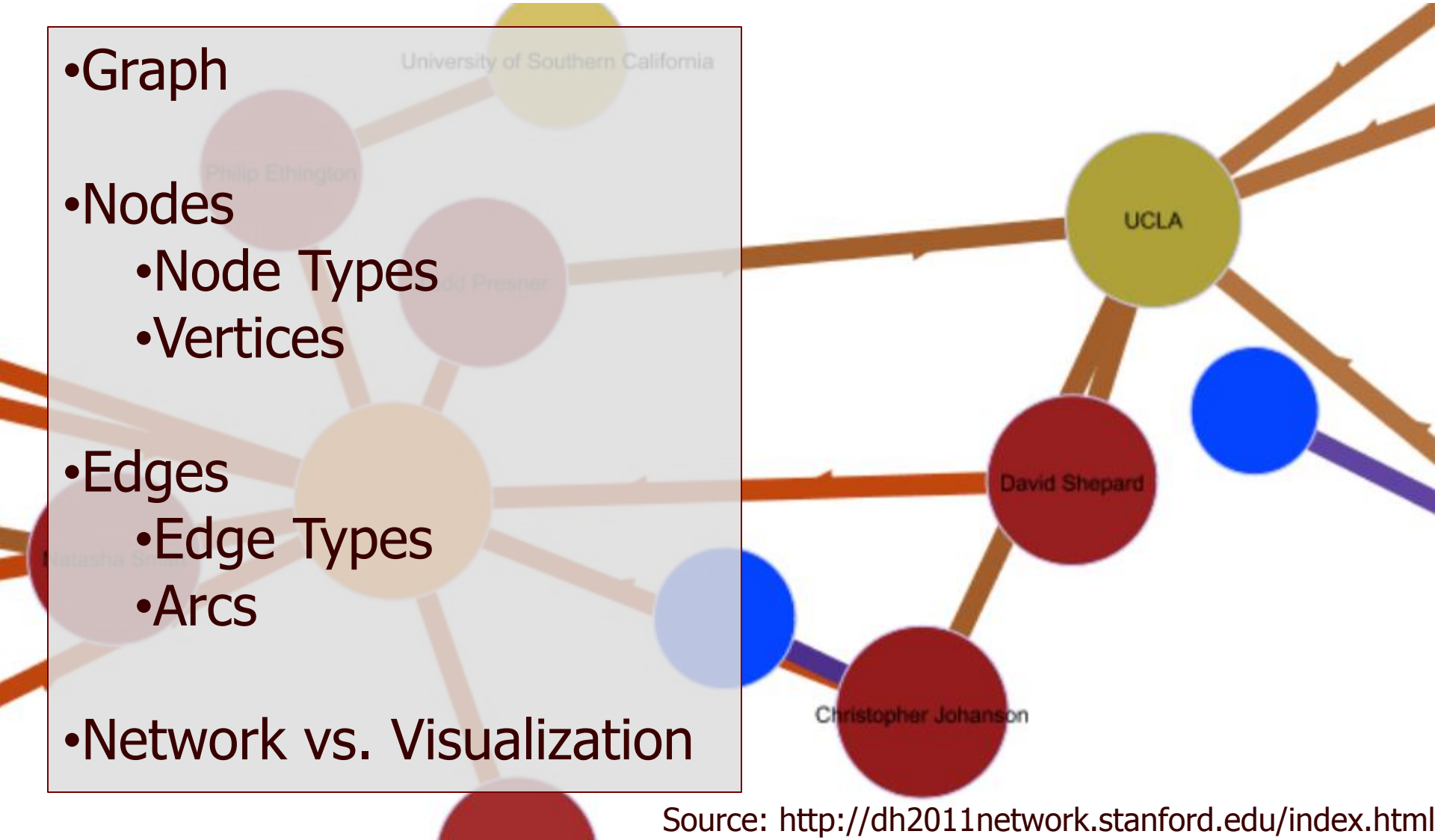
What is a network?



Source: http://dh2011network.stanford.edu/index.html

What is a network?

- Graph
- Nodes
  - Node Types
  - Vertices
- Edges
  - Edge Types
  - Arcs
- Network vs. Visualization



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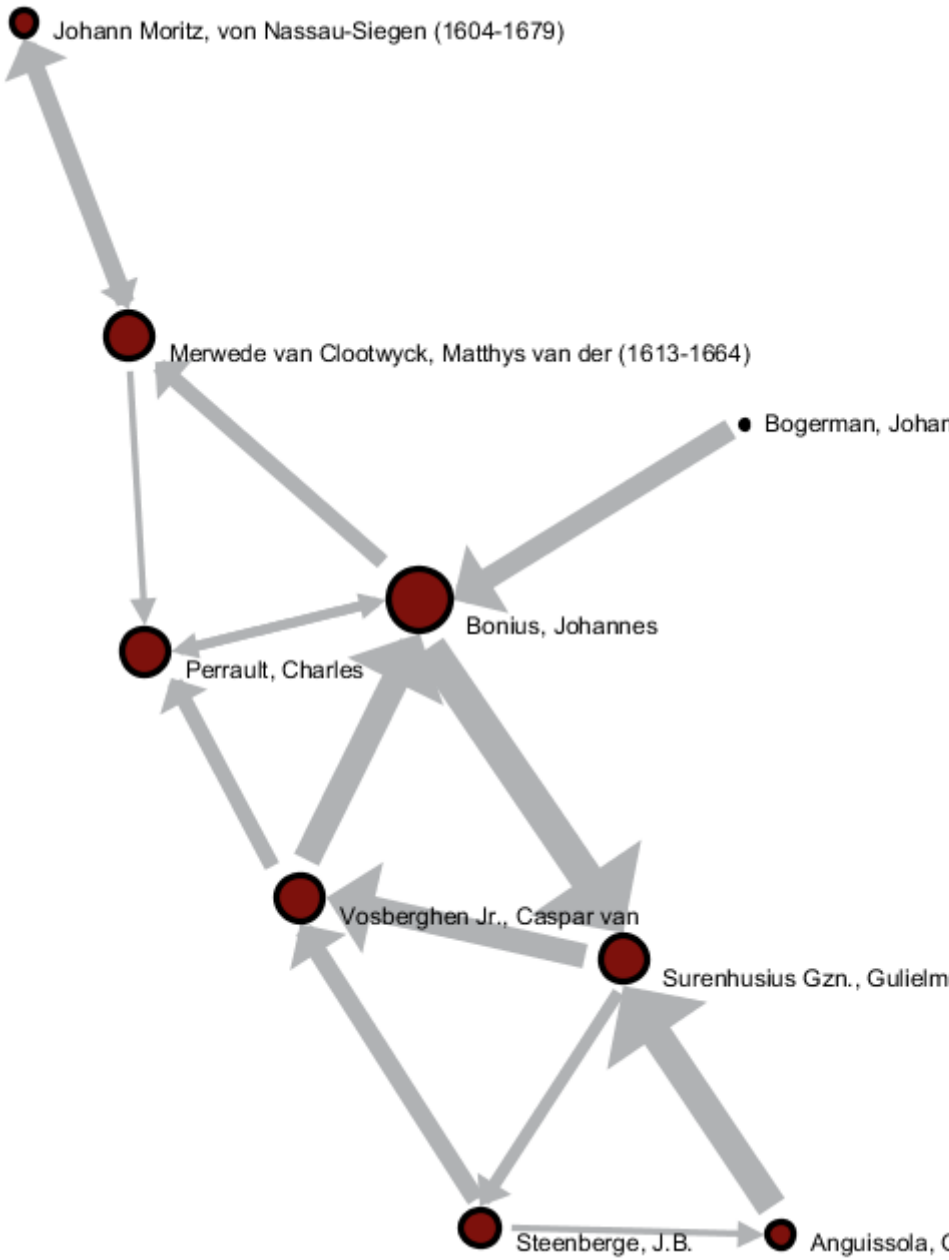
What is a network?

***Nodes**
id*int label*string totaldegree*int
16 "Merwede van Clootwyck, Matthys van der (1613-1664)" 1
36 "Perrault, Charles" 1
48 "Bonius, Johannes" 1
67 "Surenhusius Gzn., Gulielmus" 1
99 "Anguissola, Giacomo" 1
126 "Johann Moritz, von Nassau-Siegen (1604-1679)" 6
131 "Steenberge, J.B." 1
133 "Vosberghen Jr., Caspar van" 1
151 "Bogerman, Johannes (1576-1637)" 25
***DirectedEdges**
source*int target*int weight*float eyear*int syear*int
16 36 1 1640 1650
16 126 5 1641 1649
36 48 2 1630 1633
48 16 4 1637 1644
48 67 10 1645 1648
48 36 2 1632 1638
67 133 7 1644 1648
67 131 3 1642 1643
99 67 9 1640 1645
126 16 3 1641 1646
131 133 5 1630 1638
131 99 1 1637 1639
133 36 4 1645 1648
133 48 8 1632 1636
151 48 6 1644 1647



Graph Metrics – Nodes / Vertices / Entities

- Degree Centrality - direct connections
- Betweenness Centrality – # of shortest paths a node sits between
- Closeness Centrality – Distance to all nodes
- Hubs / Bridges / Isolates

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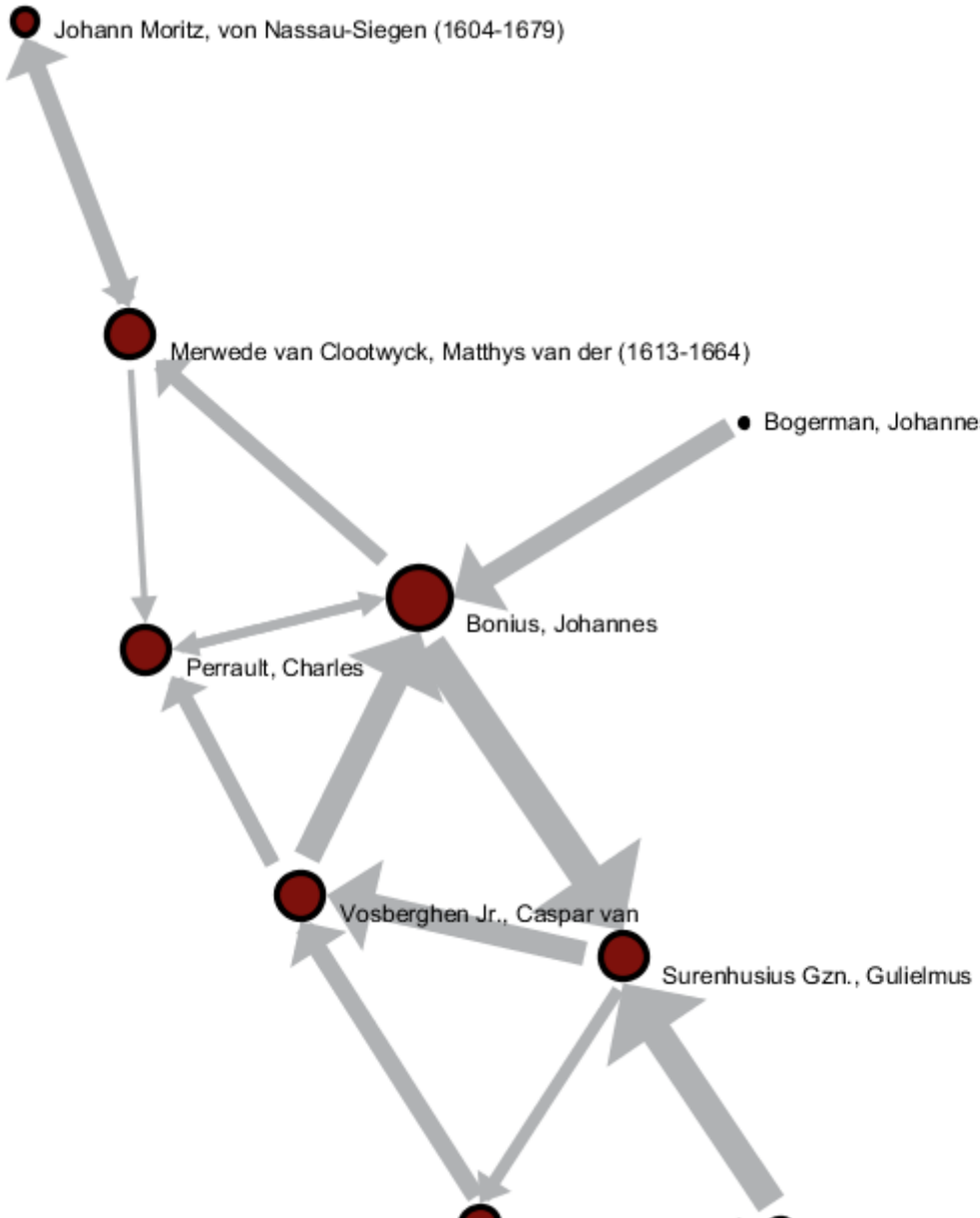

Graph Metrics – Edges / Links / Arcs / Connections / Ties

- Shortest paths – shortest distance between two nodes
- Weight – strength of tie
- Directionality – is the connection one or two-way?
- Bridge – deleting would change structure

Source: http://dh2011network.stanford.edu/index.html

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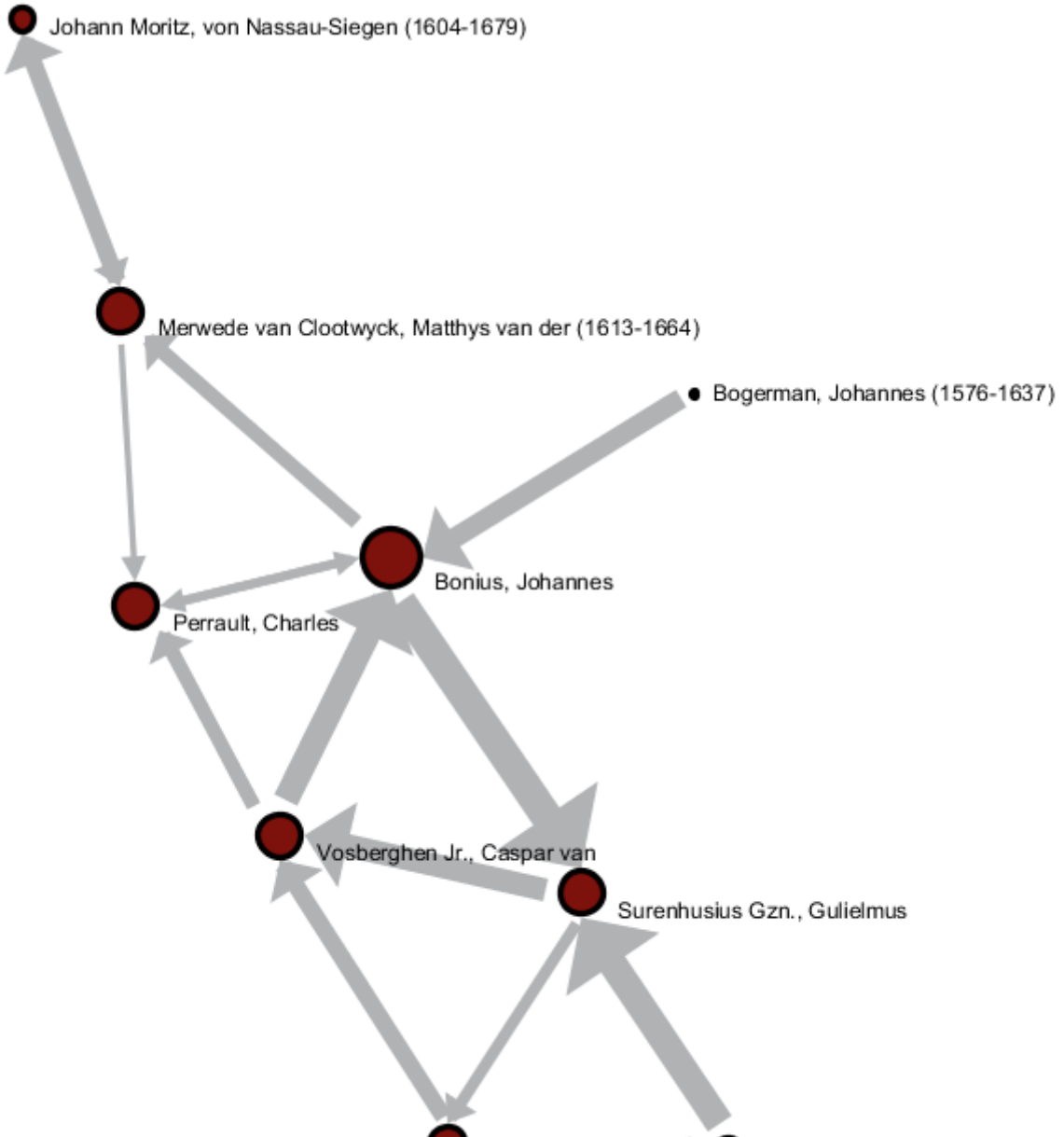

Graph Metrics – Structural

- Clusters – closely connected or similar nodes & edges
- Clustering coefficient – 'clique-ness'
- Centralization – egocentric or decentralized
- Density – 'spaghetti-ness'
- Average Path Length – wide or narrow

Source: http://dh2011network.stanford.edu/index.html

Graph Metrics – Structural

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- Density
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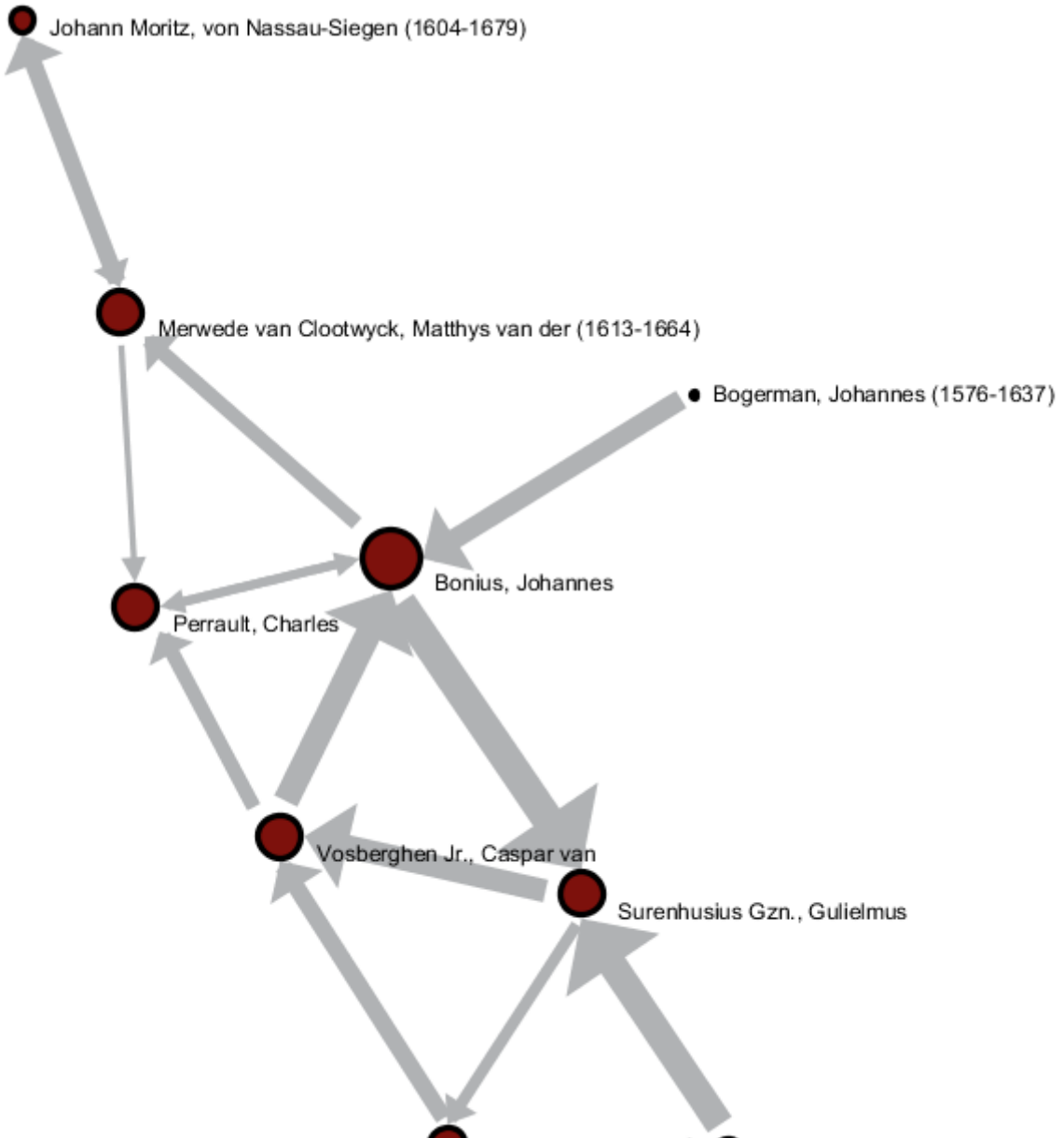

Graph Metrics – Types Of Networks

- Bi-Modal or Multi-Nodal
- Egocentric
- Dense/Sparse

Source: http://dh2011network.stanford.edu/index.html

Networks – Visualization

- Networks visualized as graphs
- Layouts
  - Force-based / Spring / GEM
  - Tree
  - Circular
- Distance Re-training

Source: http://dh2011network.stanford.edu/index.html

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Network Analysis & Visualization in the Humanities: Theory, Applications, and Pitfalls

Uses of Visualization

- Solidifies objects of inquiry
- Exploration
- Discovery
- Trend-spotting
- Evidence
- Audience Engagement
- Engaging public / funding agencies

The Importance of Visualization

[Visualization] aim at more than making the invisible visible. [It aspires] to all-at-once-ness, the condensation of laborious, step-by-step procedures in to an immediate *coup d'oeil*… What was a painstaking process of calculation and correlation—for example, in the construction of a table of variables—becomes a flash of intuition. And all-at-once intuition is traditionally the way that angels know, in contrast to the plodding demonstrations of humans.

Descartes's craving for angelic all-at-once-ness emerged forcefully in his mathematics…, compressing the steps of mathematical proof into a single bright flare of insight: "I see the whole thing at once, by intuition."

Lorraine Daston – On Scientific Observation

Warnings

[H]umanists have adopted many applications such as GIS mapping, graphs, and charts for statistical display that were developed in other disciplines… such graphical tools are a kind of intellectual Trojan horse…

Data pass themselves off as mere descriptions of a priori conditions. Rendering *observation* (the act of creating a statistical, empirical, or subjective account or image) as if it were *the same as the phenomena observed* collapses the critical distance between the phenomenal world and its interpretation, undoing the basis of interpretation on which humanistic knowledge production is based... we seem ready and eager to suspend critical judgment in a rush to visualization.

Johanna Drucker – Humanities Approaches to Graphical Display

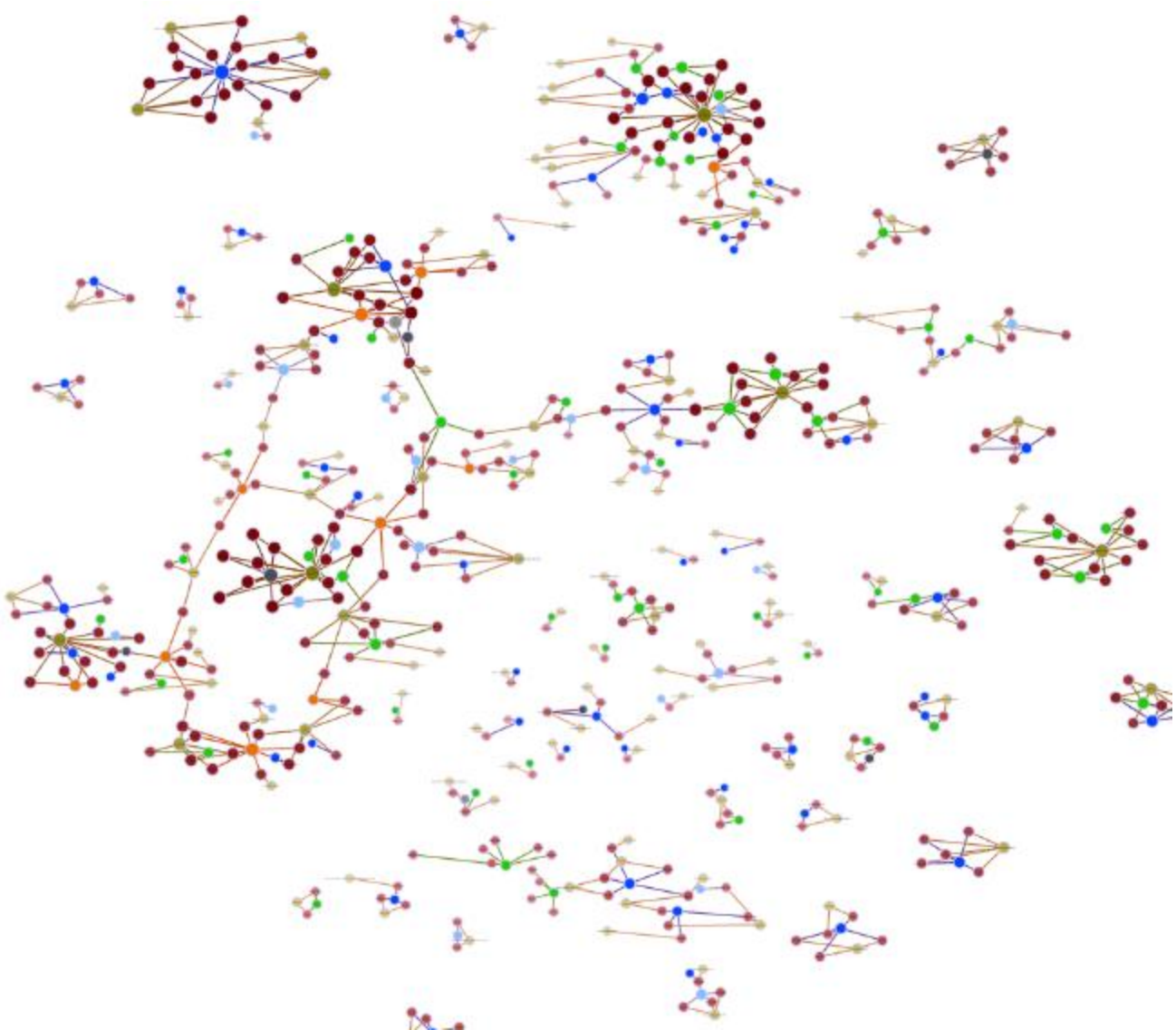
Warnings

- Data format limits use, already an act of interpretation.
- Statistics is often misused (wield it very carefully).
- Interpreting spatial distance as meaningful.
- Always include a legend (this presentation breaks that rule).
- Accidental legitimization in eyes of public.

