Tutorial 1:
Open Source Tools for S&T Data Analysis and Visualization

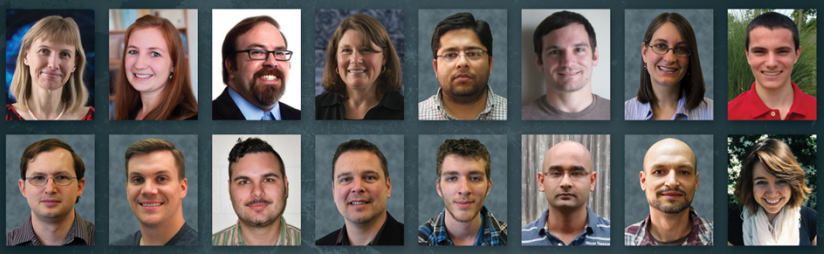
Katy Börner
Victor H. Yngve Professor of Information Science
Director, Cyberinfrastructure for Network Science Center
School of Informatics and Computing, Indiana University, USA

ISSI , Rectorate Conference Hall
Istanbul, Turkey

9:00-11:00, 11:15-13:00
June 29, 2015

Please
- download the Sci2 Tool from http://sci2.cns.iu.edu
- these slides http://cns.iu.edu/docs/presentations/2015-borner-issi-tutorial.pdf
- and complete the Pre-Tutorial Questionnaire

CNS Macroscopes are used by hundreds of thousands around the globe



Our mission is to advance datasets, tools, and services for the study of biomedical, social and behavioral science, physics, and other networks. A specific focus is research on the structure and evolution of science and technology (S&T) and the communication of results via static and interactive maps of science. Learn more at cishell.org.

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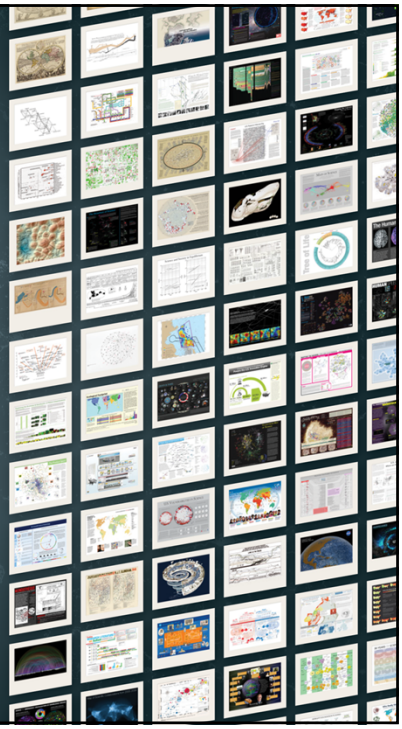
Places & Spaces Exhibit

This exhibit aims to demonstrate the power of maps to navigate and make sense of physical places and abstract topic spaces. The tenth and final iteration of maps debuted at the University of Miami on September 4, 2014, where all 100 maps will remain in display through December 11, 2014.

Phase 2 of this unique exhibit is designed to bring Macroscope tools to public places to help exhibit visitors not only learn how to **read** science maps but how to **make** them.

See all the maps and more at the new scimaps.org.



PLACES & SPACES MAPPING SCIENCE

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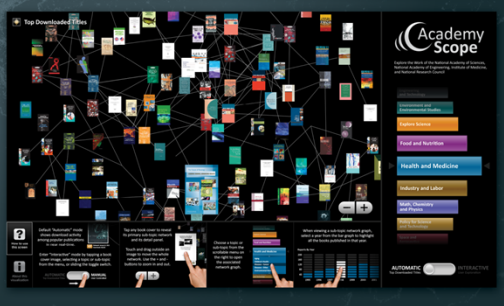
AcademyScope

AcademyScope is a state-of-the-art, interactive touch-screen visualization developed by CNS in collaboration with the National Academy of Sciences.

Using a 55-inch, multi-touch screen, viewers can explore 20 years of reports published by the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council.

Beginning in October 2014, the *AcademyScope* web application is available to the public through the National Academies Press website. Users can acccess the application through the "Browse by Topic" menu on the NAP homepage (www.nap.edu), or via the "Browse Topics" button in the header of every interior page. The application can also be accessed directly at www.nap.edu/academy-scope.

Visit cns.iu.edu/interactive_displays to learn more about the design and programming.



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IVMOOC 2015

The Information Visualization MOOC provides an overview about the state of the art in information visualization, teaching the process of producing effective visualizations that take the needs of users into account.

The inaugural IVMOOC, which launched in January 2013, attracted participants from more than 100 countries. It is one of the first MOOCs offered by IU and the first to offer an opportunity for students to work in teams with real clients. All registrants gain free access to the Scholarly Database and the Sci2 Tool.

The course can be taken for three Indiana University credits as part of the Online Data Science Program offered by the School of Informatics and Computing.

The course will return in January 2015. Learn more at ivmooc.cns.iu.edu.

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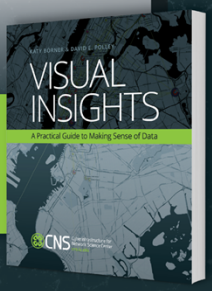

This IVMOOC companion textbook offers a gentle introduction to the design of insightful visualizations. It seamlessly blends theory and practice, giving readers both the theoretical foundation and the practical skills necessary to render data into insights.

CNS Cyberinfrastructure for Network Science Center

Tutorial Overview

9:00 Welcome and Overview of Tutorial and Attendees
9:30 The Sci2 Tool
- Download and run the Sci2 Tool
- ONE dataset, MANY analyses and visualizations

10:00 Sci2 Tool Workflows
- Temporal Analysis: Horizontal line graph of NSF projects
- Geospatial Analysis: US and world maps
- Geospatial Analysis: Geomap with network overlays
- Topical Analysis: Visualize research profiles
- Network Analysis: Co-occurrence networks and bimodal networks
- Network Analysis: Evolving collaboration networks

11:00 Networking Break

11:15 Visualization Framework
11:45 IVMOOC – MANY more Workflows
12:15 Plug-and-Play Macroscopes
12:30 Outlook and Q&A
13:00 Adjourn

6

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7