Network Analysis & Visualization in the Humanities: Examples In The Wild

Digital Humanities 2011 – Elijah Meeks

http://dh2011network.stanford.edu/



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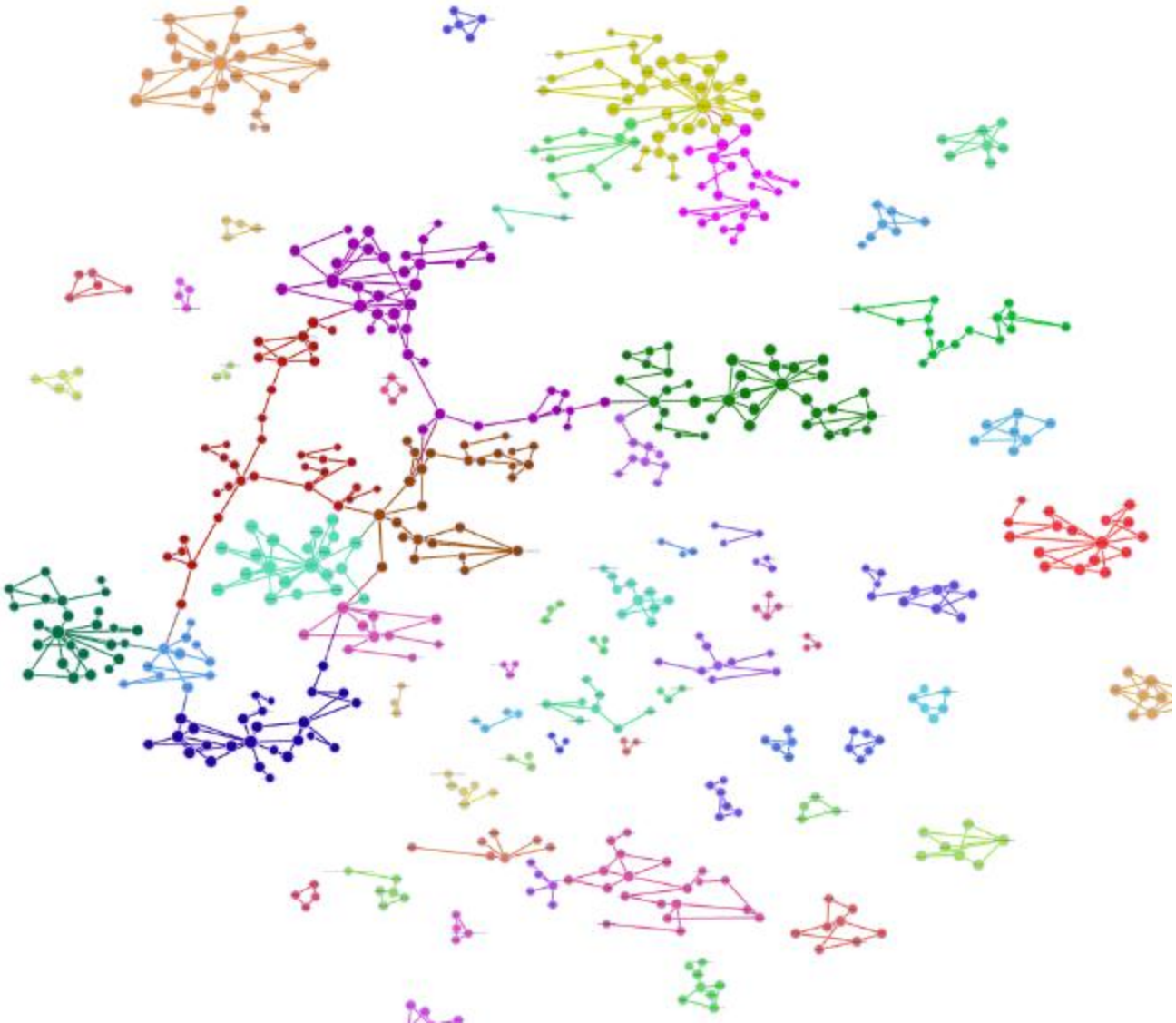

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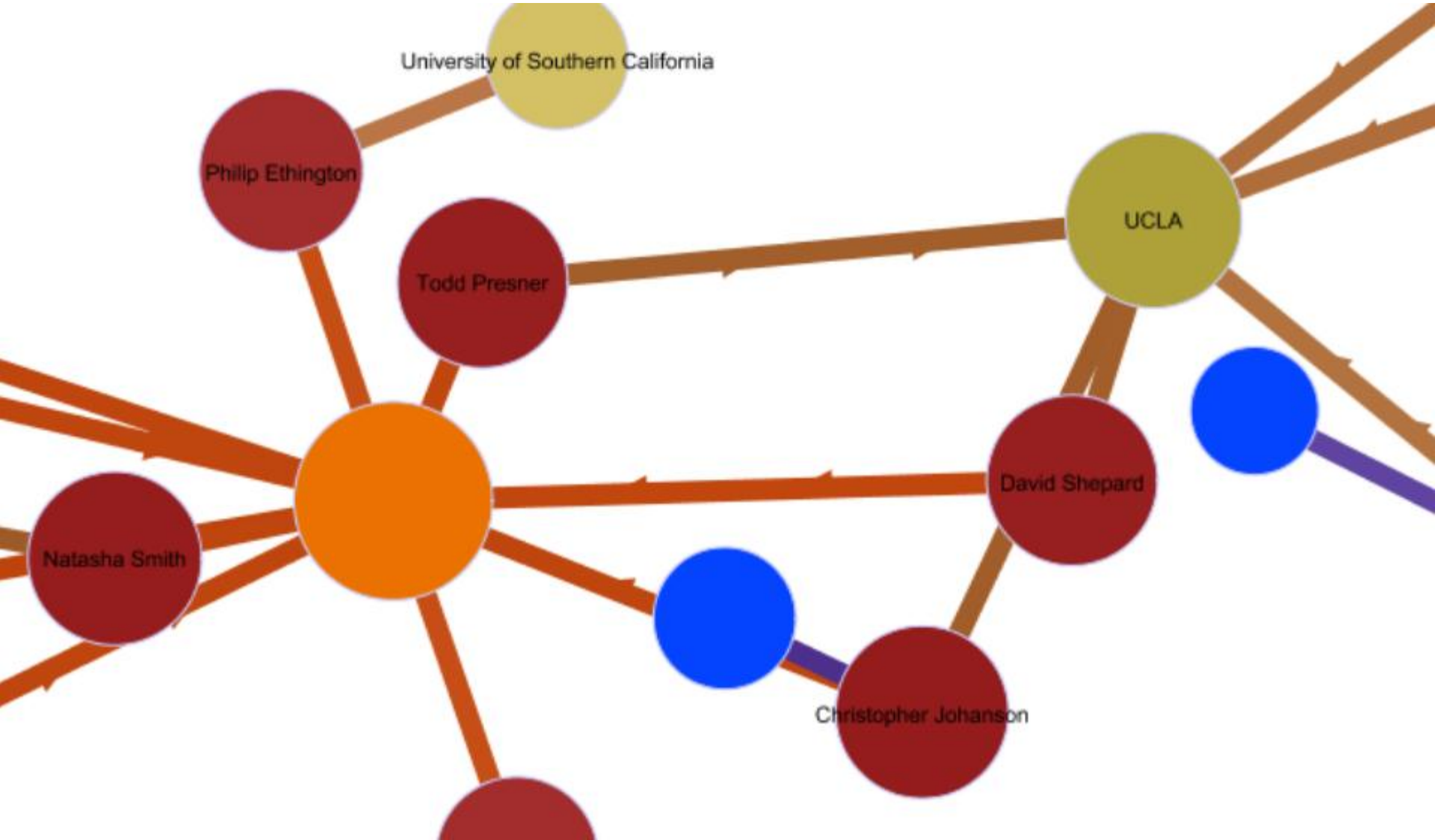


Digital Humanities 2011 – Elijah Meeks

http://dh2011network.stanford.edu/

- **General information**
- Nodes:621
- Edges:734

- **Metrics**
- Average degree:2.36

Digital Humanities 2011 – Elijah Meeks

http://dh2011network.stanford.edu/

Character Networks in the 19th Century British Novel

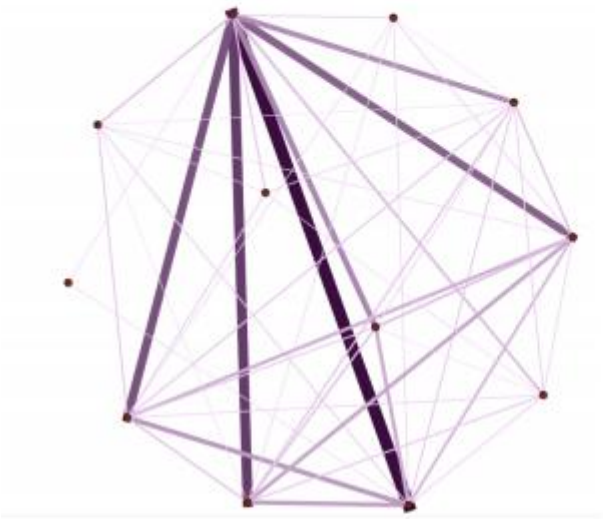
-Graham Sack

I use computational methods to count the frequency and co-occurrence of a generally ignored sub-class of common words, namely, character names. Character names are often regarded as noise and excluded from authorship and stylistics analysis because they are not consistent across texts. This study makes character names its main object of analysis because the objective is quite different: rather than style or authorship, this study attempts to make inferences about *characterization* and *social form*, two areas about which computational analysis has had comparatively little to say.

Character Network Sociograms

Figures 20 a, b, & C

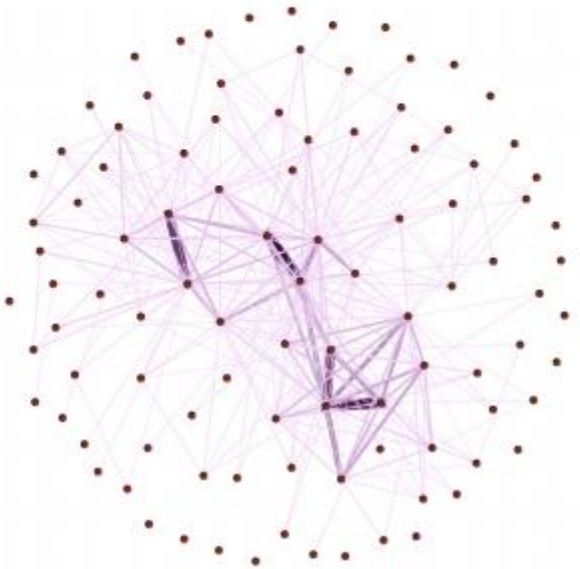
The Ambassadors (James)



General Features:
- Small network (12 characters)
- No isolates
- Very high graph density (71%) and clustering coefficient (85%)
- Low average path length (1.3)
- Low degree inequality (-4.9)
- High proportion of strong ties (28%)

Conclusions
- Tightly knit social world focused on deep relationships between small set of characters
- Social interaction broadly evenly distributed

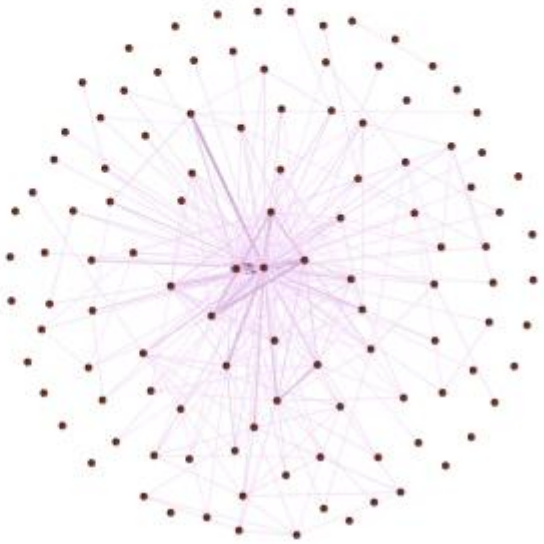
Middlemarch (Eliot))



General Features:
- Large network (99 characters)
- Moderately high % of isolates (17%)
- Low graph density (7%) and clustering coefficient 73%)
- High average path length (2.4)
- Moderate degree inequality (1.9)
- Moderate proportion of strong ties (18%)

Conclusions
- Large but comparatively integrated social world with deep interaction between core characters

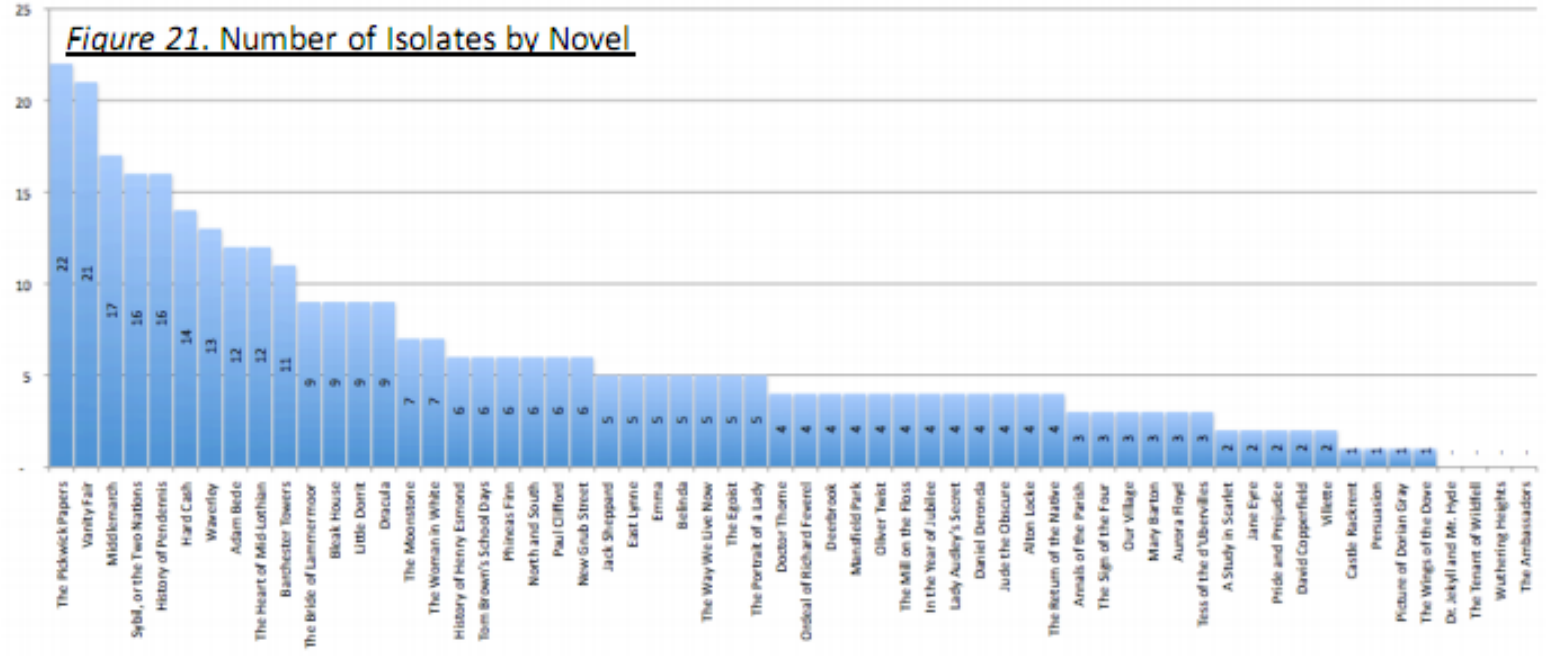
The Pickwick Papers (Dickens)

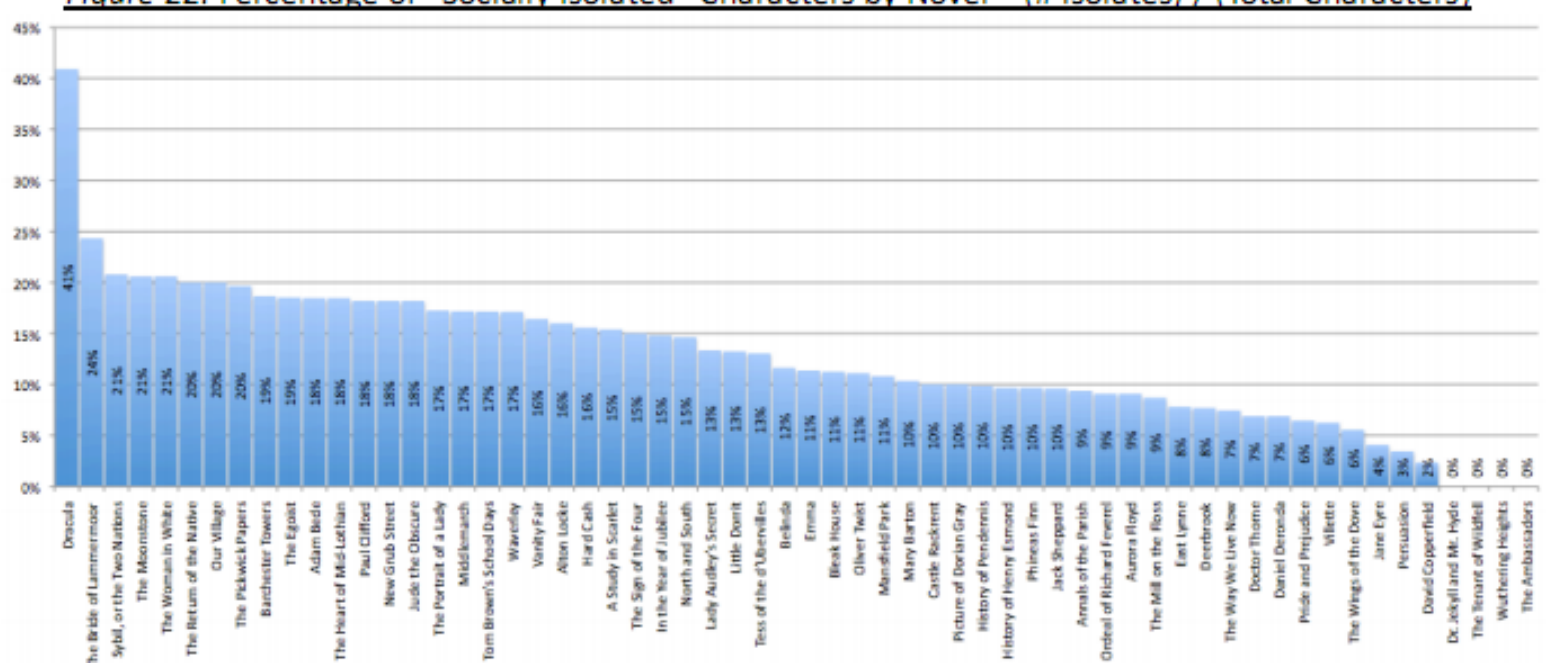


General Features:
- Large network (112 characters)
- High proportion of isolates (20%)
- Very low graph density (4%) and clustering coefficient (72%)
- High average path length (2.2)
- High degree inequality (3.0)
- Low proportion of strong ties (13%)

Conclusions
- Expansive but diffuse social world with passing social interactions and many isolated characters

Social Metrics – By Novel (1/3)





Character Networks in the 19th Century British Novel

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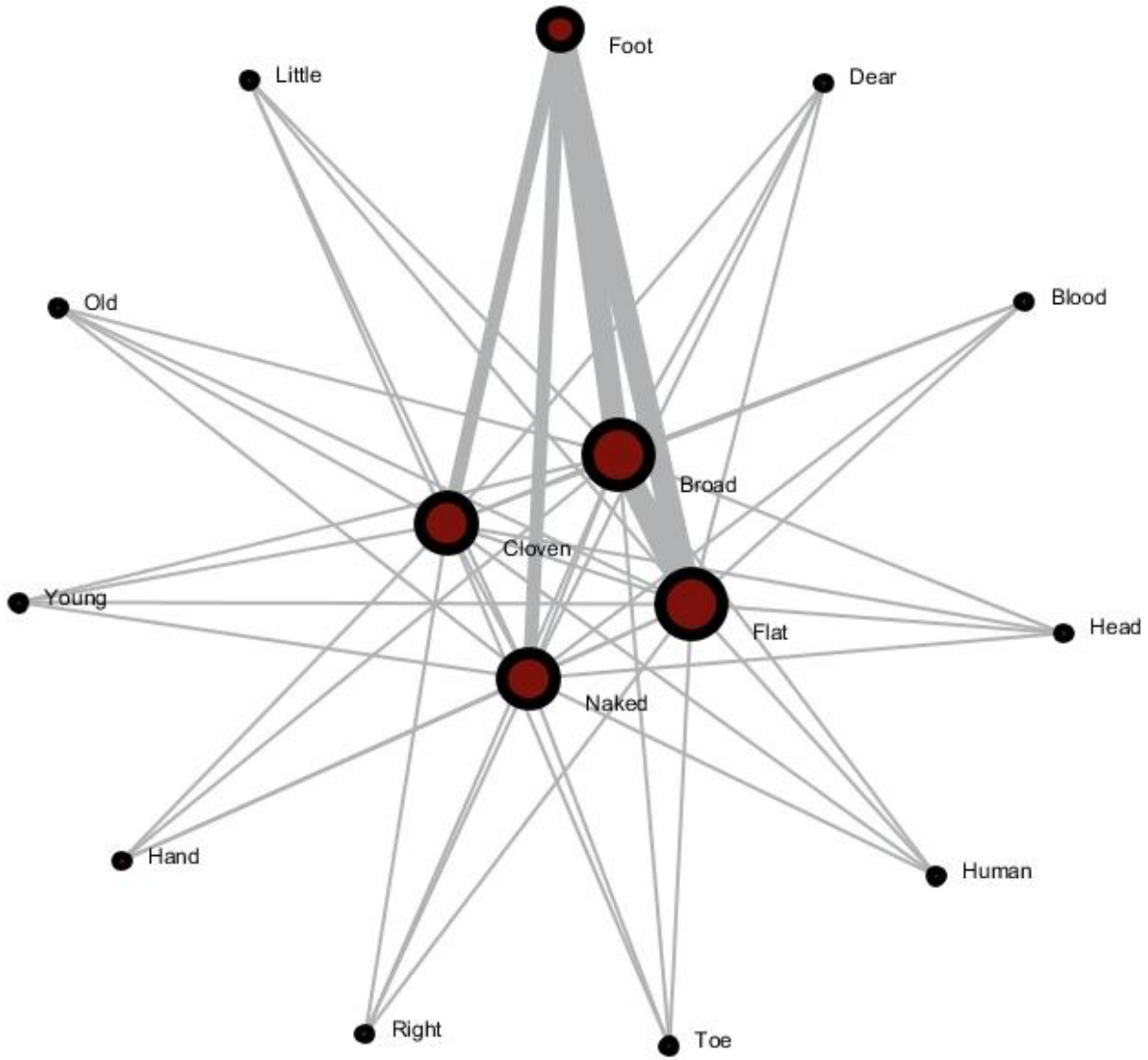
Word Co-Occurrences in European Fairytales
-Jorgensen & Weingart



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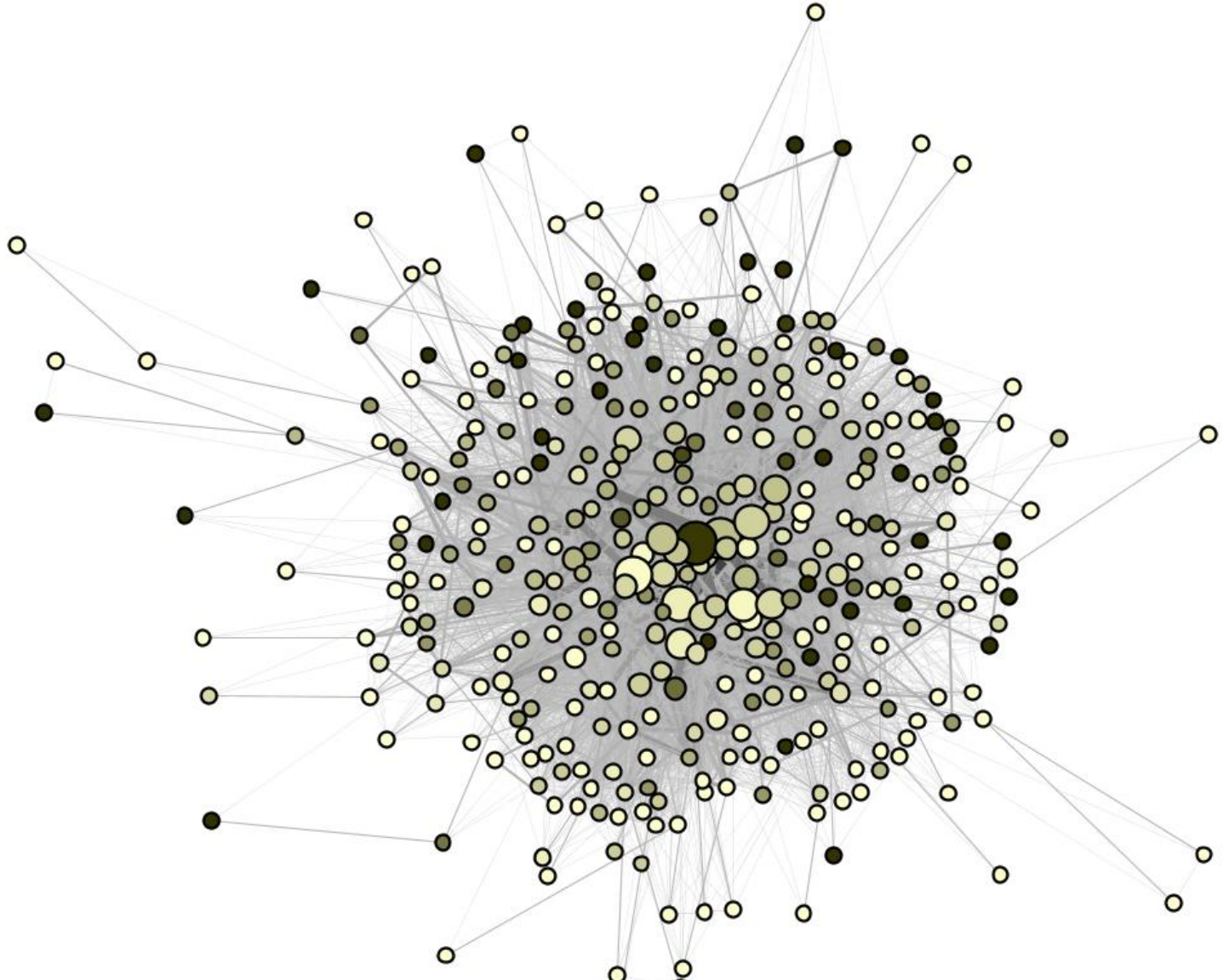

Mapping the Republic of Letters – Chang et al.

https://republicofletters.stanford.edu/#maps

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Collecting, Cleaning & Formatting Data

Data Collection

- 65% collecting, 25% cleaning, 5% formatting, 5% analysis.
- Keep analysis in mind before first data collected
- Remember not just current use but future use as well; nobody wants to do the same work five times.
- Make sure system for data entry is easy, transferrable, and as granular as possible.

Data Cleaning & Validation

- Multiple coders? Undergraduates? Check for intercoder reliability. Understand biases going in.
- Microsoft Excel is your friend (ubiquitous, easy).
- Consistency in word use and coding.
- Sanity checks at the extremes – order by size, etc.
- Check against existing databases if available.
- Make sure basic statistics make sense.

File-types

- Excel
- Database
- Text
- CSV

Network Formats

	Newton	Oldenburg	Flamsteed
Newton	0	13	38
Oldenburg	24	0	45
Flamsteed	62	7	0

- **Matrix**
- **Adjacency List**
- **Node & Edge List**

Newton	Oldenburg	13
Newton	Flamsteed	38
Oldenburg	Newton	24
Oldenburg	Flamsteed	45
Flamsteed	Newton	62
Flamsteed	Oldenburg	7

Nodes		
1	Newton	
2	Oldenburg	
3	Flamsteed	
Edges		
1	2	13
1	3	38
2	1	24
2	3	45
3	1	62
3	2	7

NWB Format

***Nodes**
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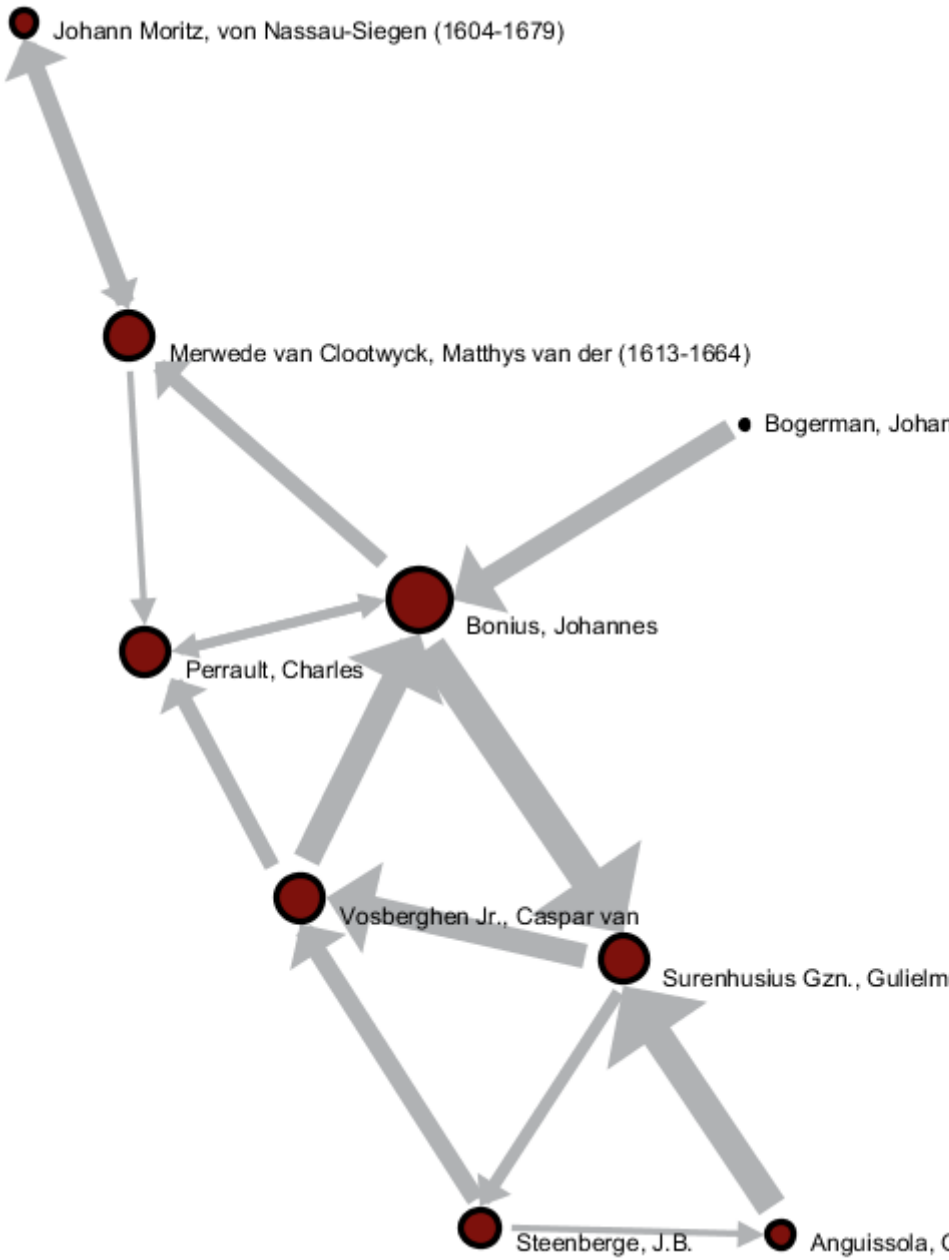

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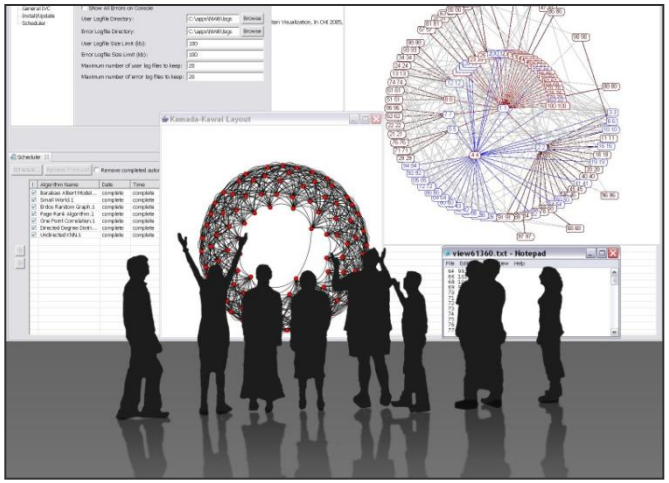
Sci2 Tool Basics:
Macroscope Design and Usage

Microscopes, Telescopes, and Macrocopes



Just as the **microscope** empowered our naked eyes to see cells, microbes, and viruses thereby advancing the progress of biology and medicine or the **telescope** opened our minds to the immensity of the cosmos and has prepared mankind for the conquest of space, **macroscopes** promise to help us cope with another infinite: the infinitely complex. Macroscopes give us a 'vision of the whole' and help us 'synthesize'. They let us detect patterns, trends, outliers, and access details in the landscape of science. Instead of making things larger or smaller, macroscopes let us observe what is at once too great, too slow, or too complex for our eyes.

Desirable Features of Macroscopes

Core Architecture & Plugins/Division of Labor: Computer scientists need to design the standardized, modular, easy to maintain and extend "core architecture". Dataset and algorithm plugins, i.e., the "filling", are provided by those that care and know most about the data and developed the algorithms: the domain experts.

Ease of Use: As most plugin contributions and usage will come from non-computer scientists it must be possible to contribute, share, and use new plugins without writing one line of code. Users need guidance for constructing effective workflows from 100+ continuously changing plugins.

Modularity: The design of software modules with well defined functionality that can be flexibly combined helps reduce costs, makes it possible to have many contribute, and increases flexibility in tool development, augmentation, and customization.

Standardization: Adoption of (industry) standards speeds up development as existing code can be leveraged. It helps pool resources, supports interoperability, but also eases the migration from research code to production code and hence the transfer of research results into industry applications and products.

Open Data and Open Code: Lets anybody check, improve, or repurpose code and eases the replication of scientific studies.

Macroscopes are similar to Flickr and YouTube and but instead of sharing images or videos, you freely share datasets and algorithms with scholars around the globe.

Börner, Katy (in press) Plug-and-Play Macroscopes. Communications of the ACM.

Macroscope Design

Custom Tools for Different Scientific Communities

Information Visualization Cyberinfrastructure

http://iv.slis.indiana.edu

Network Workbench Tool + Community Wiki

http://nwb.slis.indiana.edu

Science of Science (Sci²) Tool and Portal

http://sci.slis.indiana.edu

Epidemics Cyberinfrastructure

http://epic.slis.indiana.edu/

180+ Algorithm Plugins and Branded GUIs

+

Core Architecture

Open Services Gateway Initiative (OSGi) Framework.

http://orgi.org

Cyberinfrastructure Shell (CIShell)

http://cishell.org

CIShell Powered Tools:
Network Workbench (NWB)

Network Workbench Tool

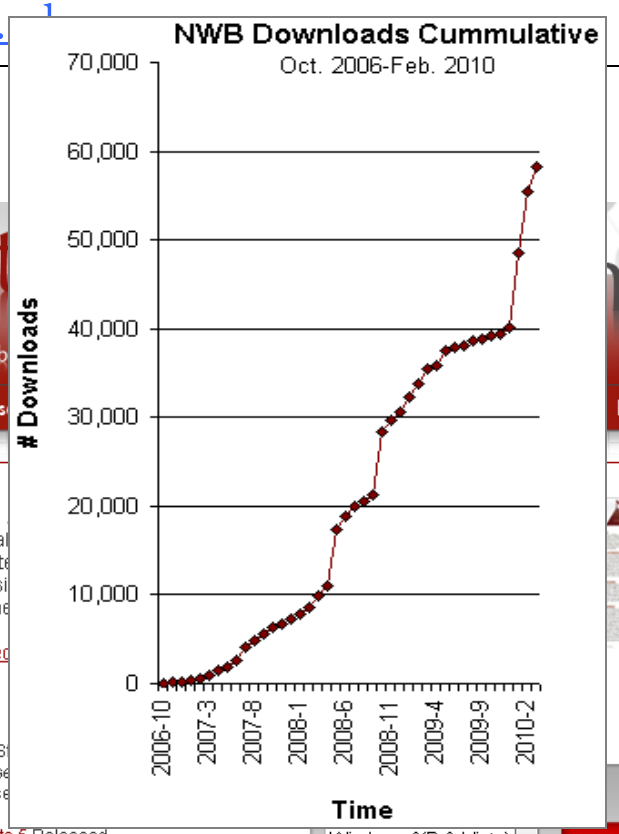
http://nwb.slis.indiana.

The Network Workbench (NWB) tool supports researchers, educators, and practitioners interested in the study of biomedical, social and behavioral science, physics, and other networks.

In February 2009, the tool provides more 169 plugins that support the preprocessing, analysis, modeling, and visualization of networks.

More than 50 of these plugins can be applied or were specifically designed for S&T studies.

It has been downloaded more than 65,000 times since December 2006.



Börner, Katy, Huang, Weixia (Bonnie), Linnemeier, Micah, Duhon, Russell Jackson, Phillips, Patrick, Ma, Nianli, Zoss, Angela, Guo, Hanning & Price, Mark. (2010). Rete-Netzwerk-Red: Analyzing and Visualizing Scholarly Networks Using the Network Workbench Tool. Scientometrics. Vol. 83(3), 863-876.

Project Details

Investigators: Katy Börner, Albert-Laszlo Barabasi, Santiago Schnell, Alessandro Vespignani & Stanley Wasserman, Eric Wernert

Software Team: Lead: Micah Linnemeier

Members: Patrick Phillips, Russell Duhon, Tim Kelley & Ann McCranie

Previous Developers: Weixia (Bonnie) Huang, Bruce Herr, Heng Zhang, Duygu Balcan, Bryan Hook, Ben Markines, Santo Fortunato, Felix Terkhorn, Ramya Sabbineni, Vivek S. Thakre & Cesar Hidalgo

Goal: Develop a large-scale network analysis, modeling and visualization toolkit for physics, biomedical, and social science research.

Amount: $1,120,926, NSF IIS-0513650 award

Duration: Sept. 2005 - Aug. 2009

Website: http://nwb.slis.indiana.edu

Project Details (cont.)

NWB Advisory Board:

James Hendler (Semantic Web) http://www.cs.umd.edu/~hendler/

Jason Leigh (CI) http://www.evl.uic.edu/spiff/

Neo Martinez (Biology) http://online.sfsu.edu/~webhead/

Michael Macy, Cornell University (Sociology) http://www.soc.cornell.edu/faculty/macy.shtml

Ulrik Brandes (Graph Theory) http://www.inf.uni-konstanz.de/~brandes/

Mark Gerstein, Yale University (Bioinformatics) http://bioinfo.mbb.yale.edu/

Stephen North (AT&T) http://public.research.att.com/viewPage.cfm?PageID=81

Tom Snijders, University of Groningen http://stat.gamma.rug.nl/snijders/

Noshir Contractor, Northwestern University http://www.spcomm.uiuc.edu/nosh/

Computational Proteomics

What relationships exist between protein targets of all drugs and all disease-gene products in the human protein–protein interaction network?

Yildrüm, Muhammed A., Kwan-II Goh, Michael E. Cusick, Albert-László Barabási, and Marc Vidal. (2007). Drug-target Network. Nature Biotechnology 25 no. 10: 1119-1126.

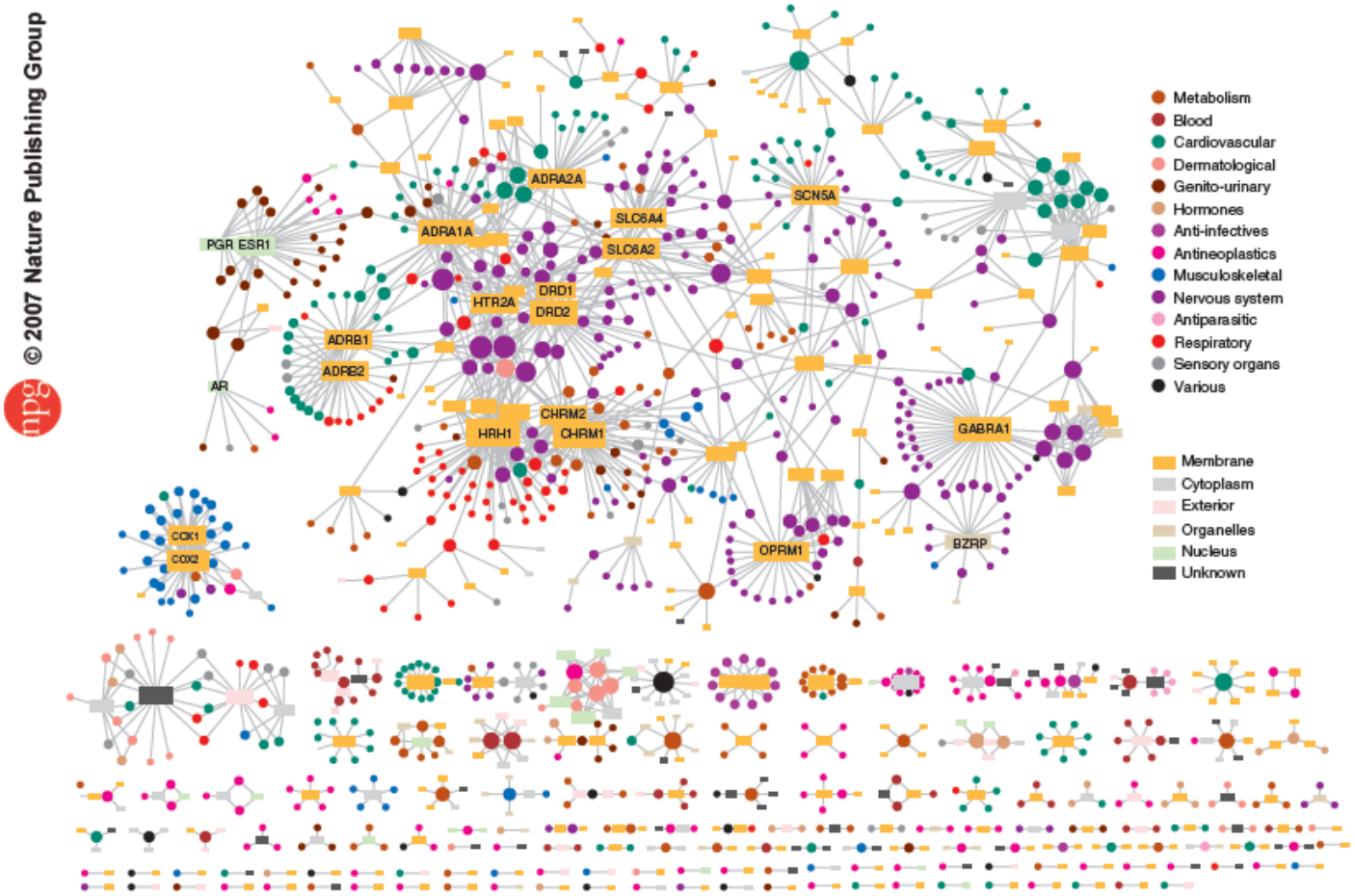


Figure 2 Drug–target network (DT network). The DT network is generated by using the known associations between FDA-approved drugs and their target proteins. Circles and rectangles correspond to drugs and target proteins, respectively. A link is placed between a drug node and a target node if the protein is a known target of that drug. The area of the drug (protein) node is proportional to the number of targets that the drug has (the number of drugs targeting the protein). Color codes are given in the legend. Drug nodes (circles) are colored according to their Anatomical Therapeutic Chemical Classification, and the target proteins (rectangular boxes) are colored according to their cellular component obtained from the Gene Ontology database.

Computational Economics

Does the type of product that a country exports matter for subsequent economic performance?

C. A. Hidalgo, B. Klinger, A.-L. Barabási, R. Hausmann (2007) The Product Space Conditions the Development of Nations. Science 317, 482 (2007).

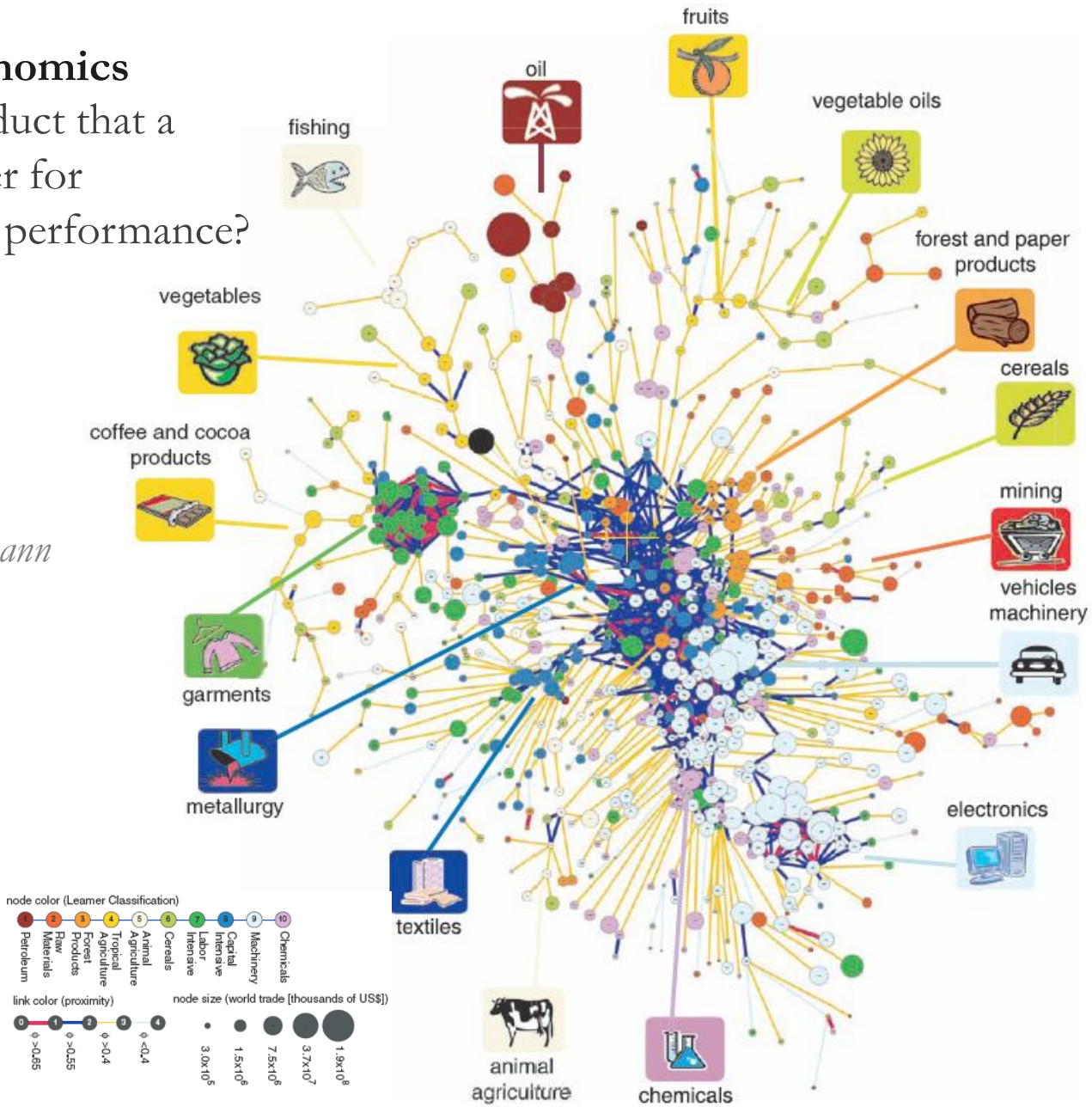


Fig. 1. The product space. (**A**) Hierarchically clustered proximity (ϕ) matrix representing the 775 SITC-4 product classes exported in the 1998–2000 period. (**B**) Network representation of the product space. Links are color coded with their proximity value. The sizes of the nodes are proportional to world trade, and their colors are chosen according to the classification introduced by Leamer.

Computational Social Science
Studying large scale social networks such as Wikipedia

Second Sight: An Emergent Mosaic of Wikipedian Activity,
The NewScientist, May 19, 2007

Second sight

Image: Bruce W. Herr and Todd M. Holloway

Power struggle

How do you keep track of the bubbling mass of information that is Wikipedia? This chaotic-looking mosaic is one attempt to show which topics are

pages at the time of writing include entries on Sheffield Wednesday football club, Mikhail Gorbachev and pigs).

The mosaic has been commended in a competition for images that visualise network dynamics, coinciding with this week's International Workshop and Conference on Network Science in Bloomington.

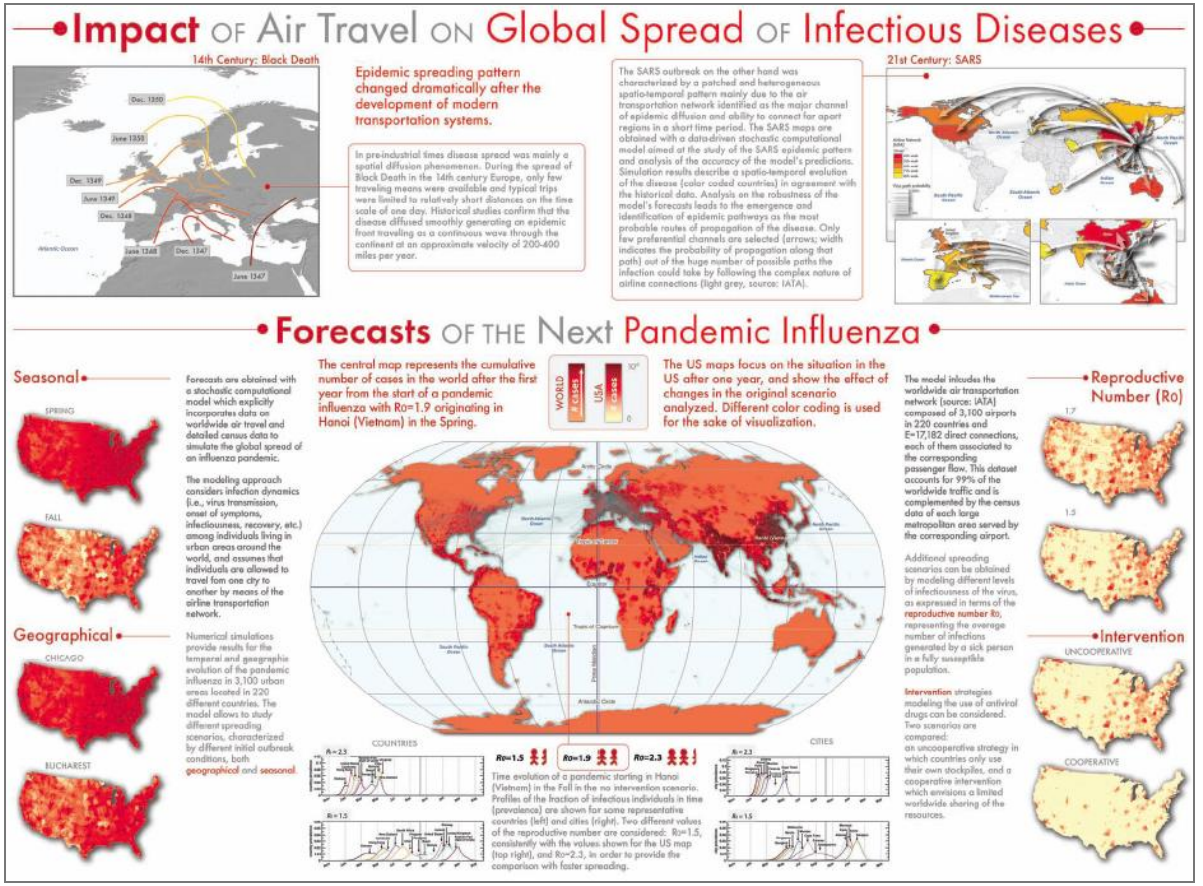
Computational Epidemics

Forecasting (and preventing the effects of) the next pandemic.

Epidemic Modeling in Complex realities, V. Colizza, A. Barrat, M. Barthelemy, A.Vespignani, Comptes Rendus Biologie, 330, 364-374 (2007).

Reaction-diffusion processes and metapopulation models in heterogeneous networks, V.Colizza, R. Pastor-Satorras, A.Vespignani, Nature Physics 3, 276-282 (2007).

Modeling the Worldwide Spread of Pandemic Influenza: Baseline Case and Containment Interventions, V. Colizza, A. Barrat, M. Barthelemy, A.-J. Valleron, A.Vespignani, PloS-Medicine 4, e13, 95-110 (2007).



NWB Tool Download, Install, and Run

NWB Tool 1.0.0

Can be freely downloaded for all major operating systems from http://nwb.slis.indiana.edu

Select your operating system from the pull down menu and download.

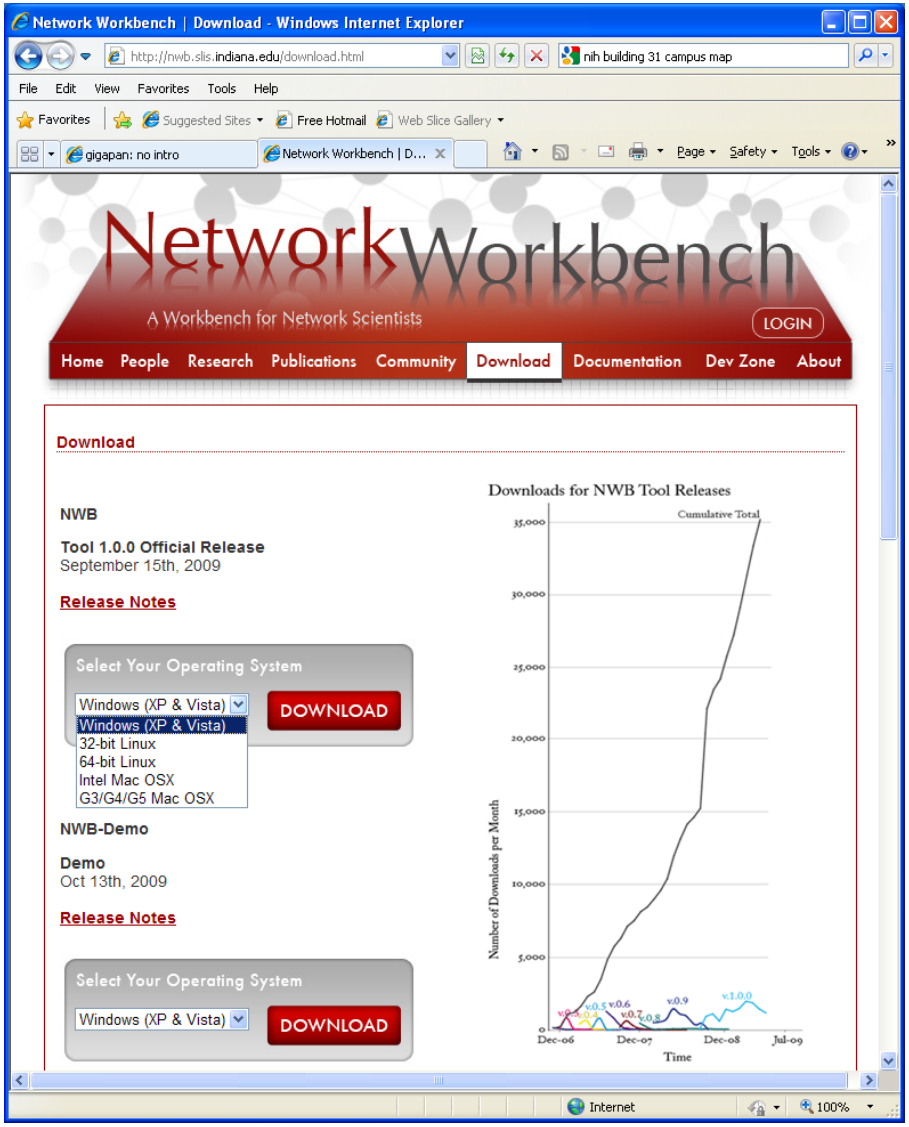
Unpack into a /nwb directory.

Run /nwb/nwb.exe

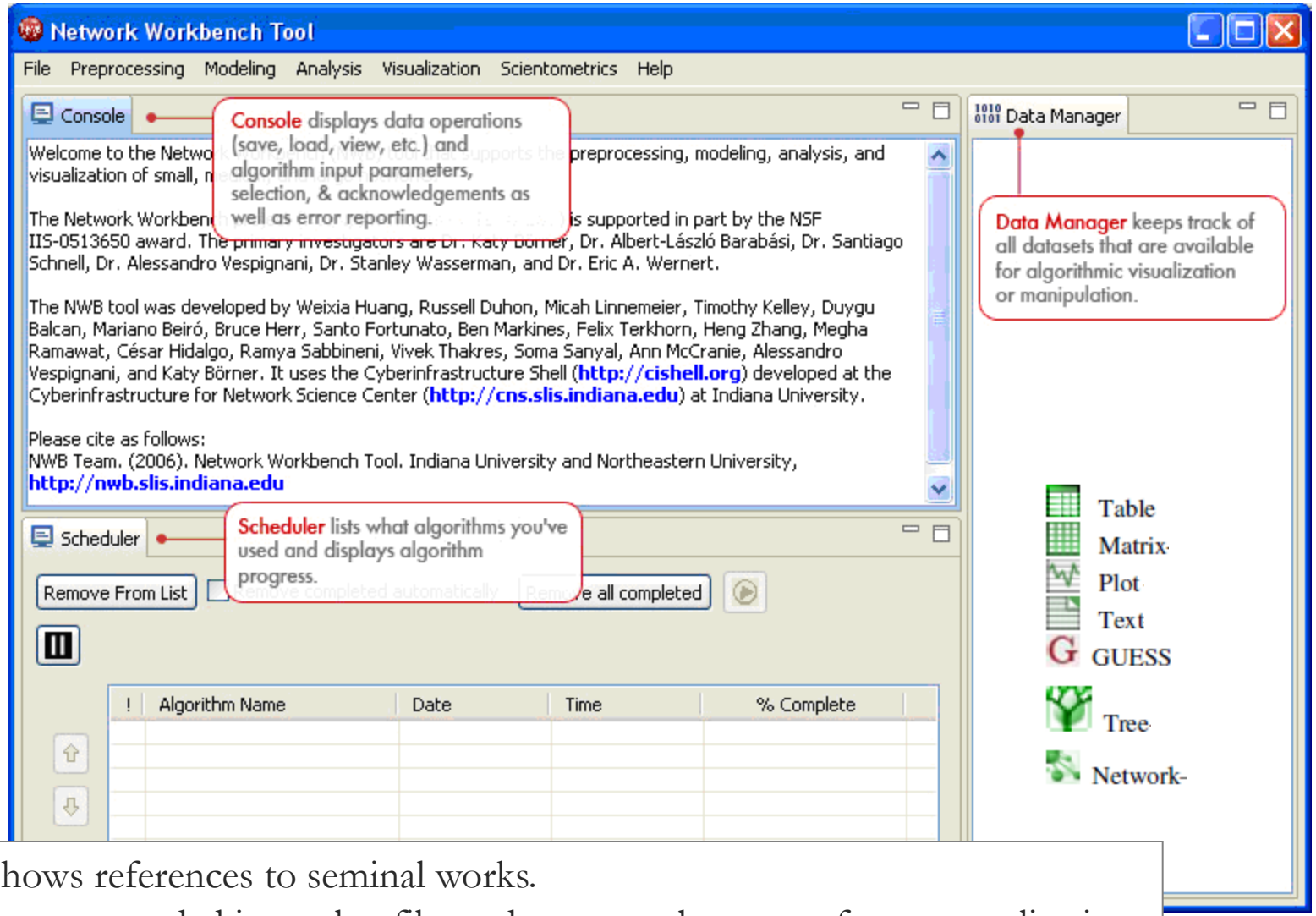
Session log files are stored in '**yournwbdirectory*/logs*' directory.

Cite as

NWB Team. (2006). Network Workbench Tool. Indiana University, Northeastern University, and University of Michigan, http://nwb.slis.indiana.edu.

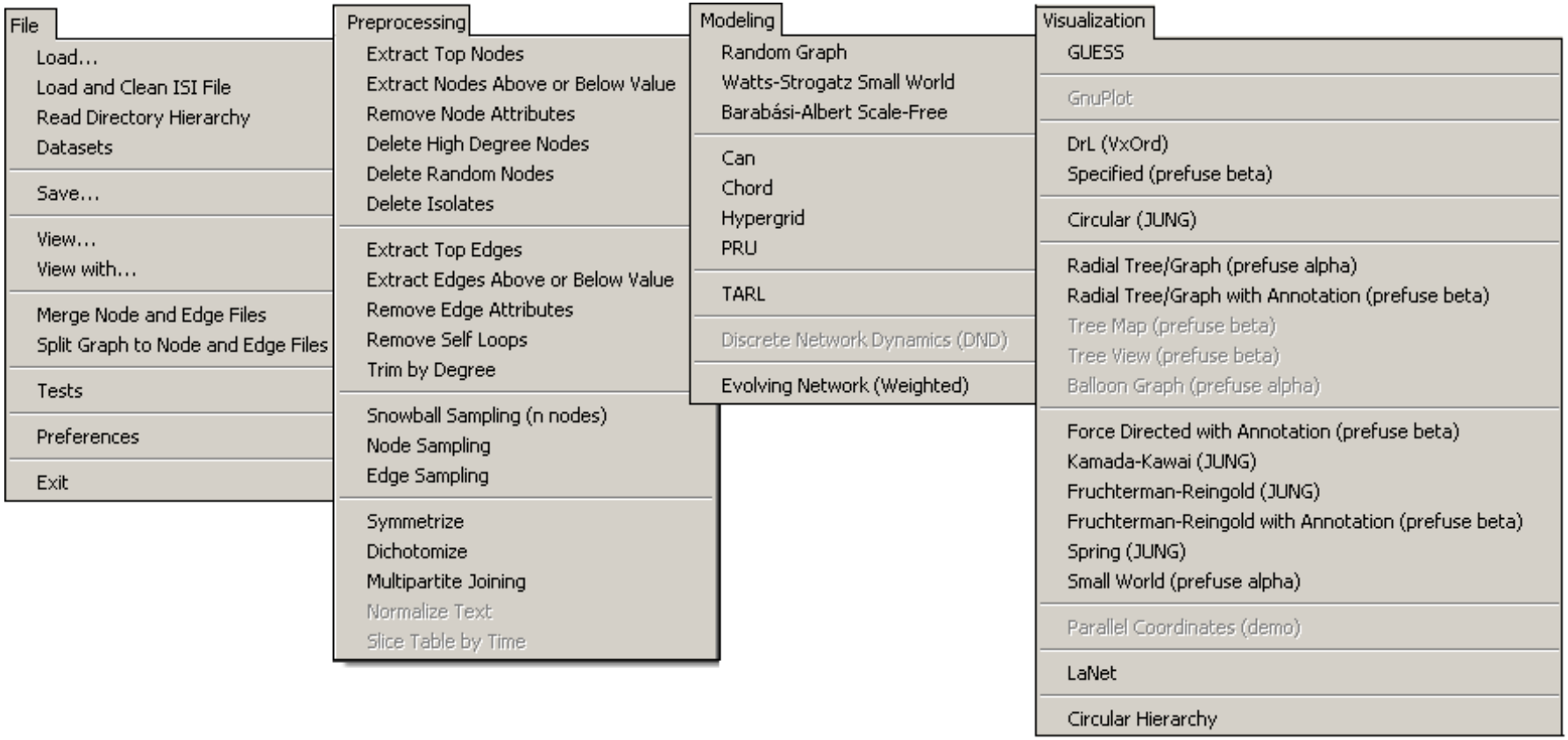


NWB Tool Interface Components



Console shows references to seminal works.
Workflows are recorded into a log file, and soon can be re-run for easy replication.
All algorithms are documented online; workflows are given in tutorials.

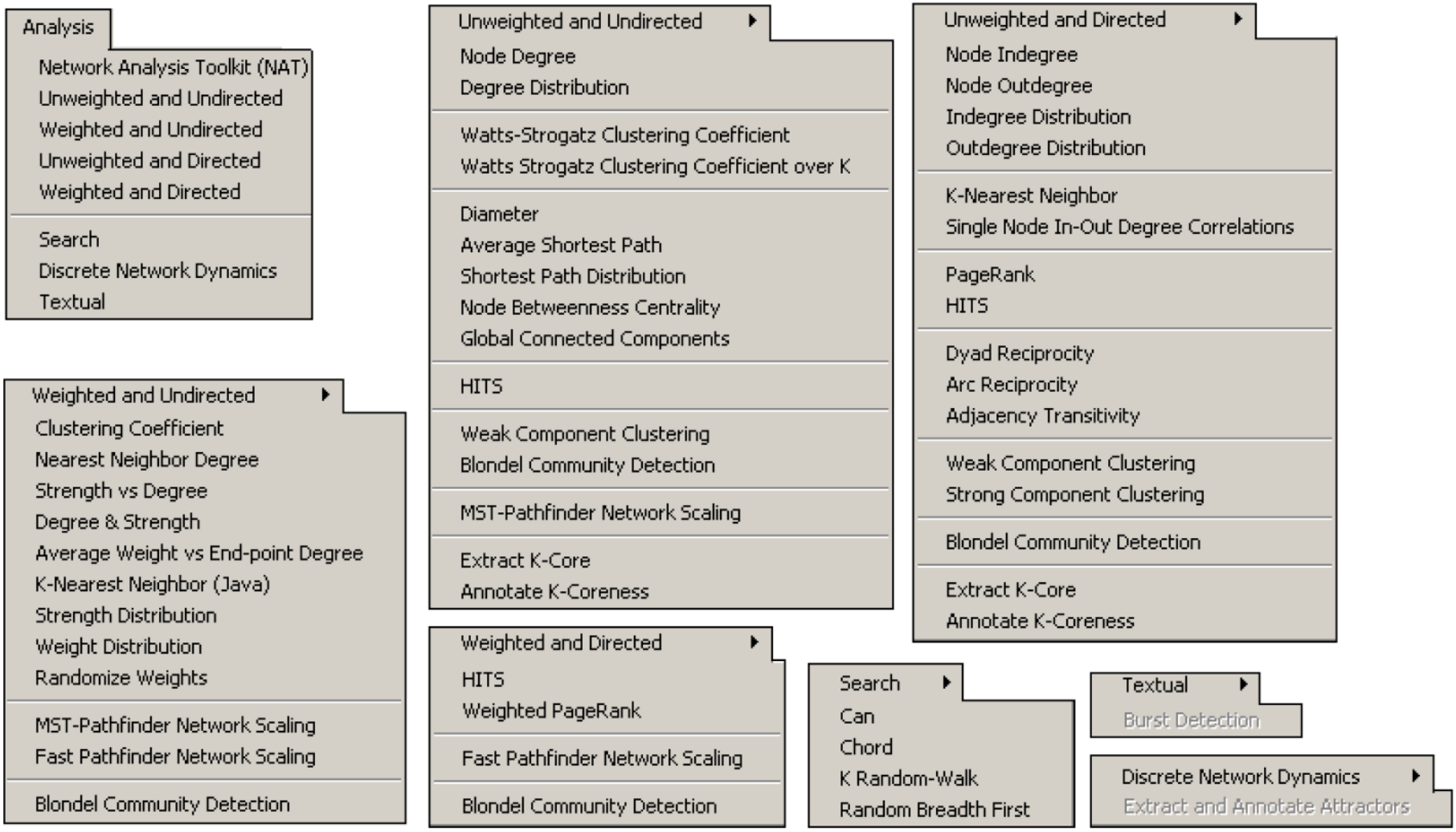
File, Preprocessing, Modeling, and Visualization Menus



Börner, Katy, Sanyal, Soma and Vespignani, Alessandro (2007). **Network Science.** In Blaise Cronin (Ed.), *ARIST*, Information Today, Inc./American Society for Information Science and Technology, Medford, NJ, Volume 41, Chapter 12, pp. 537-607.

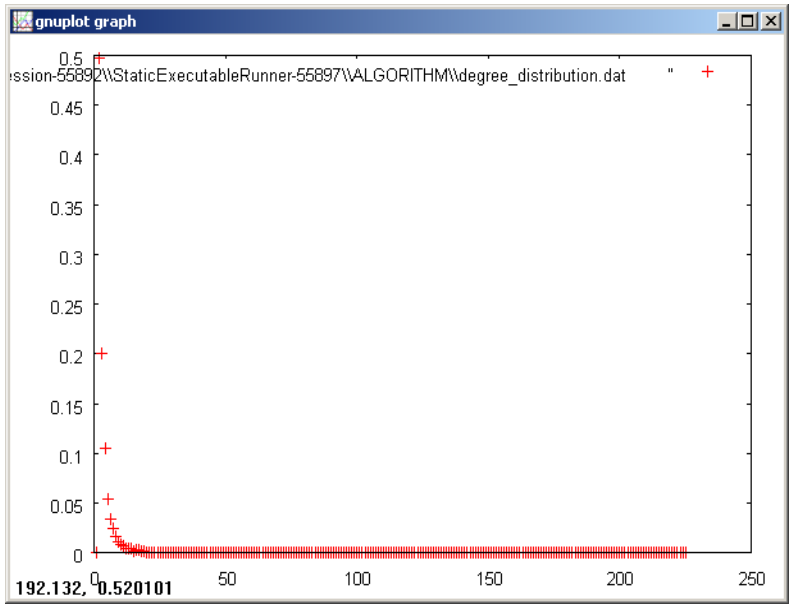
http://ivl.slis.indiana.edu/km/pub/2007-borner-arist.pdf

Analysis Menu and Submenus



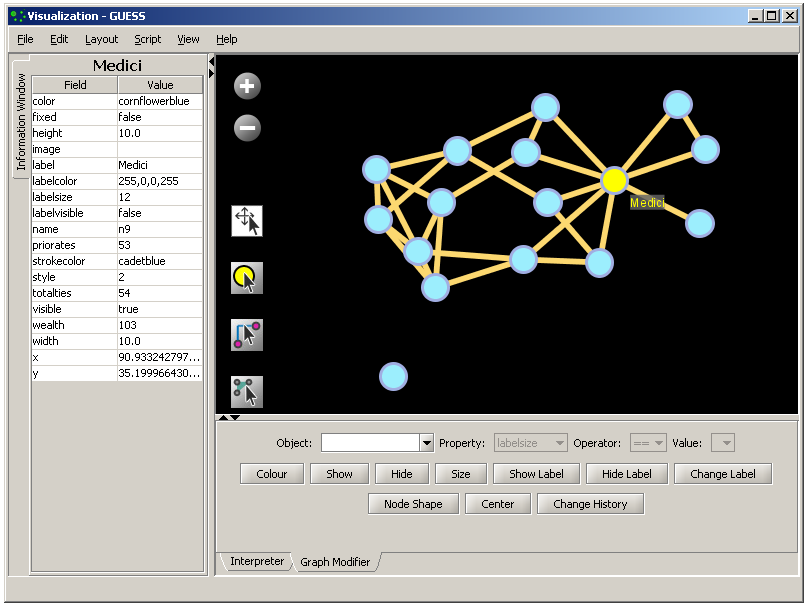
Börner, Katy, Sanyal, Soma and Vespignani, Alessandro (2007). **Network Science.** In Blaise Cronin (Ed.), *ARIST*, Information Today, Inc./American Society for Information Science and Technology, Medford, NJ, Volume 41, Chapter 12, pp. 537-607. http://ivl.slis.indiana.edu/km/pub/2007-borner-arist.pdf

Integrated Tools



Gnuplot

portable command-line driven interactive data and function plotting utility http://www.gnuplot.info/.



GUESS

exploratory data analysis and visualization tool for graphs and networks.

https://nwb.slis.indiana.edu/community/?n=VisualizeData.GUESS.

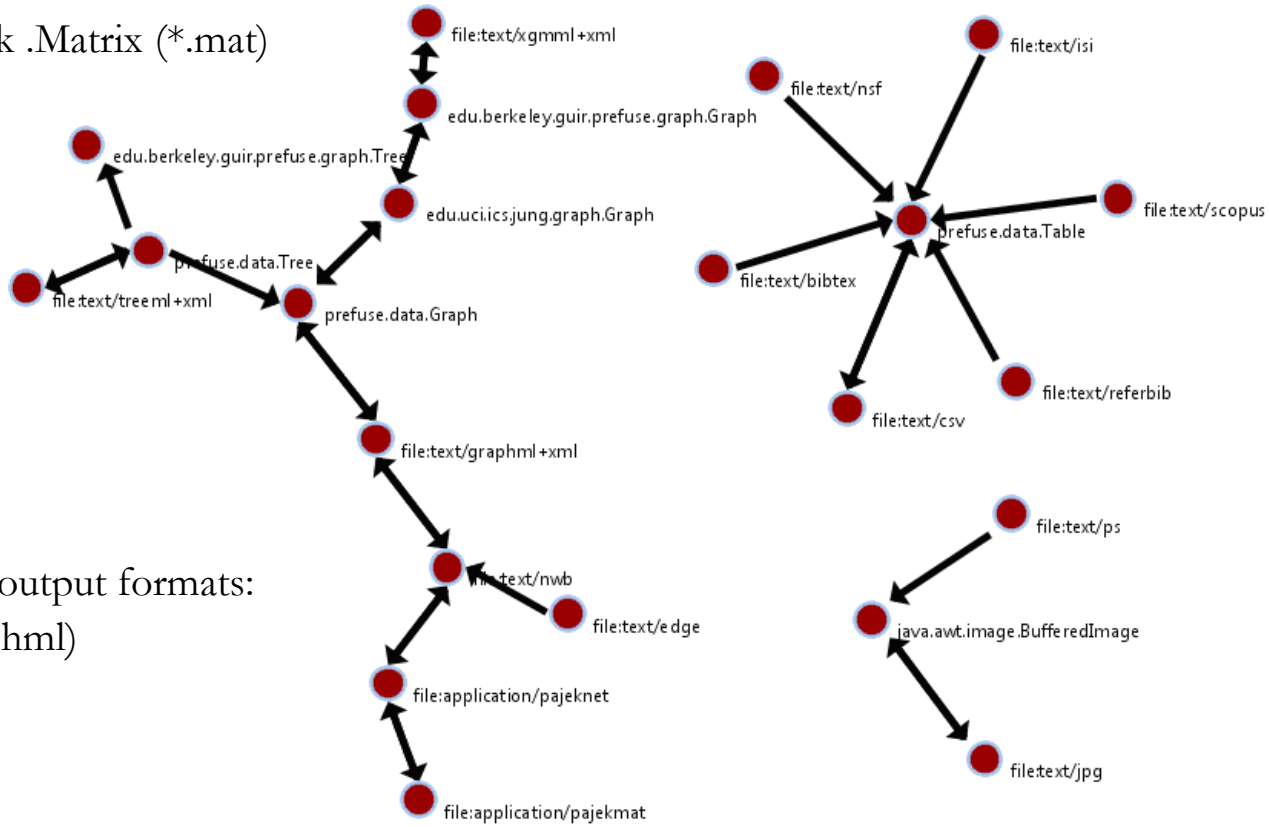
Supported Data Formats

The NWB tool supports loading the following input file formats:

- GraphML (*.xml or *.graphml)
- XGMML (*.xml)
- Pajek .NET (*.net) & Pajek .Matrix (*.mat)
- NWB (*.nwb)
- TreeML (*.xml)
- Edge list (*.edge)
- CSV (*.csv)
- ISI (*.isi)
- Scopus (*.scopus)
- NSF (*.nsf)
- Bibtex (*.bib)
- Endnote (*.enw)

and the following network file output formats:

- GraphML (*.xml or *.graphml)
- Pajek .MAT (*.mat)
- Pajek .NET (*.net)
- NWB (*.nwb)
- XGMML (*.xml)
- CSV (*.csv)



Formats are documented at https://nwb.slis.indiana.edu/community/?n=DataFormats.HomePage.

CIShell Powered Tools:

Science of Science (Sci2) Tool

Science of Science (Sci2) Tool

http://sci.slis.indiana.edu

- Explicitly designed for SoS research and practice, well documented, easy to use.
- Empowers many to run common studies while making it easy for exports to perform novel research.
- Advanced algorithms, effective visualizations, and many (standard) workflows.
- Supports micro-level documentation and replication of studies.
- Is open source—anybody can review and extend the code, or use it for commercial purposes.

nature

Vol 464|25 March 2010

OPINION

SUMMARY

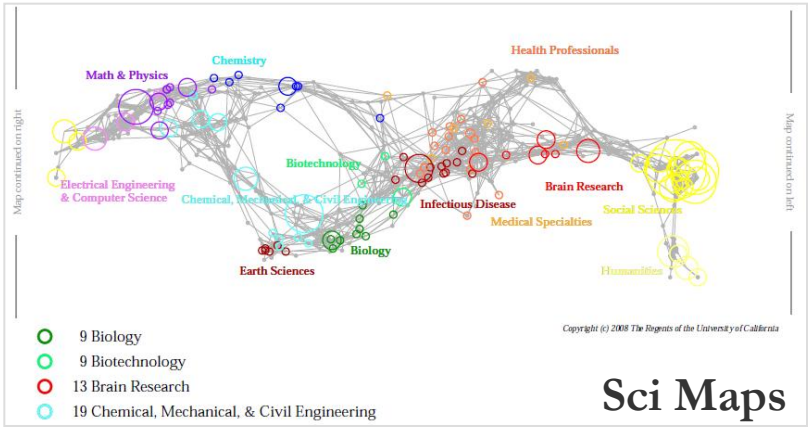
- Existing metrics have known flaws
- A reliable, open, joined-up data infrastructure is needed
- Data should be collected on the full range of scientists' work
- Social scientists and economists should be involved

Let's make science metrics more scientific

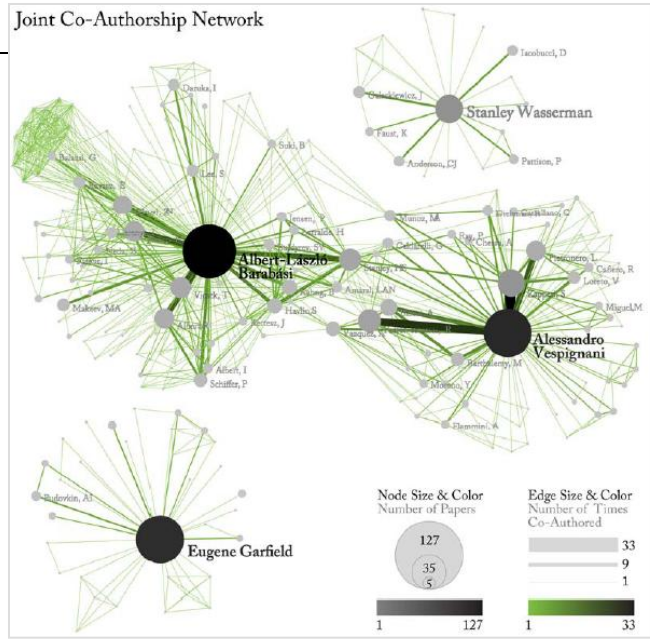
To capture the essence of good science, stakeholders must combine forces to create an open, sound and consistent system for measuring all the activities that make up academic productivity, says **Julia Lane**.

Sci² Tool – "Open Code for S&T Assessment"

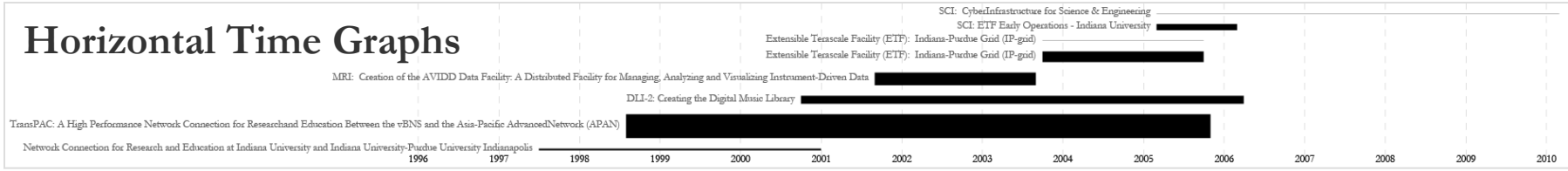
OSGi/CIShell powered tool with NWB plugins and many new scientometrics and visualizations plugins.



Sci Maps

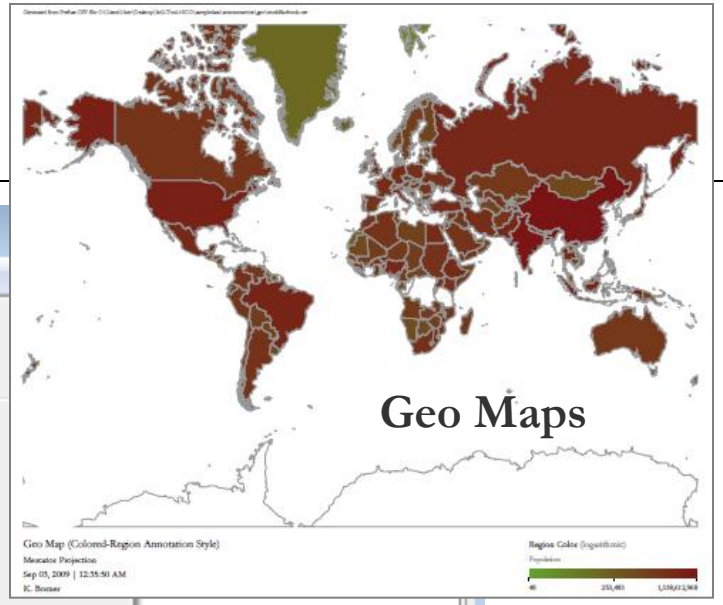


GUESS Network Vis



Börner, Katy, Huang, Weixia (Bonnie), Linnemeier, Micah, Duhon, Russell Jackson, Phillips, Patrick, Ma, Nianli, Zoss, Angela, Guo, Hanning & Price, Mark. (2009). Rete-Netzwerk-Red: Analyzing and Visualizing Scholarly Networks Using the Scholarly Database and the Network Workbench Tool. Proceedings of ISSI 2009: 12th International Conference on Scientometrics and Informetrics, Rio de Janeiro, Brazil, July 14-17 . Vol. 2, pp. 619-630.

Sci² Tool



Sci² Tool

File Preprocessing Modeling Analysis Visualization Scientometrics Help

Console

Welcome to the Science of Science Tool (Sci
The development of this tool is supported in
Network Science center and the School of Li
Indiana University, the National Science Fou
and IIS-0715303, and the James S. McDonnel
Cyberinfrastructure portal (http://sci.slis.ind

The primary investigators are Katy Börner, In
SciTech Strategies Inc. The Sci² tool was dev
J. Duhon, Patrick A. Phillips, Chintan Tank, a
Cyberinfrastructure Shell (http://cishell.org)
for Network Science Center (http://cns.slis.i
Many algorithm plugins were derived from t
(http://nwb.slis.indiana.edu).

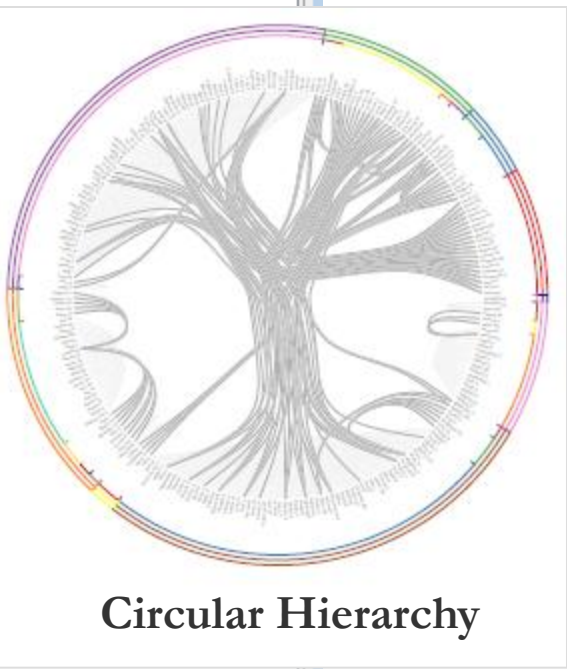
Please cite as follows:
Sci² Team. (2009). Science of Science Tool. In
Strategies Inc., http://sci.slis.indiana.edu.
.....

Scheduler

Remove From List | Remove completed

!	Algorithm Name	Date	Time	% Com
☑	Extract Co-Author Netw...	09/03/2009	00:15:20 AM	
☑	Load and Clean ISI File	09/03/2009	00:15:05 AM	

GUESS
GnuPlot
Radial Tree/Graph (prefuse alpha)
Radial Tree/Graph with Annotation (prefuse beta)
Tree View (prefuse beta)
Tree Map (prefuse beta)
Force Directed with Annotation (prefuse beta)
Fruchterman-Reingold with Annotation (prefuse beta)
DrL (VxOrd)
Specified (prefuse beta)
Horizontal Line Graph
Circular Hierarchy
Geo Map (circle annotations)
Geo Map (region coloring annotations)
Image Viewer
RefMapper



Sci² Tool: Download, Install, and Run

Sci² Tool 0.5 Alpha (May 2011)

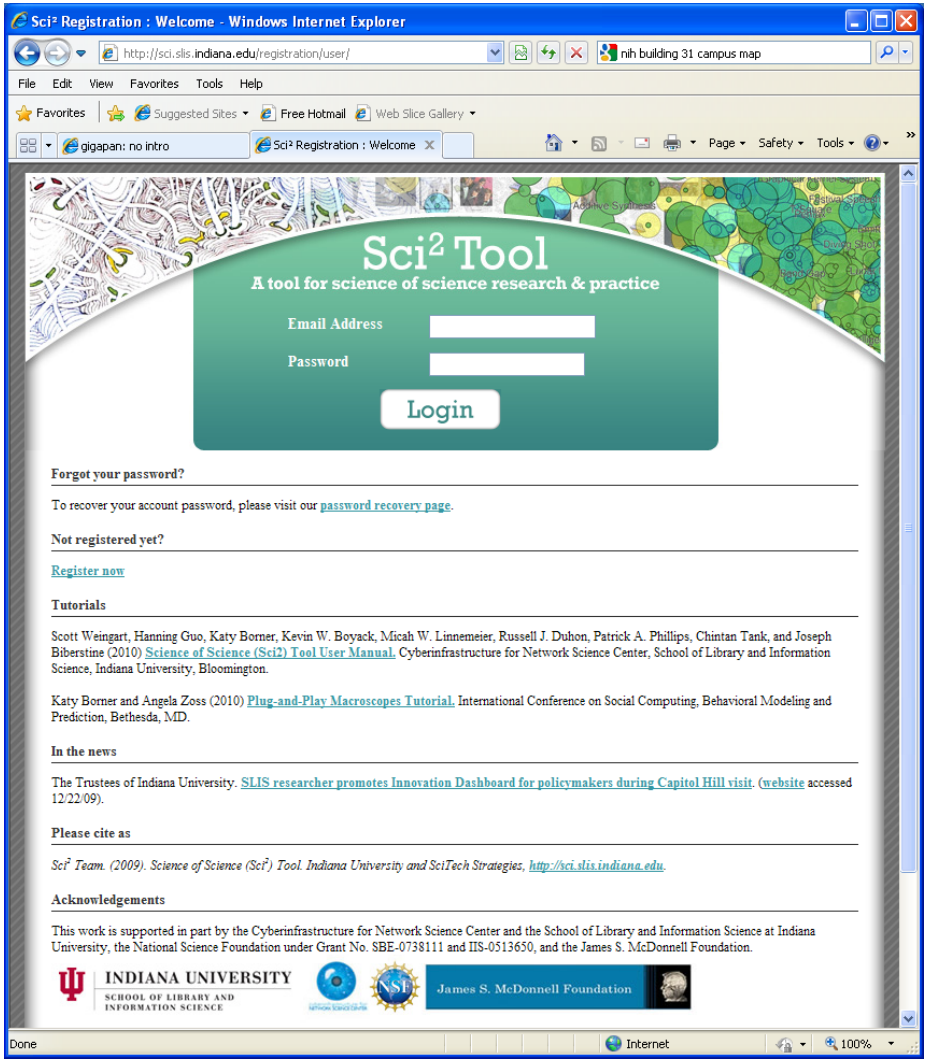
Can be freely downloaded for all major operating systems from http://sci.slis.indiana.edu/sci2

Select your operating system from the pull down menu and download.

Unpack into a /sci2 directory.

Run /sci2/sci2.exe

Session log files are stored in '**yournwbdirectory*/logs*' directory.



Cite as

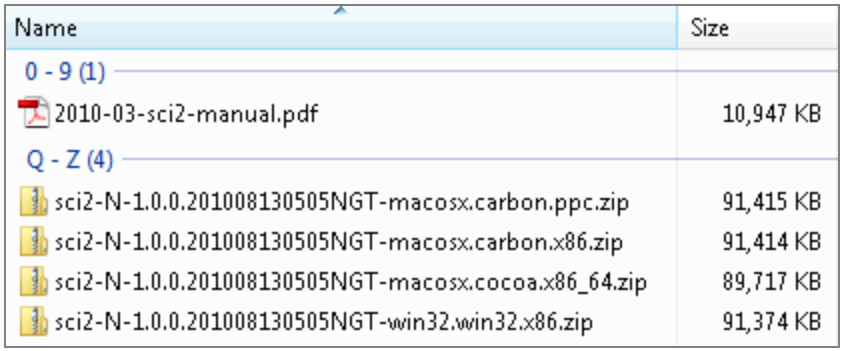
Sci² Team. (2009). Science of Science (Sci²) Tool. Indiana University and SciTech Strategies, http://sci.slis.indiana.edu

Sci² Tool: Download, Install, and Run

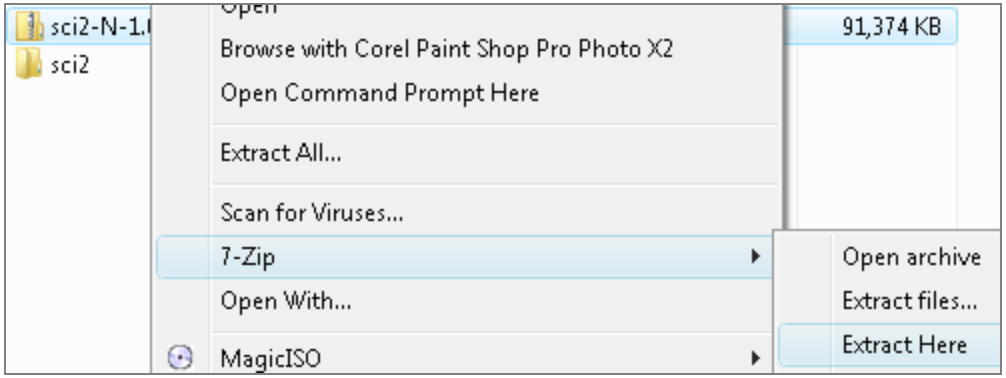
Sci² Tool 0.5 Alpha (May 2011)

Has new features such as

- New Geographic Visualizations
- STAR database (download separately)
- Colored Horizontal Bar Graphs
- Supports ASCII UTF-8 characters
- Bug fixes, streamlined workflows



Unzip and run /sci2/sci2.exe



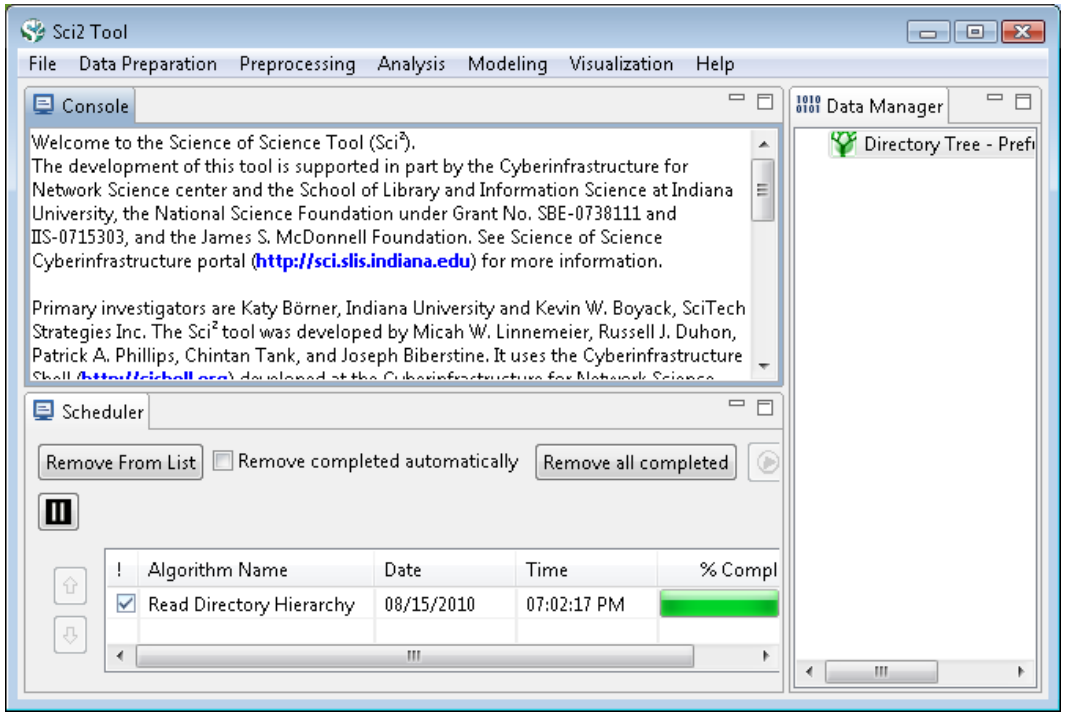
Cite as

Sci² Team. (2009). Science of Science (Sci²) Tool. Indiana University and SciTech Strategies, http://sci.slis.indiana.edu

Sci2 Tool Interface Components

Use

- **Menu** to read data, run algorithms.
- **Console** to see work log, references to seminal works.
- **Data Manager** to select, view, save loaded, simulated, or derived datasets.
- **Scheduler** to see status of algorithm execution.



All workflows are recorded into a log file (see /sci2/logs/…), and soon can be re-run for easy replication. If errors occur, they are saved in a error log to ease bug reporting.

All algorithms are documented online; workflows are given in tutorials, see http://sci.slis.indiana.edu/sci2 and http://nwb.slis.indiana.edu > Community

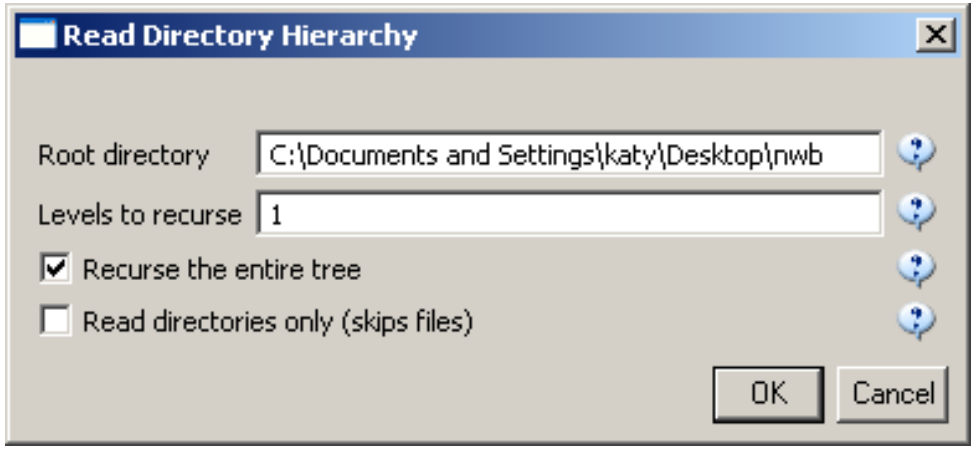
Contents

See Sci2 Manual

2010-03-sci2-manual.pdf

Sci2 Tool – Read+Visualize Sci2 Tool Directory Tree

Use *'File > Read Directory Hierarchy'* with parameters

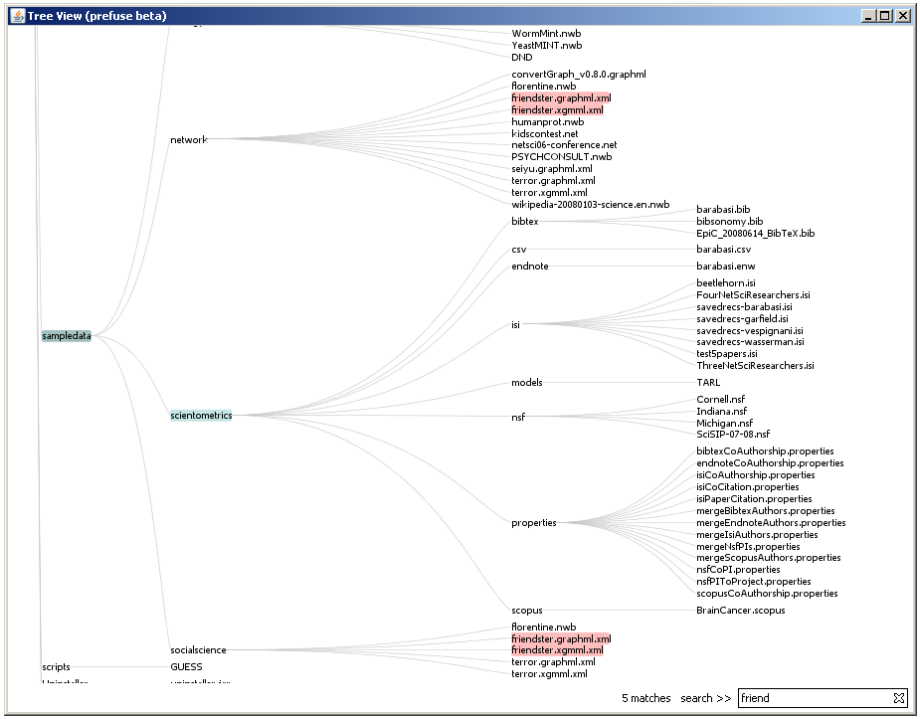


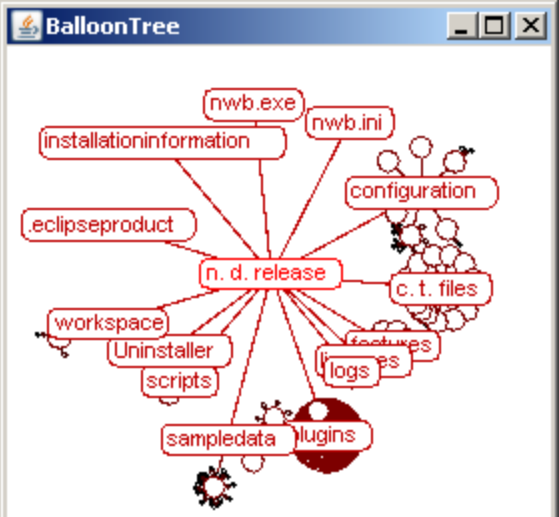
Visualize resulting *'Directory Tree - Prefuse (Beta) Graph'* using

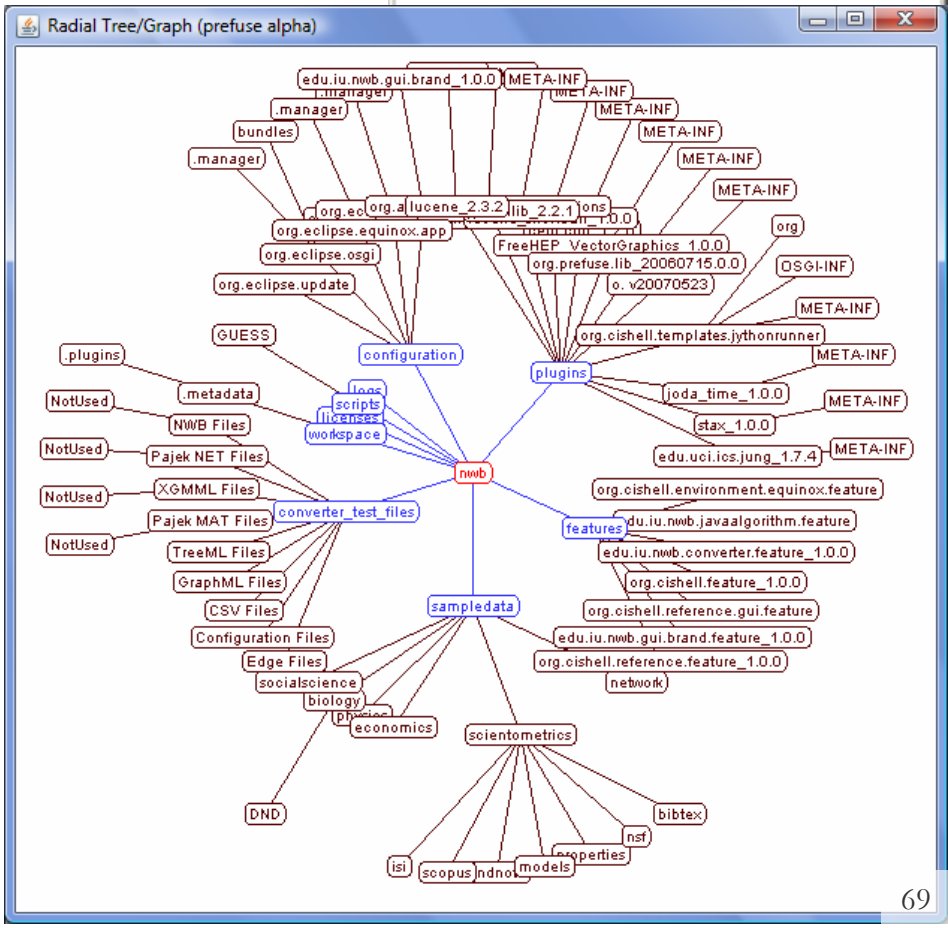
- *'Visualization > Tree View (prefuse beta)'*
- *'Visualization > Tree Map (prefuse beta)'*
- *'Visualization > Balloon Graph (prefuse alpha)'*
- *'Visualization > Radial Tree/Graph (prefuse alpha)'*

Different views of the /nwb directory hierarchy.

Note the size of the /plugin directory.







Studying Four Major NetSci Researchers (ISI Data)

FourNetSciResearchers.isi	
Time frame:	1955-2007
Region(s):	Miscellaneous
Topical Area(s):	Network Science
Analysis Type(s):	Paper Citation Network, Co-Author Network, Bibliographic Coupling Network, Document Co-Citation Network, Word Co-Occurrence Network

Thomson Reuter's Web of Knowledge (WoS) is a leading citation database cataloging over 10,000 journals and over 120,000 conferences. Access it via the "Web of Science" tab at http://www.isiknowledge.com (**note:** access to this database requires a paid subscription). Along with Scopus, WoS provides some of the most comprehensive datasets for scientometric analysis.

To find all publications by an author, search for the last name and the first initial followed by an asterisk in the author field.

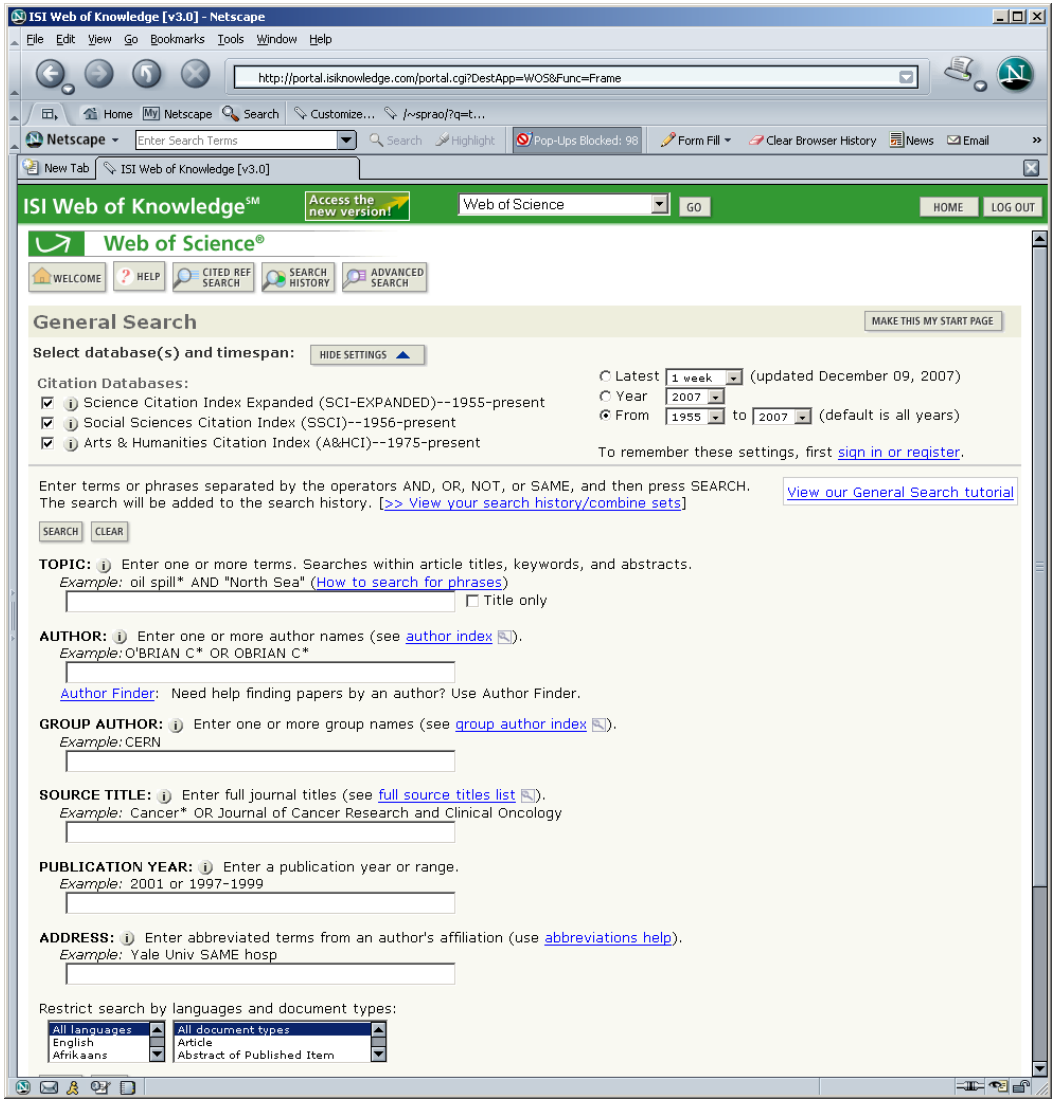
Data Acquisition from Web of Science

Download all papers by

- Eugene Garfield
- Stanley Wasserman
- Alessandro Vespignani
- Albert-László Barabási

from

- Science Citation Index Expanded (SCI-EXPANDED) --1955-present
- Social Sciences Citation Index (SSCI)--1956-present
- Arts & Humanities Citation Index (A&HCI)--1975-present



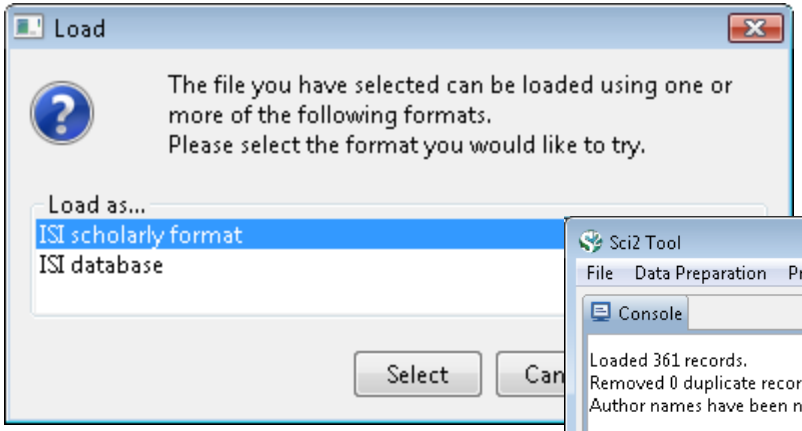
Comparison of Counts

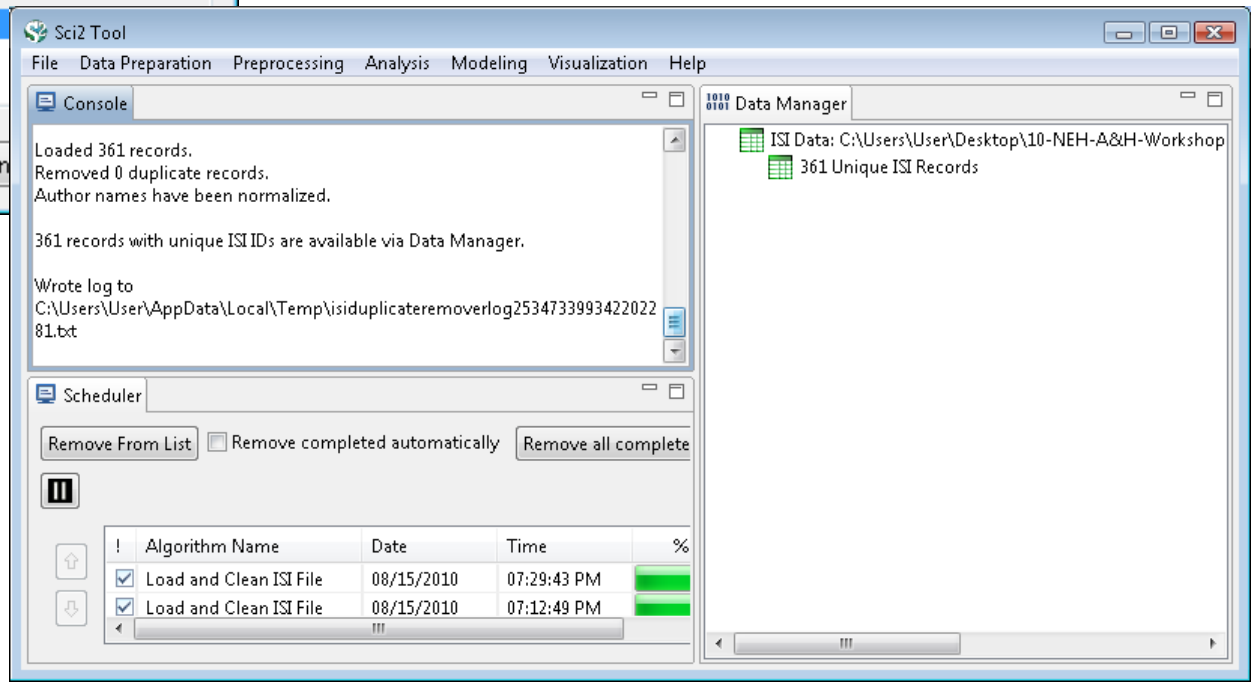
No books and other non-WoS publications are covered.

	Age	Total # Cites	Total # Papers	H-Index	
Eugene Garfield	82	1,525	672	31	
Stanley Wasserman		122	35	17	
Alessandro Vespignani	42	451	101	33	
Albert-László Barabási	40	2,218	126	47	*(Dec 2007)*
	41	16,920	159	52	*(Dec 2008)*

Extract Co-Author Network

Load *'yoursci2directory*/sampledata/scientometrics/isi/FourNetSciResearchers.isi'* using *'File > Load'* and parameters



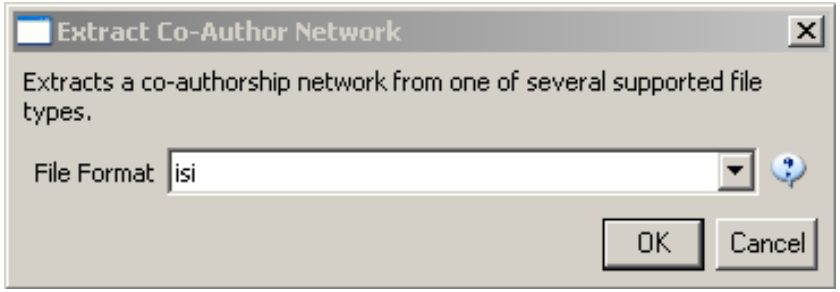


And file with 361 records appears in Data Manager.

Extract Co-Author Network

(see section 5.1.4.2 on correcting duplicate/misspelled author names)

To extract the co-author network, select the *'361 Unique ISI Records'* table and run *'Data Preparation > Extract Co-Author Network'* using isi file format:



The result is an undirected but weighted network of co-authors in the Data Manager.

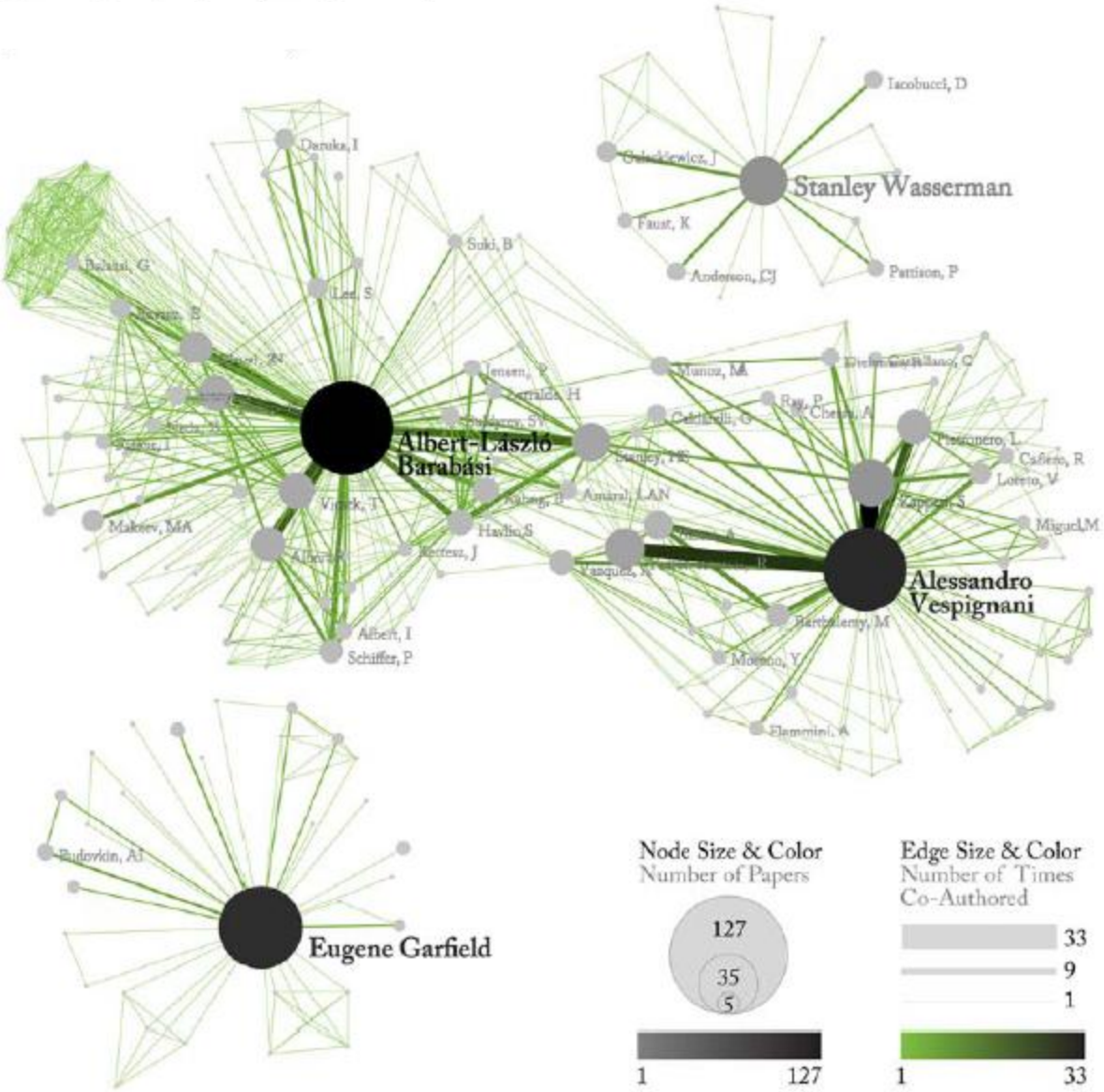
Run *'Analysis > Network > Network Analysis Toolkit (NAT)'* to calculate basic properties: the network has 247 nodes and 891 edges.

Use *'Analysis > Network > Unweighted and Undirected > Node Degree' to calculate the number of neighbors for each node.*

To view the complete network, select the *'Extracted Co-Authorship Network'* and run *'Visualization > Networks > GUESS'.*

Network is loaded with random layout. In GUESS, run *'Layout > GEM'* and 'Layout > Bin Pack' to improve layout.

Co-Author Network of all Four NetsSci Researchers

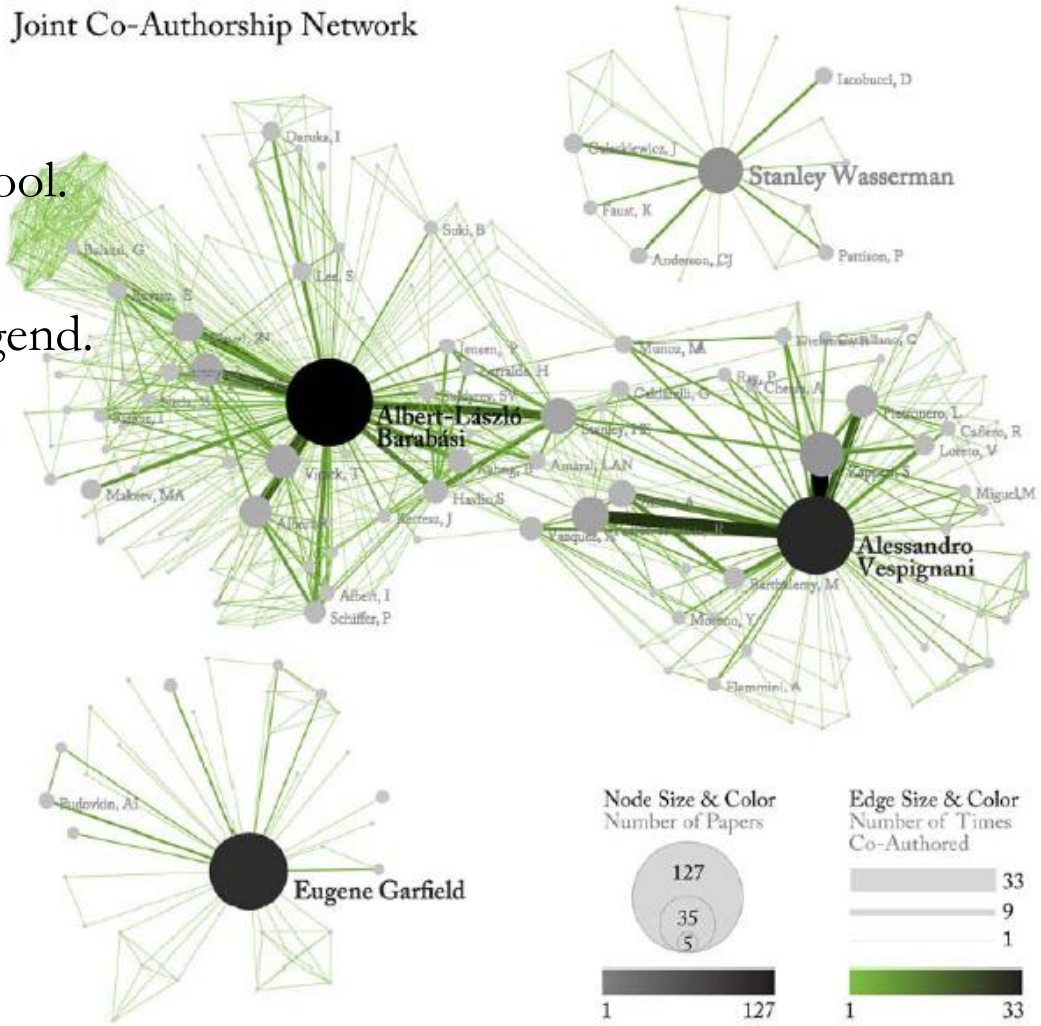


Co-Author Network of all Four NetsSci Researchers

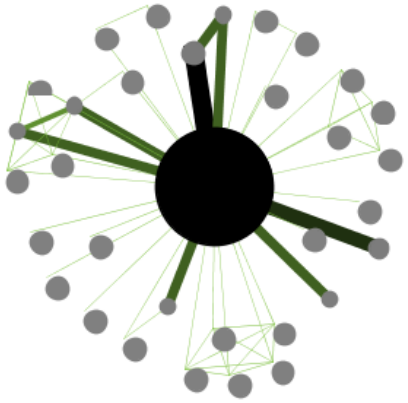
Use the GUESS Graph Modifier to change color and size coding.

Calculate node degrees in Sci2 Tool.

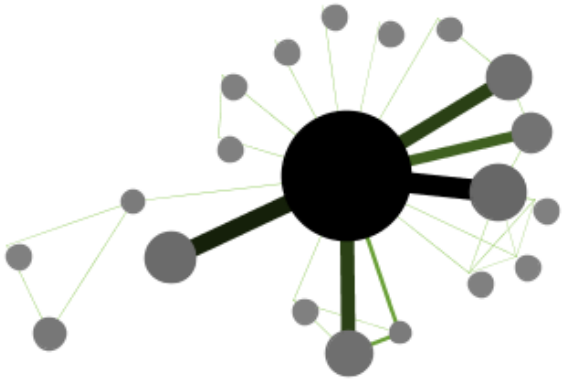
Use a graphic program to add legend.



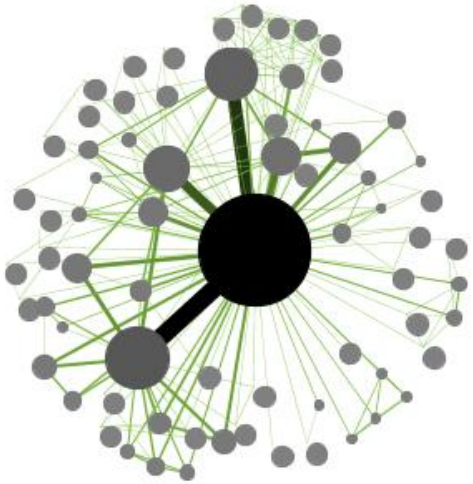
Individual Co-Author Networks (Read/map 4 files separately)



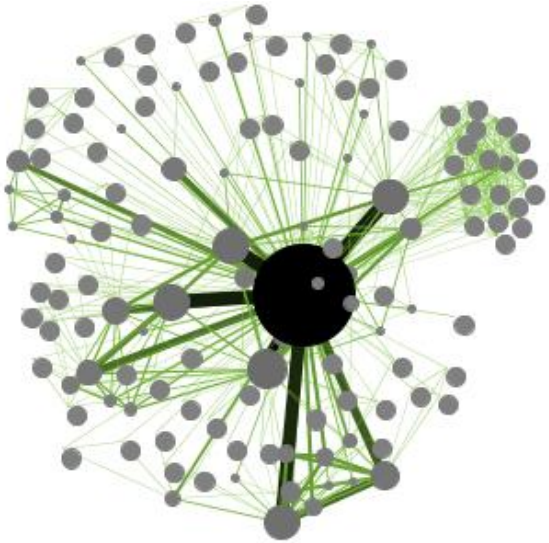
Eugene Garfield



Stanley Wasserman



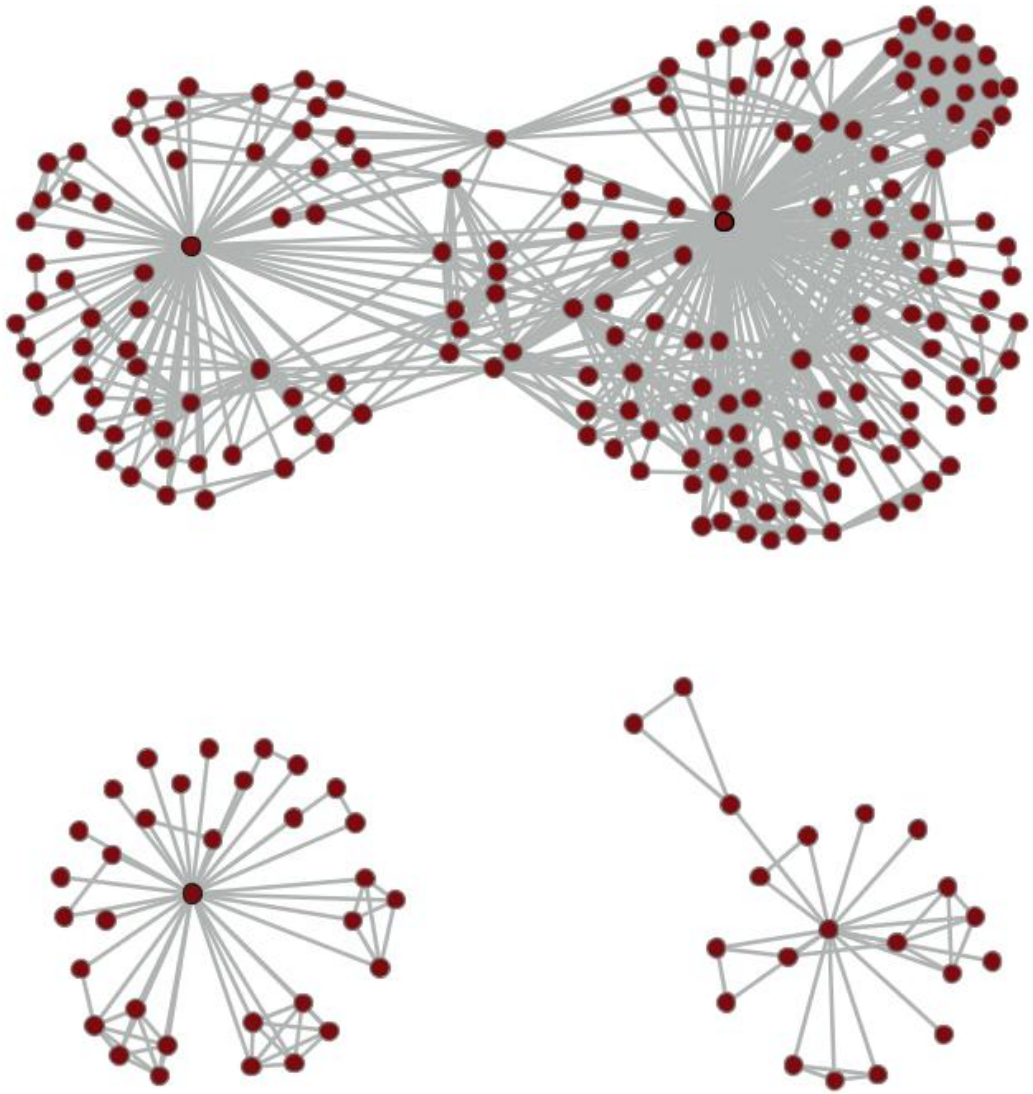
Alessandro Vespignani



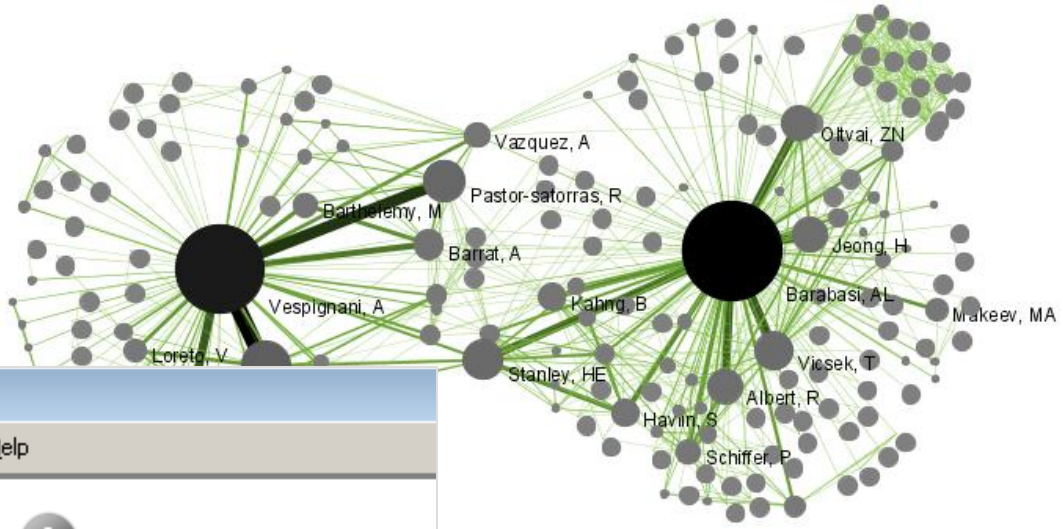
Albert-László Barabási

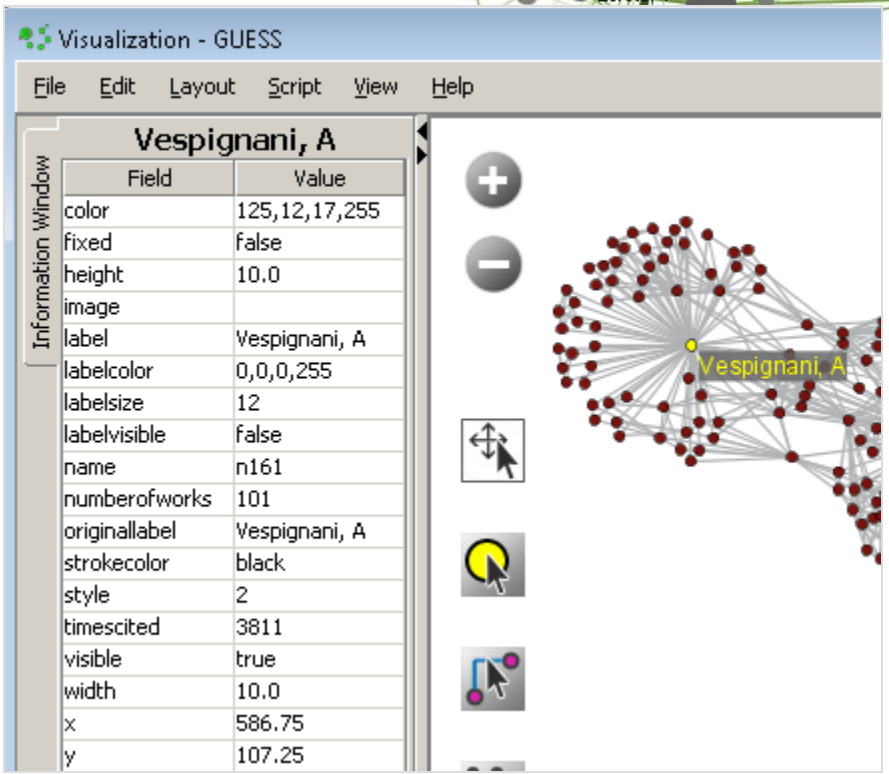
Network Visualization: Node Layout

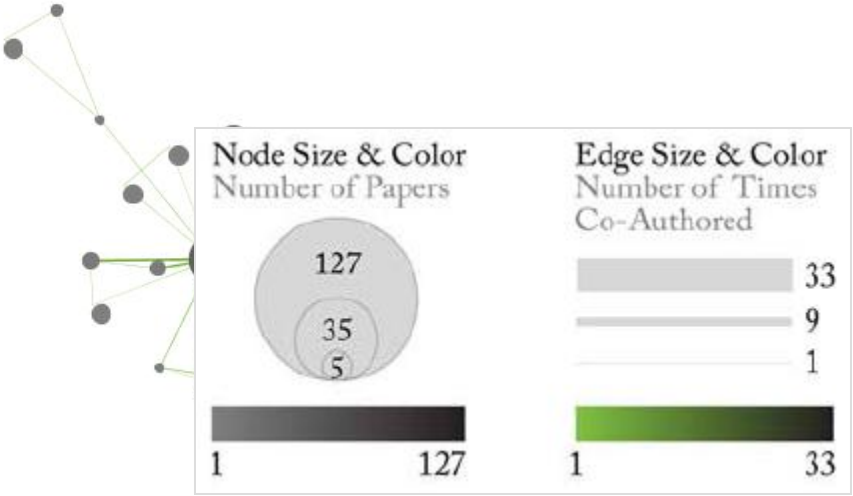
Load and Clean ISI File was selected.
Loaded 361 records.
Removed 0 duplicate records.
Author names have been normalized.
361 records with unique ISI IDs are available via Data Manager.
.....
Extract Co-Author Network was selected.
Input Parameters:
File Format: isi
.....
Network Analysis Toolkit (NAT) was selected.
Nodes: 247
Edges: 891
.....
GUESS was selected.



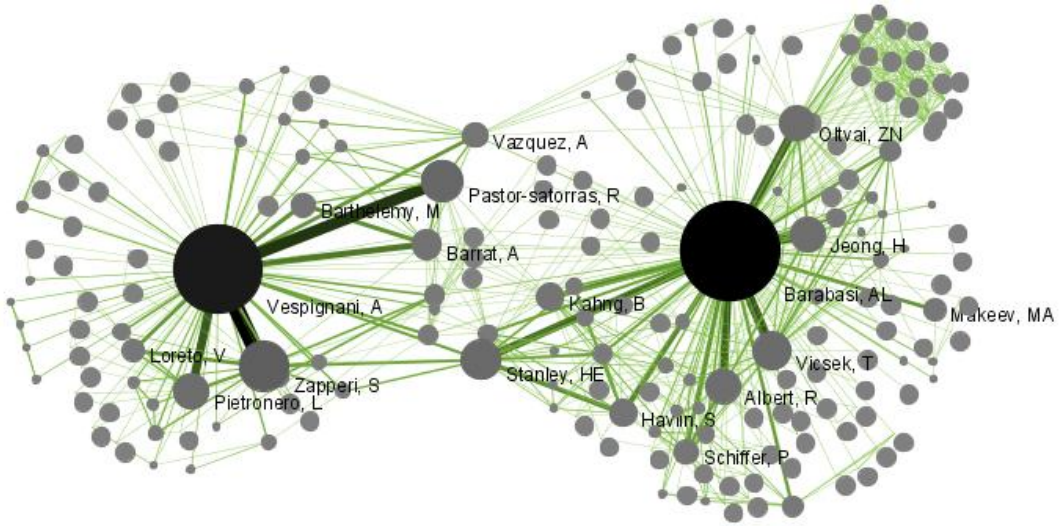
Network Visualization:
Color/Size Coding by Data Attribute Values







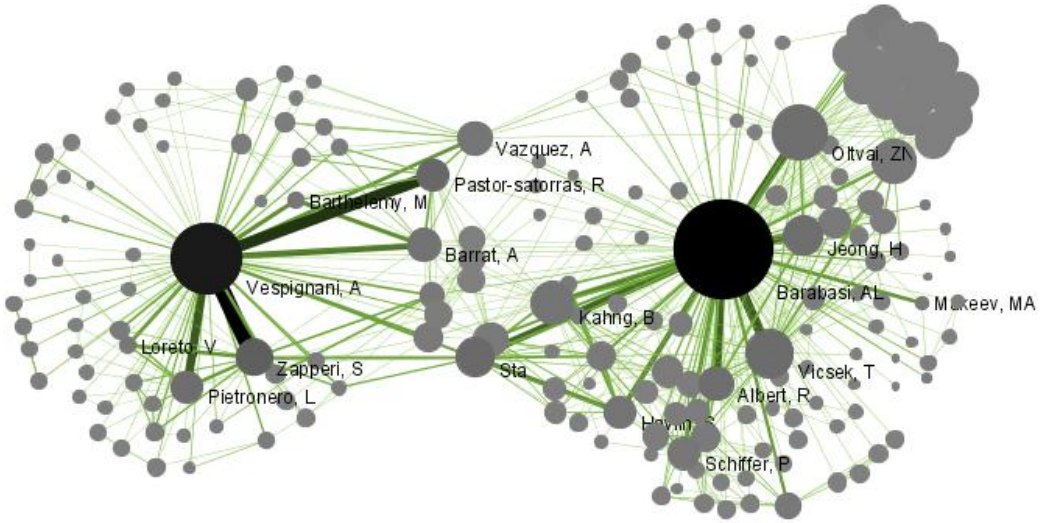
Network Visualization: Giant Component



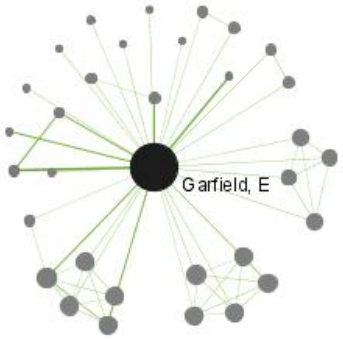
.....
Weak Component Clustering was selected.
Implementer(s): Russell Duhon
Integrator(s): Russell Duhon

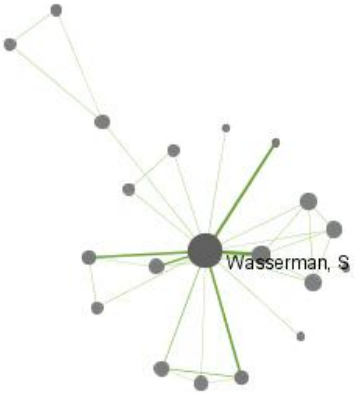
Input Parameters:
Number of top clusters: 10
3 clusters found, generating graphs for the top 3 clusters.
.....

Network Visualization: Color/Size Coding by Degree

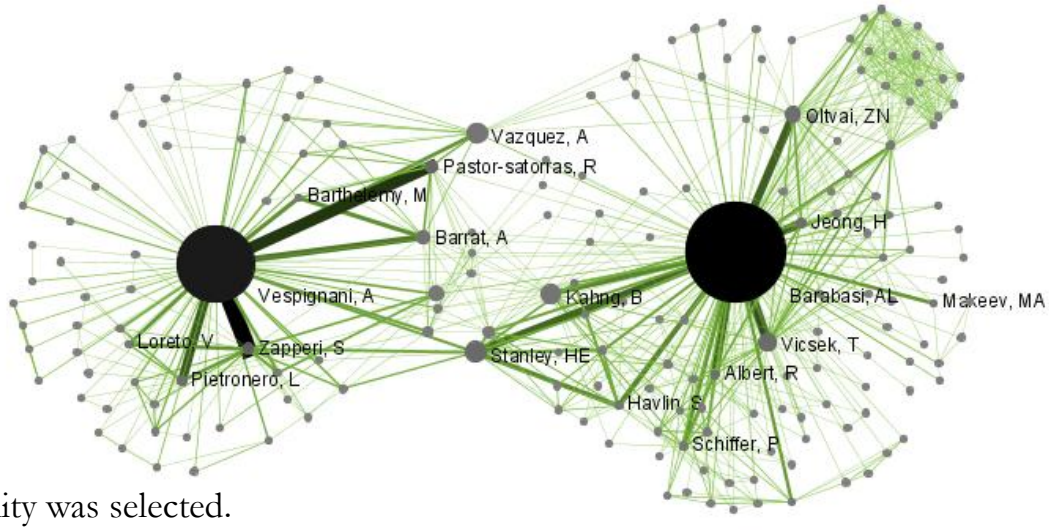


.....
Node Degree was selected.
Documentation:
https://nwb.slis.indiana.edu/community/?n=AnalyzeData.NodeDegree
.....





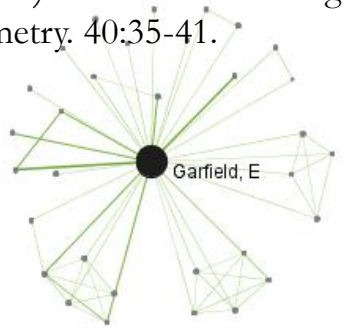
Network Visualization:
Color/Size Coding by Betweeness Centrality

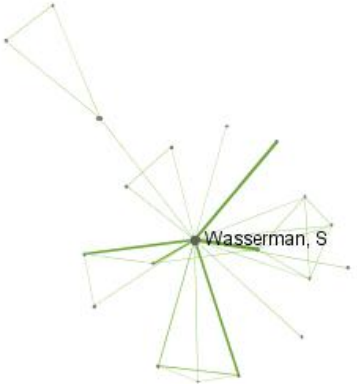


.....
Node Betweenness Centrality was selected.
Author(s): L. C. Freeman
Implementer(s): Santo Fortunato
Integrator(s): Santo Fortunato, Weixia Huang
Reference: Freeman, L. C. (1977). A set of measuring centrality based on betweenness. Sociometry. 40:35-41.

Input Parameters:
Number of bins: 10

umber of bins: 10
.....





Network Visualization:
Reduced Network After Pathfinder Network Scaling

.....

MST-Pathfinder Network Scaling was selected.

Input Parameters:

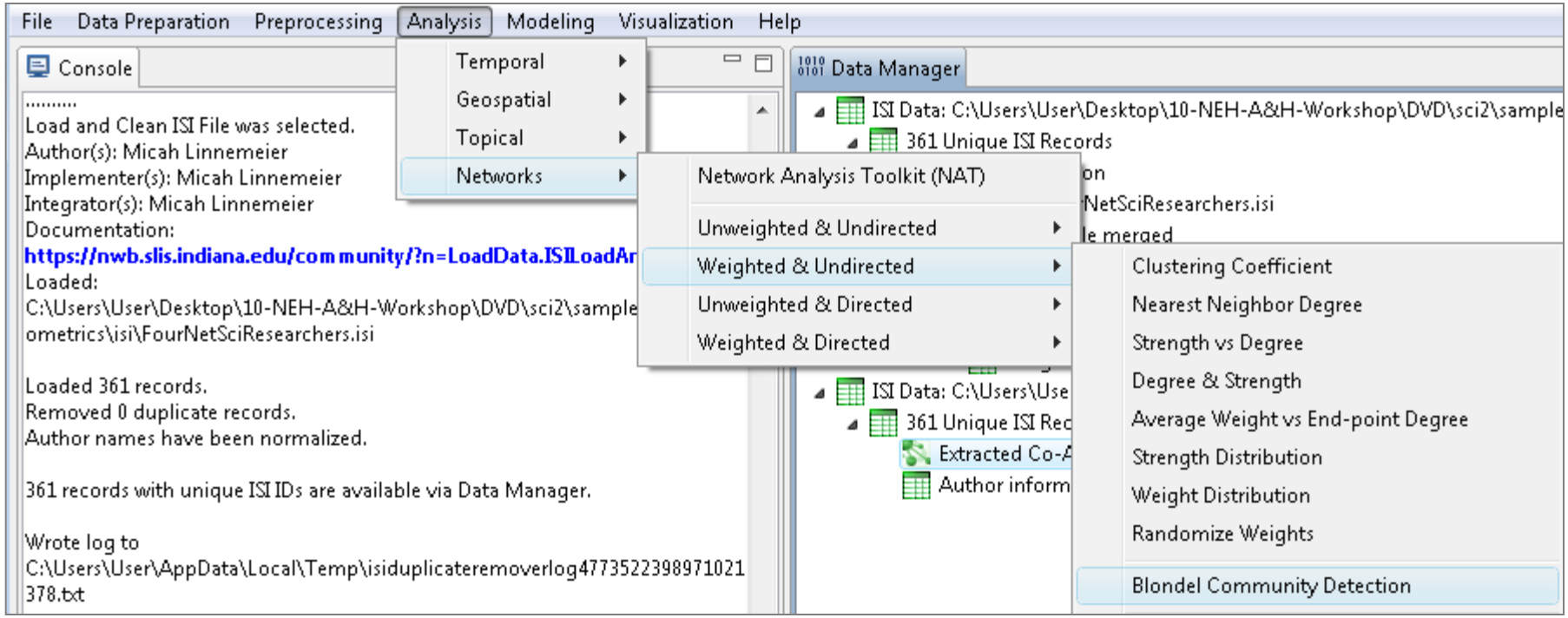
Weight Attribute measures: SIMILARITY

Edge Weight Attribute: weight

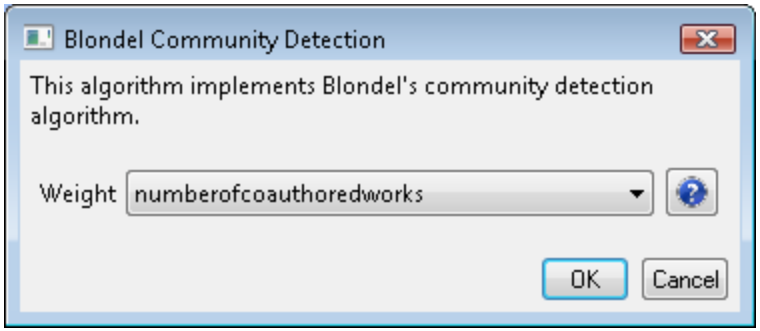
.....

Network Visualization: Circular Hierarchy Visualization

Select Co-Author Network and run Blondel Community detection:

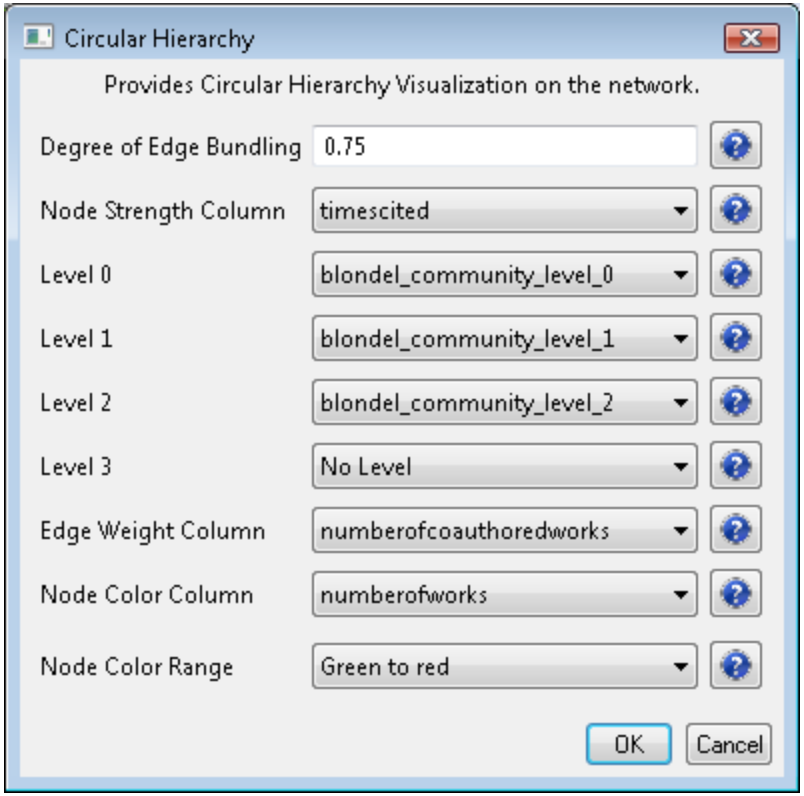


With parameter values



Network Visualization: Circular Hierarchy Visualization

Visualize resulting file using *'Visualization > Networks > Circular Hierarchy'* with parameter values



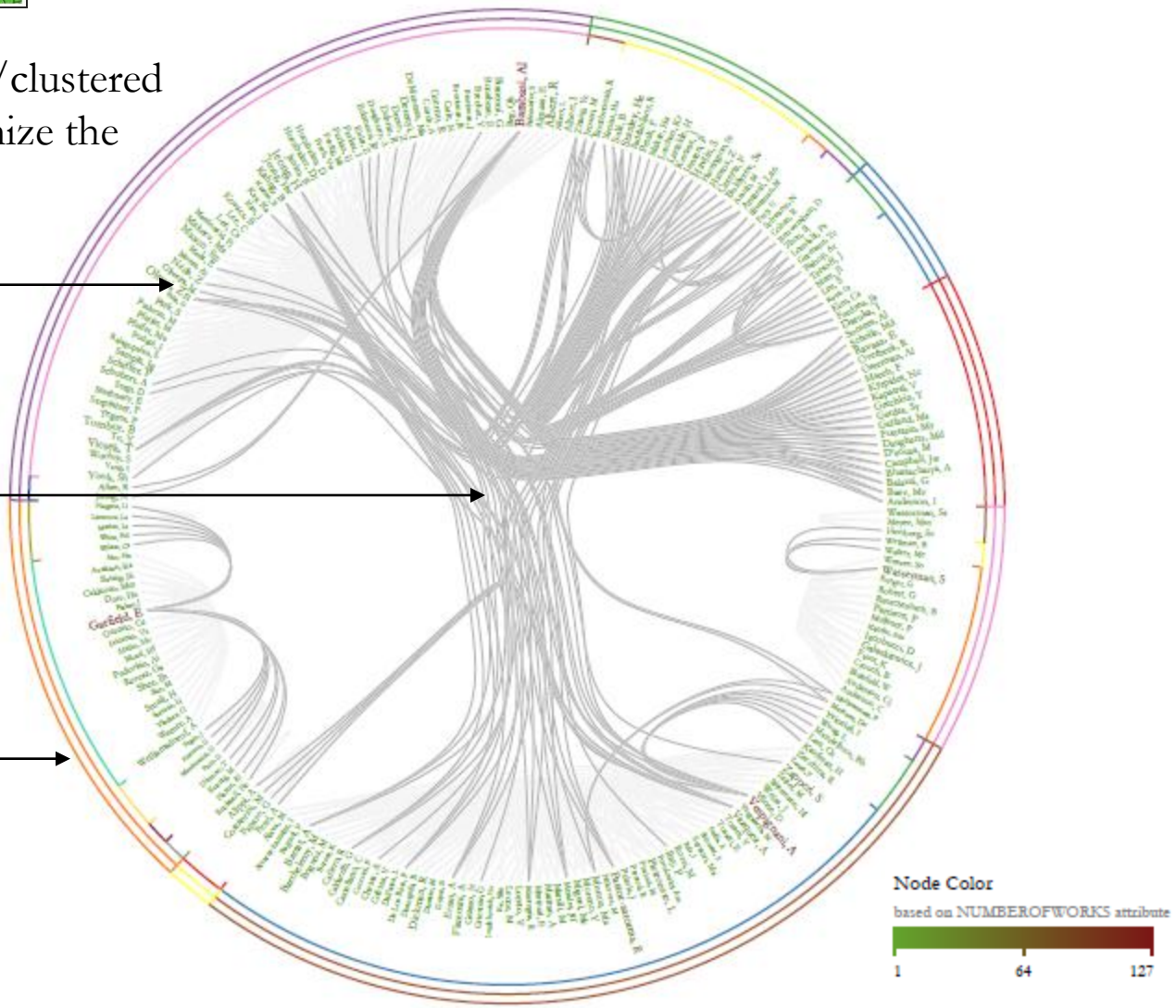
Network Visualization: Circular Hierarchy Visualization

Nodes that are interlinked/clustered are spatially close to minimize the number of edge crossings.

Node labels, e.g., author names.

Network structure using edge bundling.

Color coded cluster hierarchy according to Blondel community detection algorithm.



Note:
Header/footer info, legend, and more meaningful color coding are under development.

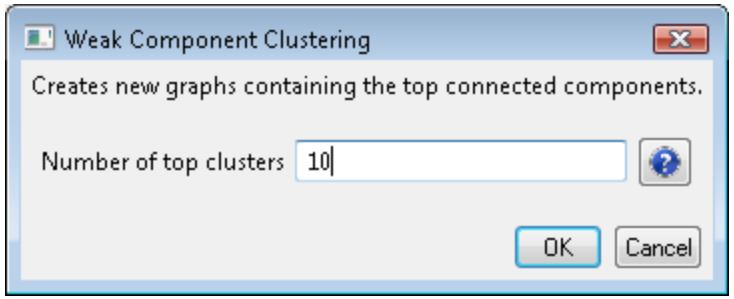
Paper-Citation Network Layout

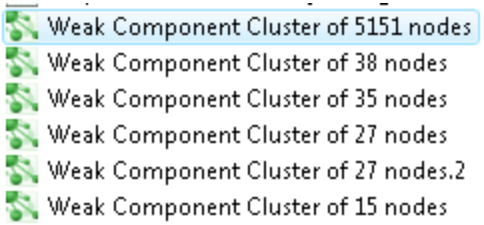
To extract the paper-citation network, select the *'361 Unique ISI Records'* table and run *'Data Preparation > Text Files > Extract Paper Citation Network.'*

The result is a unweighted, directed network of papers linked by citations, named *Extracted paper-citation network* in the Data Manager.

Run *NAT* to calculate that the network has 5,342 nodes and 9,612 edges. There are 15 weakly connected components. (0 isolates)

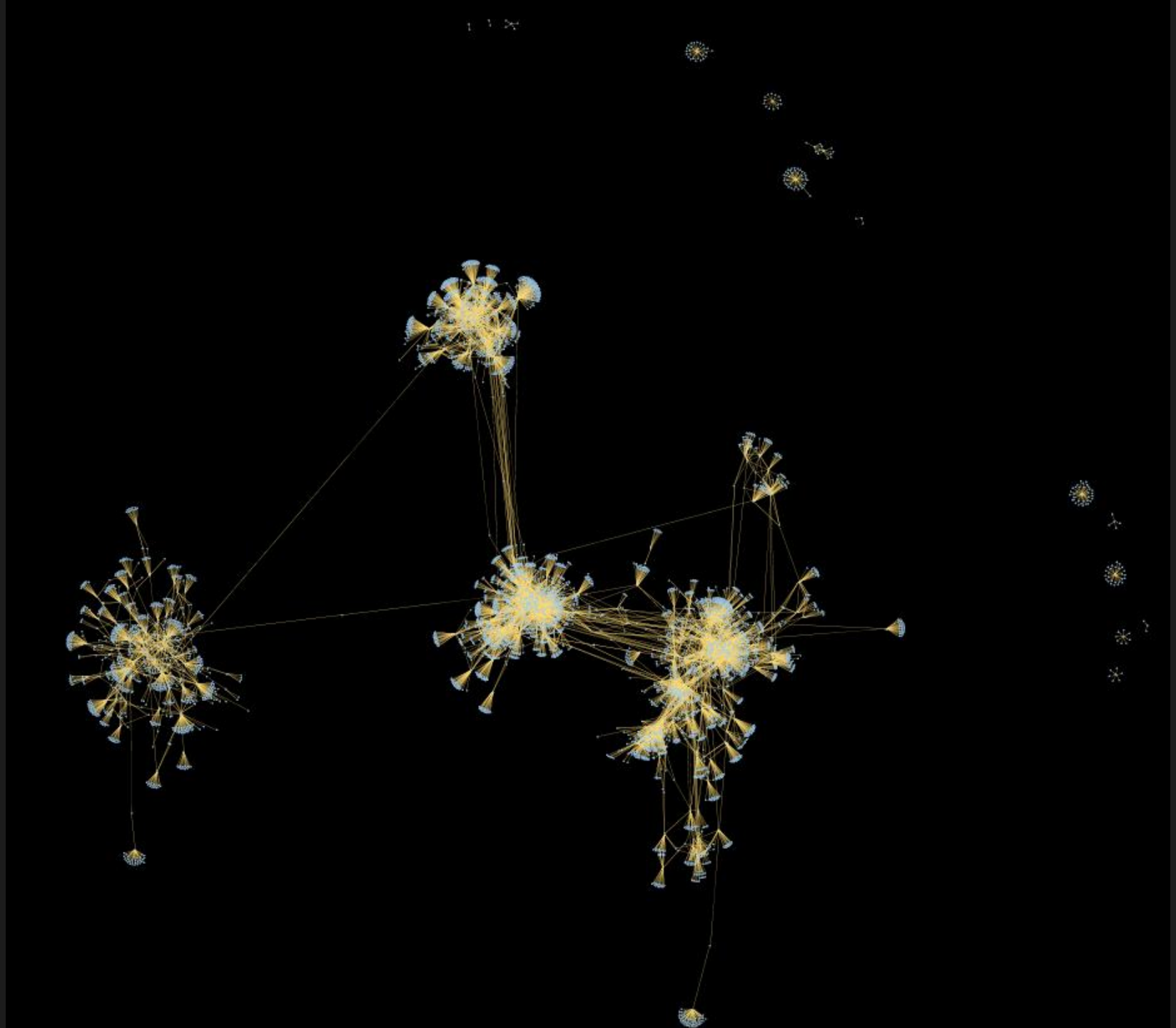
Run *'Analysis > Networks > Unweighted and Directed > Weak Component Clustering'* with parameters





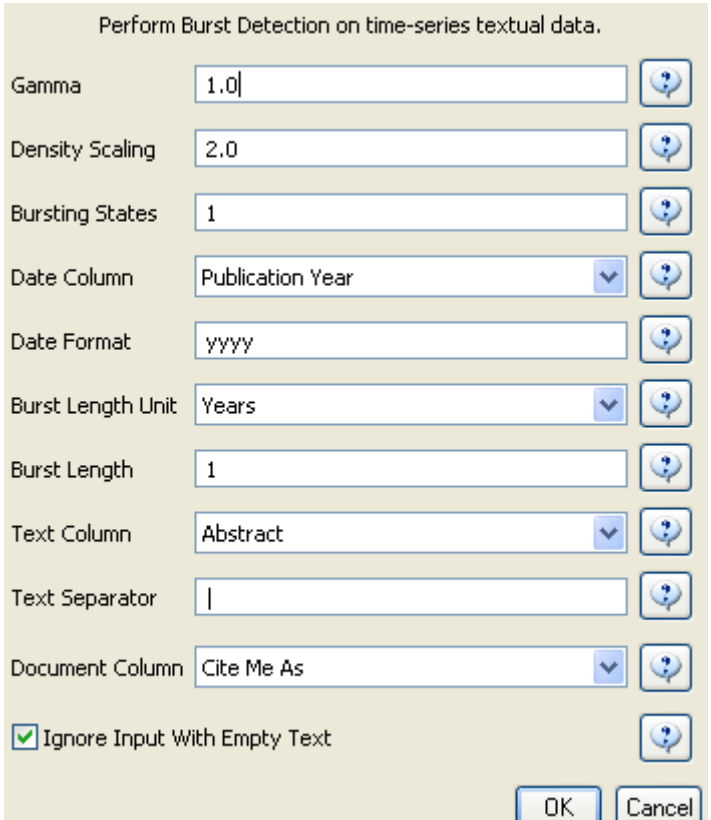
to identify top-10 largest components. The largest (giant) component has 5,151 nodes.

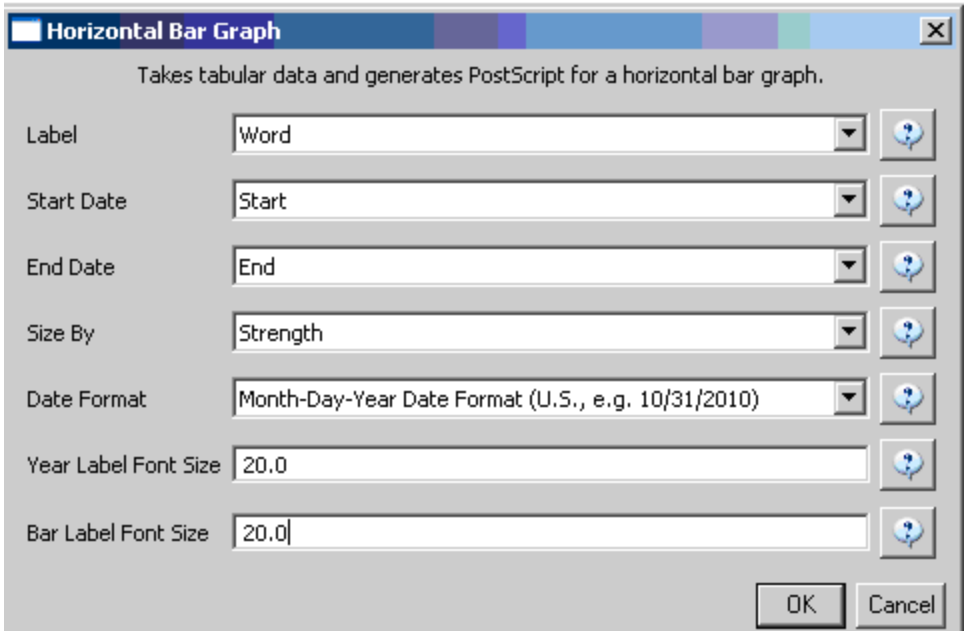
To view the complete network, select the network and run *'Visualization > GUESS'*.



Burst Analysis for Abstracts

Run '*Preprocessing > Topical > Lowercase, Tokenize, Stem, and Stopword Text* with the 'Abstract' box checked followed by '*Analysis > Topical > Burst Detection*' with parameters on the left and then run '*Visualize > Temporal > Horizontal Line Graph*' with parameters on right.

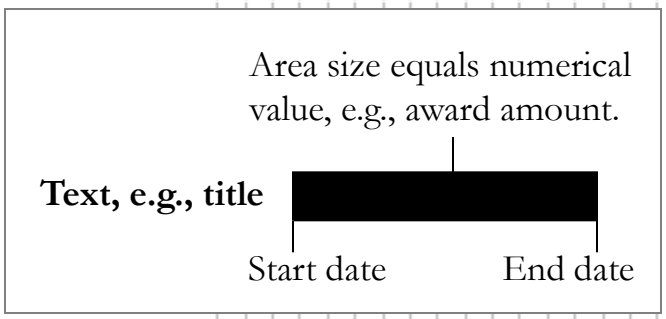




Date and time of analysis: March 28, 2010 7:43:48 PM EDT
Input data: Burst detection analysis (Year, Reference): maximum burst level 1

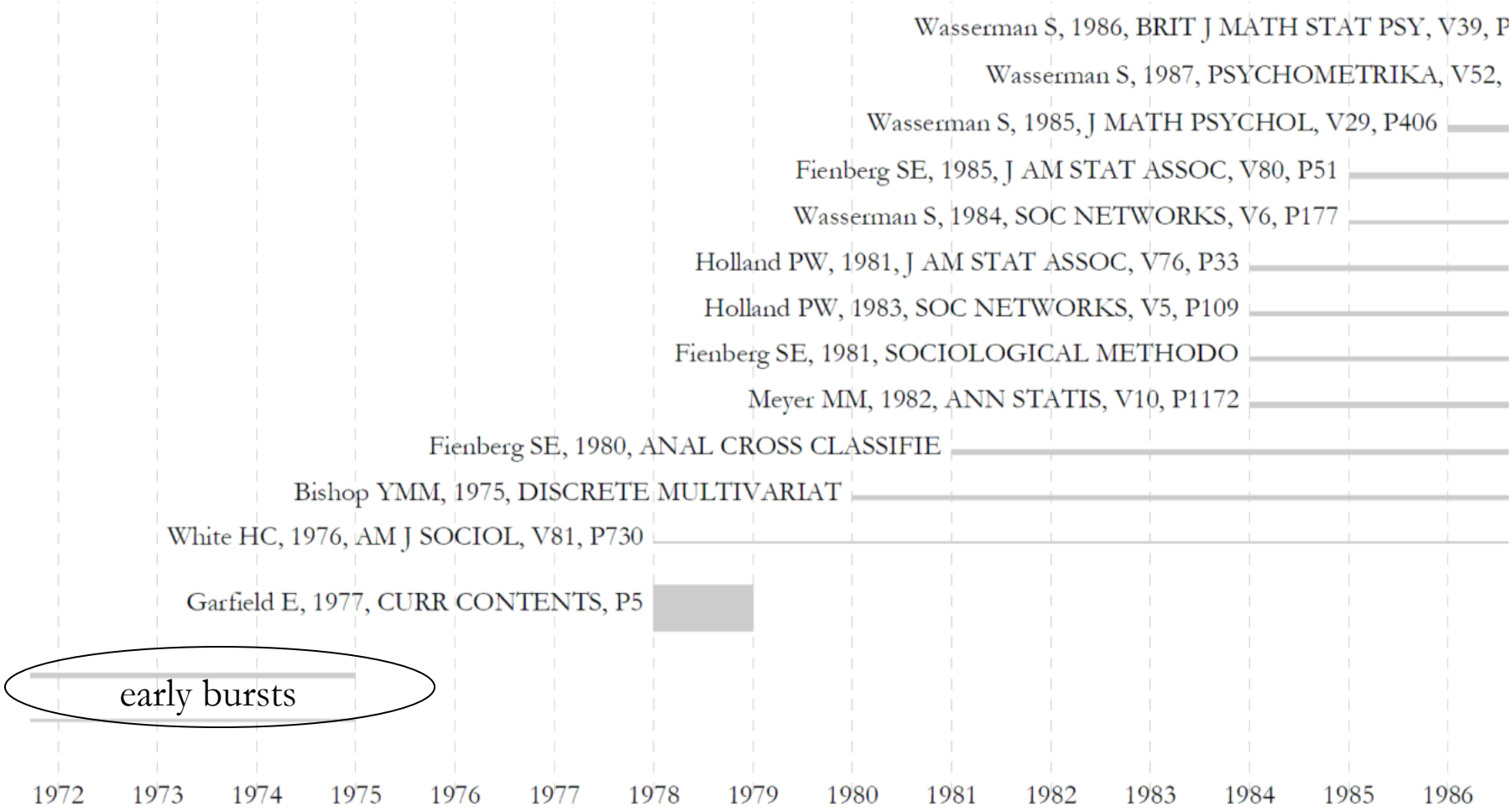
Horizontal Bar Graph for maximum burst level 1

Label Column: Word
Start Date Column: Start
End Date Column: End
Size By Column: Strength
Date Format Column: Month-Day-Year Date Format
Year Label Font Size: 20.0
Bar Label Font Size: 20.0



Cyberinfrastructure for Network Science Center (2009) Horizontal Bar Graph. Indiana University, http://sci.slis.indiana.edu

Burst Analysis Result



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2:15-2:25 Break

2:25-3:00 Sci2 Tool Basics

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3:35-4:00 Sci2 Research Demonstration: Mapping the Republic of Letters

4:00-4:30 Q&A and Technical Assistance

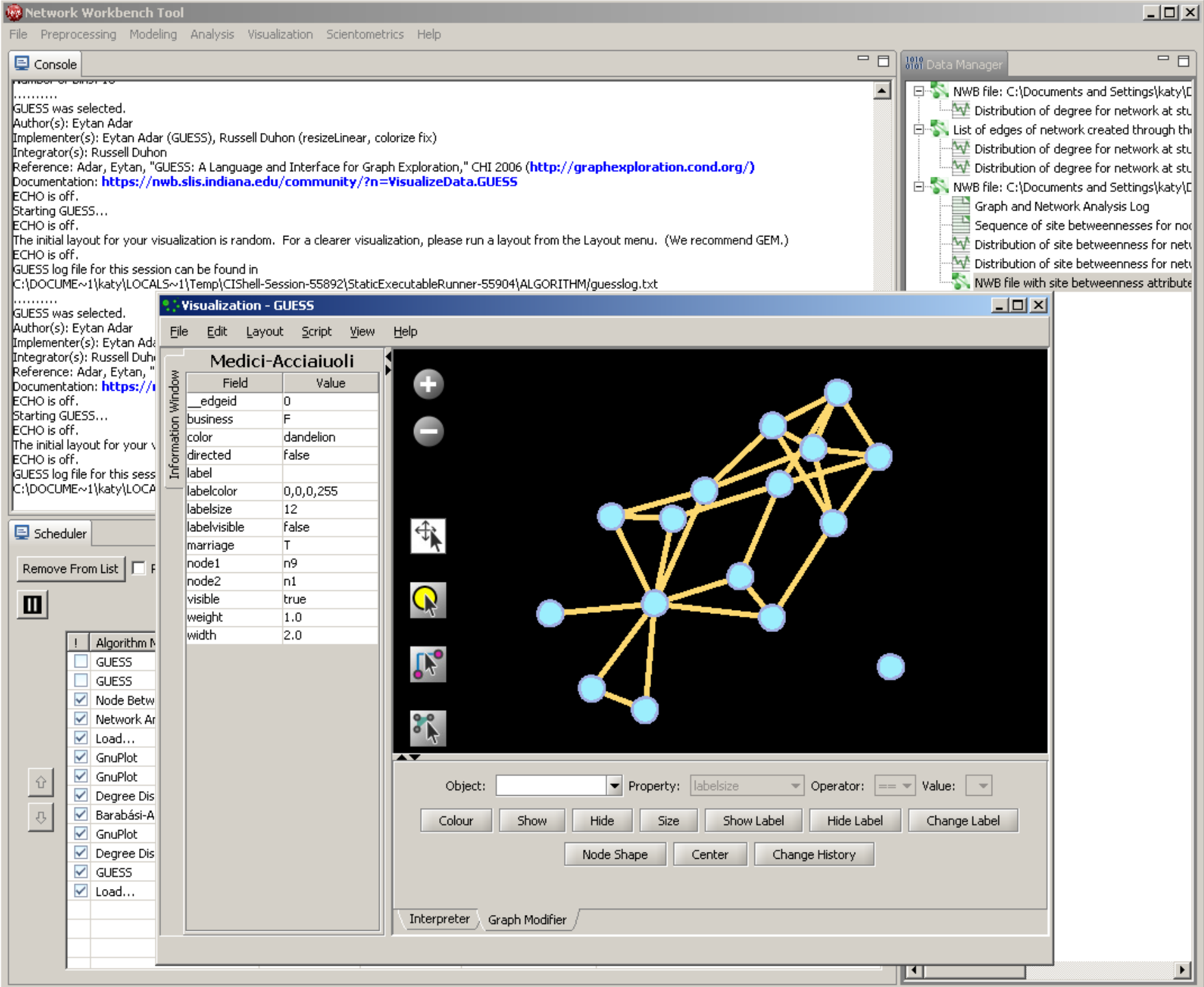
Workflow Design:
Padgett's Florentine Families

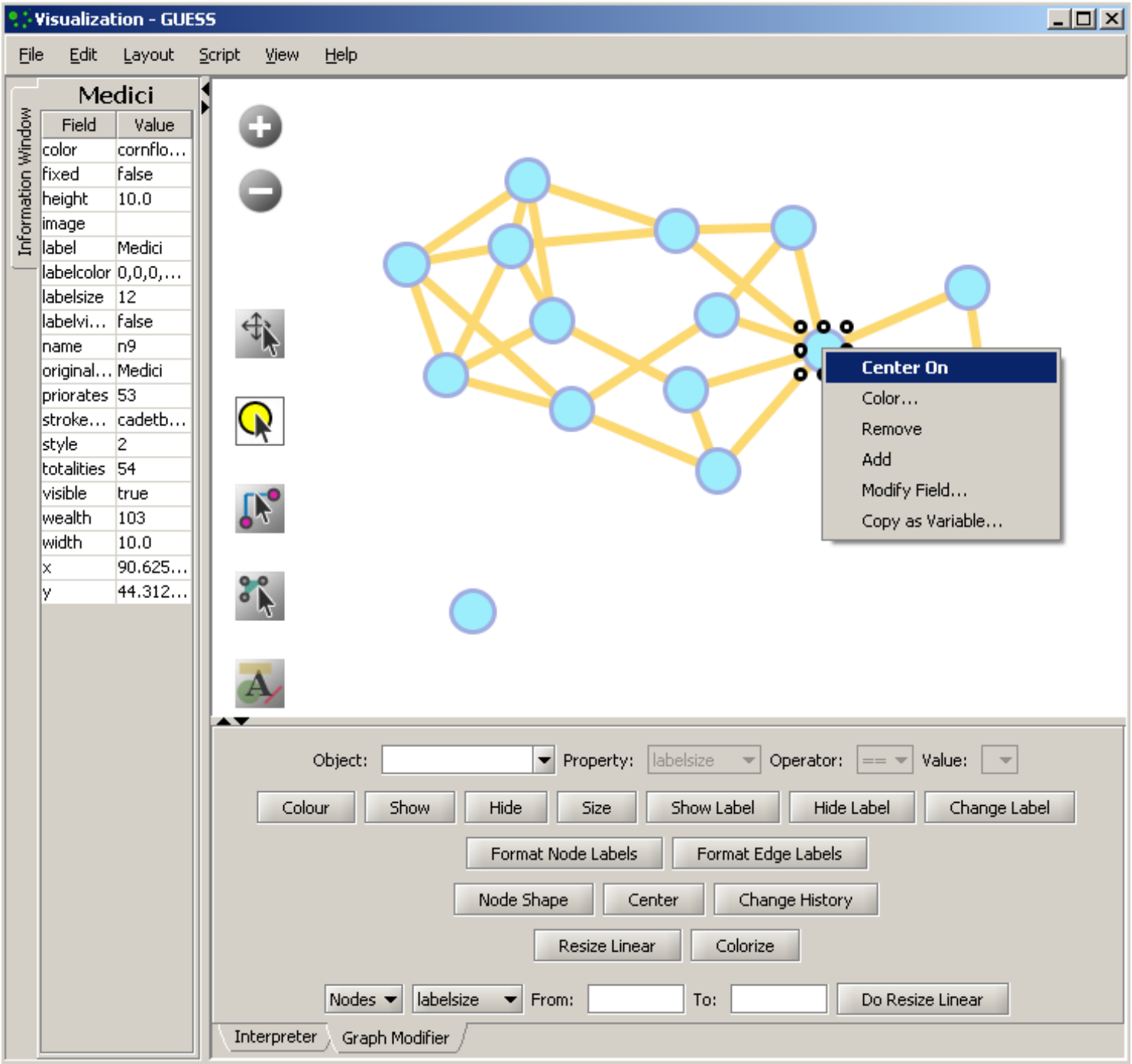
Padgett's Florentine Families - Compute Basic Network Properties & View in GUESS

- Load **yoursci2directory*/sampledata/socialscience/florentine.nwb*
- Run *'Analysis > Network Analysis Toolkit (NAT)'* to get basic properties.

This graph claims to be undirected.
Nodes: 16
Isolated nodes: 1
Node attributes present: label, wealth, totalities, priorates
Edges: 27
No self loops were discovered.
No parallel edges were discovered.
Edge attributes:
Nonnumeric attributes:
Example value
marriag...T
busines...F
Average degree: 3.375
There are 2 weakly connected components. (1 isolates)
The largest connected component consists of 15 nodes.
Did not calculate strong connectedness because this graph was not directed.
Density (disregarding weights): 0.225

- Optional: Run 'Analysis > Unweighted & Undirected > Node Betweenness Centrality' with default parameters.
- Select network and run *'Visualization > GUESS'* to open GUESS with file loaded.
- Apply 'Layout > GEM'.
- Open NWB File


Network Workbench Tool
File Preprocessing Modeling Analysis Visualization Scientometrics Help
Console
GUESS was selected.
Author(s): Eytan Adar
Implementer(s): Eytan Adar (GUESS), Russell Duhon (resizeLinear, colorize fix)
Integrator(s): Russell Duhon
Reference: Adar, Eytan, "GUESS: A Language and Interface for Graph Exploration," CHI 2006 (http://graphexploration.cond.org/)
Documentation: https://nwb.slis.indiana.edu/community/?n=VisualizeData.GUESS
ECHO is off.
Starting GUESS...
ECHO is off.
The initial layout for your visualization is random. For a clearer visualization, please run a layout from the Layout menu. (We recommend GEM.)
ECHO is off.
GUESS log file for this session can be found in
C:\DOCUME~1\katy\LOCALS~1\Temp\CIShell-Session-55892\StaticExecutableRunner-55904\ALGORITHM/guesslog.txt
Data Manager
NWB file: C:\Documents and Settings\katy\D
Distribution of degree for network at stu
List of edges of network created through th
Distribution of degree for network at stu
Distribution of degree for network at stu
NWB file: C:\Documents and Settings\katy\D
Graph and Network Analysis Log
Sequence of site betweennesses for noc
Distribution of site betweenness for netu
Distribution of site betweenness for netu
NWB file with site betweenness attribute
Visualization - GUESS
File Edit Layout Script View Help
Information Window
Medici-Acciaiuoli
Field Value
__edgeid 0
business F
color dandelion
directed false
label
labelcolor 0,0,0,255
labelsize 12
labelvisible false
marriage T
node1 n9
node2 n1
visible true
weight 1.0
width 2.0
Object: Property: labelsize Operator: == Value:
Colour Show Hide Size Show Label Hide Label Change Label
Node Shape Center Change History
Interpreter Graph Modifier
Scheduler
Remove From List
GUESS
GUESS
Node Betw
Network Ar
Load...
GnuPlot
GnuPlot
Degree Dis
Barabási-A
GnuPlot
Degree Dis
GUESS
Load...



Pan:

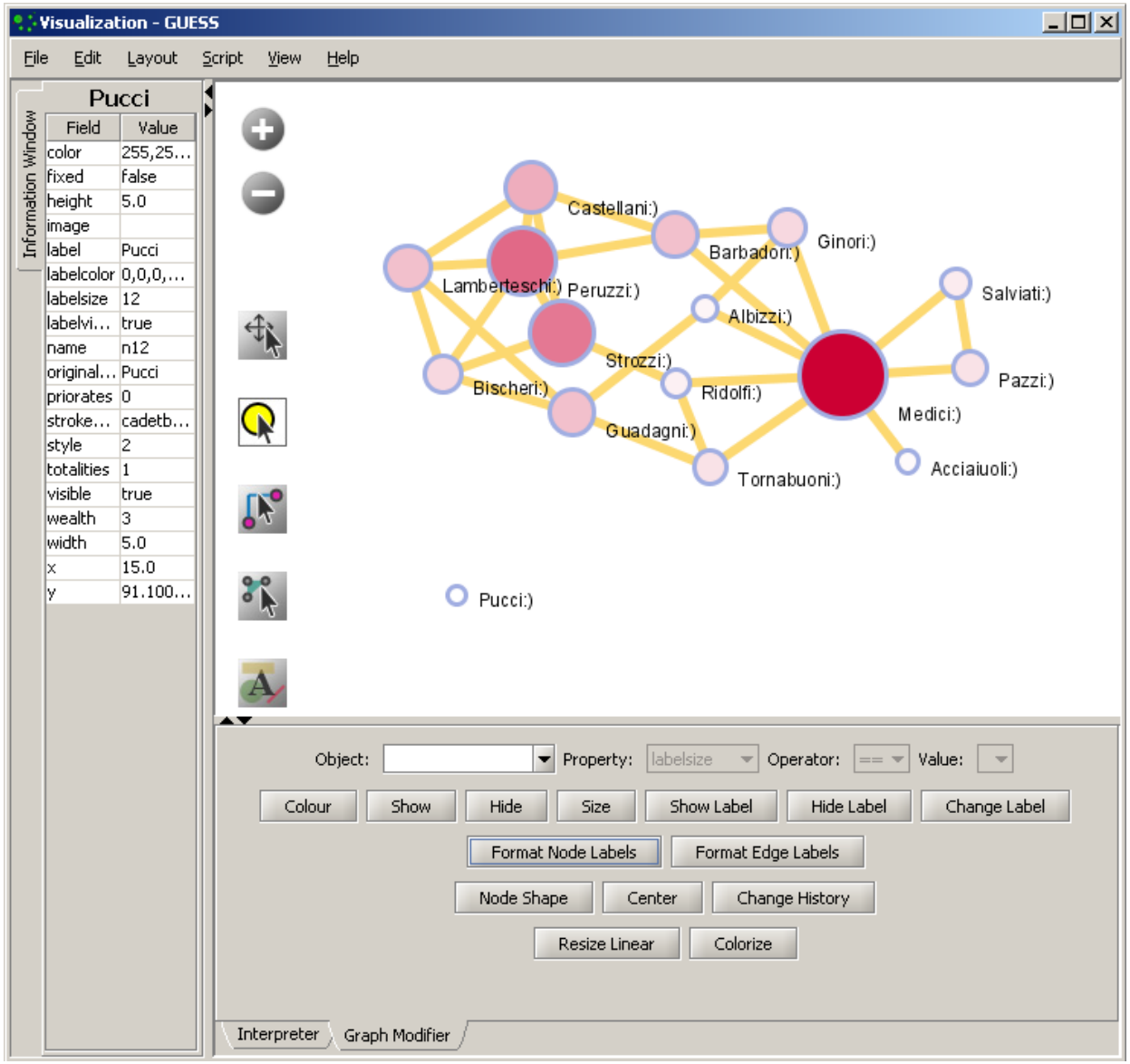
"grab" the background by holding left-click and moving your mouse.

Zoom:

Using scroll wheel, press the "+" and "-" buttons in the upper-left hand corner, or right-click and move the mouse left or right. Center graph by selecting 'View -> Center'.

Select  to select/move single nodes. Hold down 'Shift' to select multiple.

Right click to modify Color, etc.



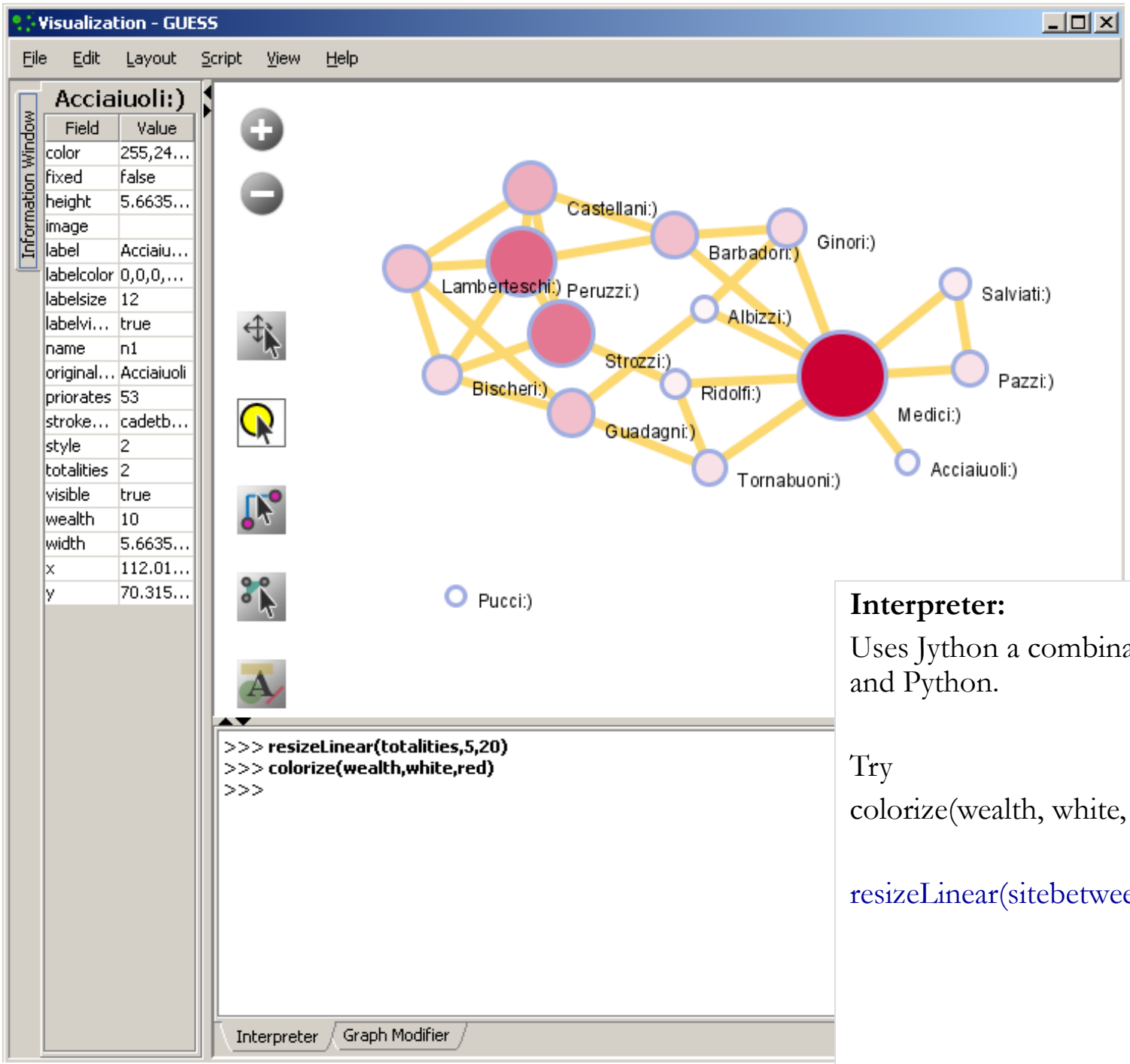
Graph Modifier:

Select "all nodes" in the Object drop-down menu and click 'Show Label' button.

Select 'Resize Linear > Nodes > totalities' drop-down menu, then type "5" and "20" into the From" and To" Value box separately. Then select 'Do Resize Linear'.

Select 'Colorize> Nodes>totalities', then select white and enter (204,0,51) in the pop-up color boxes on in the "From" and "To" buttons.

Select "Format Node Labels", replace default text {originallabel} with your own label in the pop-up box 'Enter a formatting string for node labels.'



Interpreter:

Uses Jython a combination of Java and Python.

Try

colorize(wealth, white, red)

resizeLinear(sitebetweenness, 5, 25)

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Sci2 Research Demonstration: Mapping the Republic of Letters

Mapping the Republic of Letters

- Load *Sample Data/sampleLettersNetwork.nwb*
- Run *'Analysis > Network Analysis Toolkit (NAT)'* to get basic properties.

This graph claims to be directed.

Nodes: 9

Isolated nodes: 0

Node attributes present: label, totaldegree

Edges: 15

No self loops were discovered.

No parallel edges were discovered.

Edge attributes:

Did not detect any nonnumeric attributes.

…

- Select *Analysis > Networks > Unweighted & Directed > Node Betweenness Centrality* with 'weight' for Weight Attribute
- Select *Analysis > Networks > Unweighted & Directed > Adjacency Transitivity*
- Select *Analysis > Networks > Unweighted & Directed > Dyad Reciprocity*
- Select network and run *'Visualization > GUESS'* to open GUESS with file loaded.
- Apply 'Layout > GEM'.
- Export / Import Node Positions – notice that full network is needed before doing this

Mapping the Republic of Letters

- Load *Sample Data/CEN1640.nwb, Sample Data/CEN1641.nwb, and Sample Data/CEN1642.nwb*
- Run *'Analysis > Network Analysis Toolkit (NAT)'* to get basic properties.

Nodes: 868
Isolated nodes: 0
Edges: 898
No self loops were discovered.
No parallel edges were discovered.
Average total degree: 2.0691
Average in degree: 1.0346
Average out degree: 1.0346
This graph is not weakly connected.
There are 95 weakly connected components. (0 isolates)
The largest connected component consists of 607 nodes.
This graph is not strongly connected.
…

- Select network and run *'Visualization > GUESS'* to open GUESS with file loaded.
- Apply 'Layout > GEM'.
- Export / Import Node Positions – notice that full network is needed before doing this

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Possible Workflows

- Geographic Visualizations
- Word Co-Occurrence Analysis
- Your Data

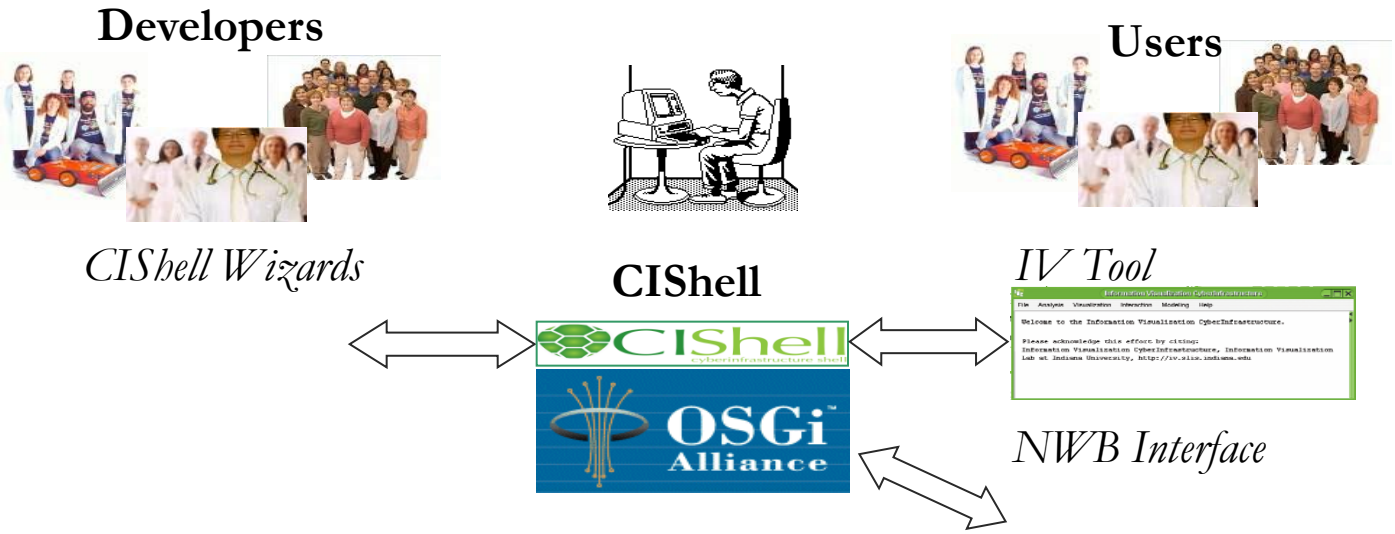
Extraneous Slides

- Adding Plugins to CIShell Powered Tools
- OSGi/CIShell Adoption

Cyberinfrastructure Shell (CIShell)

http://cishell.org

- CIShell is an open source software specification for the integration and utilization of datasets, algorithms, and tools.
- It extends the Open Services Gateway Initiative (OSGi) (http://www.osgi.org), a standardized, component oriented, computing environment for networked services widely used in industry since 10 years.
- Specifically, CIShell provides "sockets" into which existing and new datasets, algorithms, and tools can be plugged using a wizard-driven process.



CIShell – Builds on OSGi Industry Standard

CIShell is built upon the Open Services Gateway Initiative (OSGi) Framework.

OSGi (http://www.osgi.org) is

- A standardized, component oriented, computing environment for networked services.
- Successfully used in the industry from high-end servers to embedded mobile devices since 8 years.
- Alliance members include IBM (Eclipse), Sun, Intel, Oracle, Motorola, NEC and many others.
- Widely adopted in open source realm, especially since Eclipse 3.0 that uses OSGi R4 for its plugin model.

Advantages of Using OSGi

- Any CIShell algorithm is a service that can be used in any OSGi-framework based system.
- Using OSGi, running CIShells/tools can connected via RPC/RMI supporting peer-to-peer sharing of data, algorithms, and computing power.

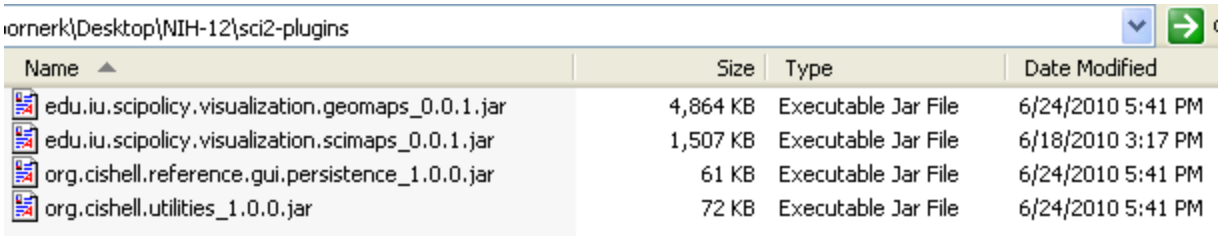
Ideally, CIShell becomes a standard for creating OSGi Services for algorithms.

CIShell – Converter Graph

- No central data format.
- Sci^2 Tool has 26 external and internal data formats and 35 converters.
- Their relationships can be derived by running 'File > Converter Graph' and plotted as shown here. Note that some conversions are symmetrical (double arrow) while others are one-directional (arrow).

CIShell – Add new Plugins, e.g., UCSD Science Map

- Not all code can be shared freely (yet).
- To make the UCSD Science Map and new geomaps available via the Sci² menu, simply add



to the '*yourdirectory/plugin*' directory and restart the tool.

The files were made available in /sci2-plugins directory on the computers in the tutorial room.

The rights to the UCSD map are owned by the Regents of UCSD. Usage does not require a separate, signed agreement or an additional request to our office if consistent with the permission. As a courtesy, please send information on how the map is being used to

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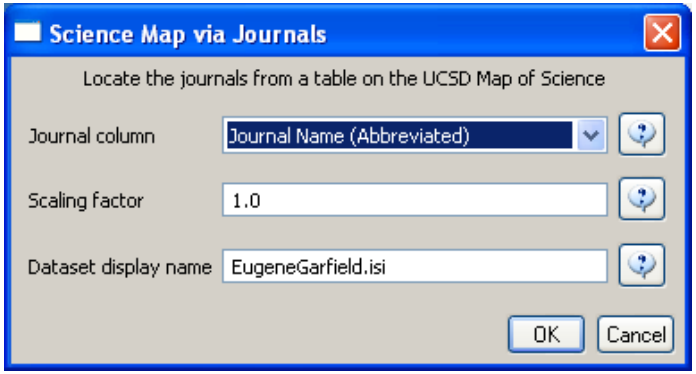
- To delete algorithms that you do not use, simply delete the corresponding *.jar files in the plugin directory.
- Customize your menu structure accordingly—see next slide.

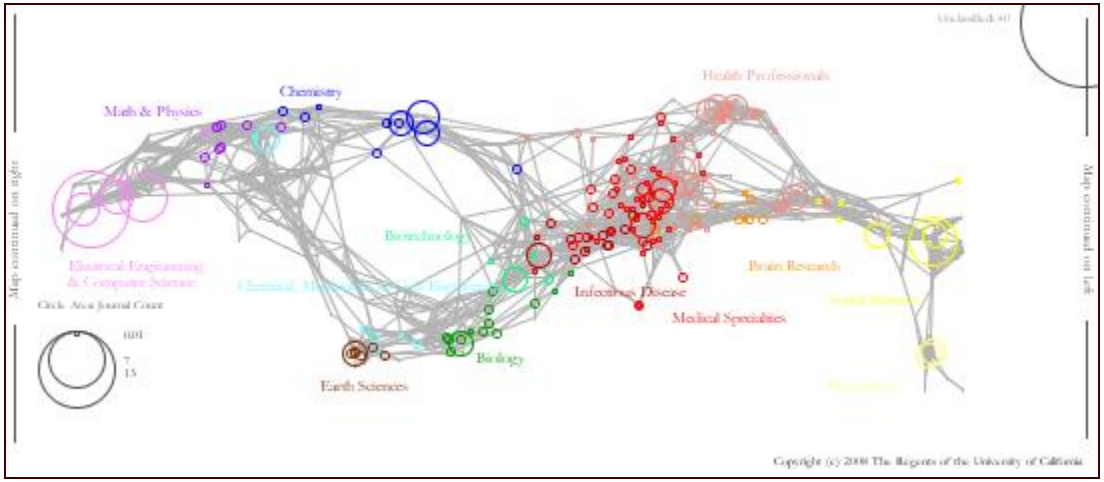
CIShell – Add new Plugins, e.g., UCSD Science Map

- After you added the new plugins, load an ISI file using 'File > Load and Clean ISI File > EugeneGarfield.isi.'

  The file can be found in the */sampledata/scientometrics/isi* directory.
- Select '99 Unique ISI Records' file in Data Manger and run 'Visualization > Topical > Science Map via Journals' with parameters:

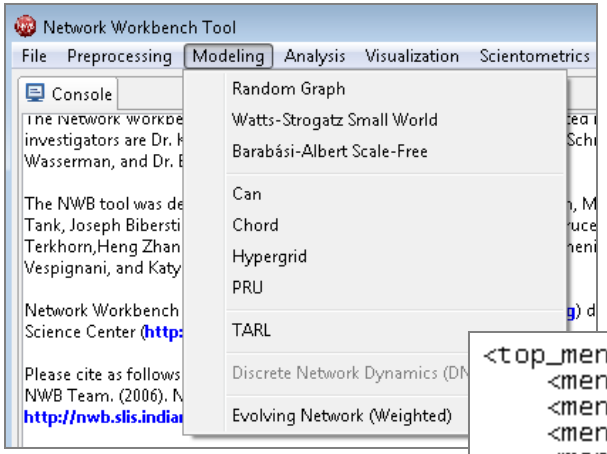


- The result is a science map overlay of Garfield's papers and a listing of journals in 13 fields of science below. See details in **Tutorial #6**.



CIShell – Customize Menu

- The file *'yourtooldirectory/configuration/default_menu.xml'* encodes the structure of the menu system.
- In NWB Tool, the Modeling menu (left) is encoded by the following piece of xml code:




```
<top_menu name="Modeling">
    <menu pid="edu.iu.nwb.modeling.erdosrandomgraph"/>
    <menu pid="edu.iu.nwb.modeling.smallworld"/>
    <menu pid="edu.iu.nwb.modeling.barabasialbert"/>
    <menu type="break"/>
    <menu pid="edu.iu.iv.modeling.p2p.can.CanAlgorithm"/>
    <menu pid="edu.iu.iv.modeling.p2p.chord.ChordAlgorithm"/>
    <menu pid="edu.id.iv.modeling.p2p.hypergrid.Hypergrid"/>
    <menu pid="edu.iu.iv.modeling.p2p.pru.PruAlgorithm"/>
    <menu type="break"/>
    <menu pid="edu.iu.iv.modeling.tarl.TarlAlgorithm"/>
    <menu type="break"/>
    <menu pid="edu.iu.nwb.modeling.discretenetworkdynamics.DNDAlgorithm"/>
    <menu type="break"/>
    <menu pid="edu.iu.nwb.modeling.weighted.evolvingnetwork"/>
</top_menu>
```

CIShell – Integrate New Algorithms

Algorithm Developer's Guide

Overview

The Cyberinfrastructure Shell (CIShell) is an open source, community-driven platform for the integration and utilization of datasets, algorithms, tools, and computing resources. Algorithm integration support is built in for Java and most other programming languages. Being Java based, it will run on almost all platforms. The software and specification is released under an Apache 2.0 License.

This guide attempts to aid algorithm developers in creating algorithms for CIShell (and applications built on CIShell).

This guide tries to contain all the information a new developer needs, but where necessary, it may cite the CIShell 1.0 Specification (API) or the OSGi Service Platform Specification, Release 4 (API). While the guide tries to make beginning algorithm development easier, the CIShell Specification has the last word on how the CIShell Platform works.

Table of Contents

http://cishell.org/?n=DevGuide.NewGuide

OSGi/CIShell Adoption

CIShell/OSGi is at the core of different CIs and a total of 169 unique plugins are used in the

- ***Information Visualization*** (http://iv.slis.indiana.edu),
- ***Network Science (NWB Tool)*** (http://nwb.slis.indiana.edu),
- ***Scientometrics and Science Policy (Sci^2 Tool)*** (http://sci.slis.indiana.edu), and
- ***Epidemics*** (http://epic.slis.indiana.edu) research communities.

Most interestingly, a number of other projects recently adopted OSGi and one adopted CIShell:

Cytoscape (http://www.cytoscape.org) lead by Trey Ideker, UCSD is an open source bioinformatics software platform for visualizing molecular interaction networks and integrating these interactions with gene expression profiles and other state data (Shannon et al., 2002).

Taverna Workbench (http://taverna.sourceforge.net) lead by Carol Goble, University of Manchester, UK is a free software tool for designing and executing workflows (Hull et al., 2006). Taverna allows users to integrate many different software tools, including over 30,000 web services.

MAEviz (https://wiki.ncsa.uiuc.edu/display/MAE/Home) managed by Shawn Hampton, NCSA is an open-source, extensible software platform which supports seismic risk assessment based on the Mid-America Earthquake (MAE) Center research.

TEXTrend (http://www.textrend.org) lead by George Kampis, Eötvös University, Hungary develops a framework for the easy and flexible integration, configuration, and extension of plugin-based components in support of natural language processing (NLP), classification/mining, and graph algorithms for the analysis of business and governmental text corpuses with an inherently temporal component.

As the functionality of OSGi-based software frameworks improves and the number and diversity of dataset and algorithm plugins increases, the capabilities of custom tools will expand.

The Changing Scientific Landscape

Star Scientist -> Research Teams might have 100 or more members & exist few months only.
Users -> Contributors students, faculty, practitioners.
Disciplinary -> Cross-disciplinary with different cultures, languages, approaches.
One Specimen -> Data Streams updated nightly or even more frequently

High Quality Open Data

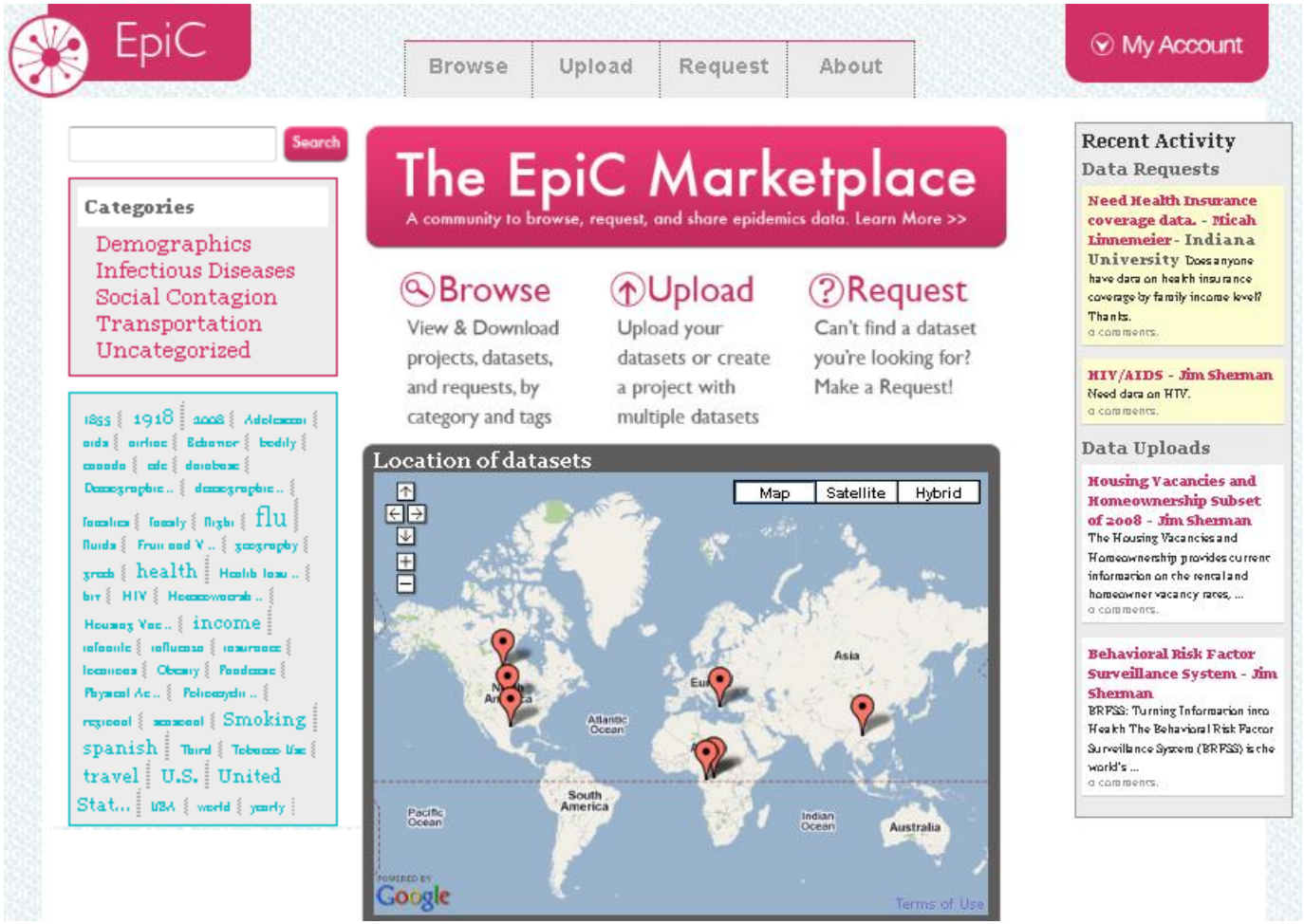
Scholarly Database: 23 million scholarly records
http://sdb.slis.indiana.edu

VIVO National Researcher Networking
http://vivoweb.org

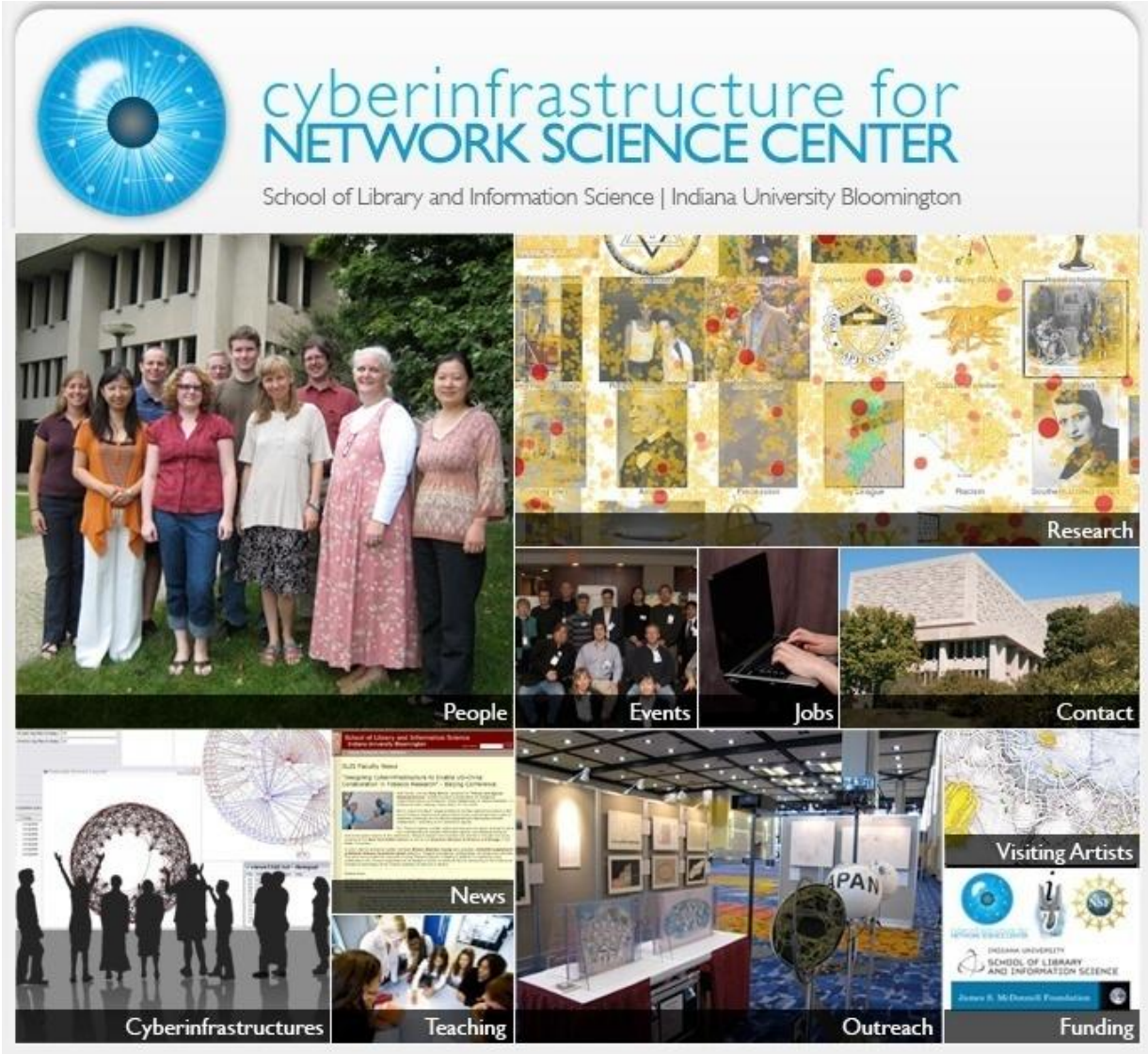
Static Instrument -> Evolving Cyberinfrastructure (CI) daily learning and documentation.

Macroscopes can make a major difference if they support:
Division of Labor – proper incentive structures are key.
Ease of Use – learn from YouTube, Flickr, Wikipedia
Modularity – plug-and-play helps reduce costs; increases flexibility, augmentation, customization
Standardization – speeds up 'translation' into products/practice.
Open Data and Open Code – use the minds of millions!

Epidemics Marketplace



http://dev.epic.slis.indiana.edu



All papers, maps, cyberinfrastructures, talks, press are linked from http://cns.slis.indiana.edu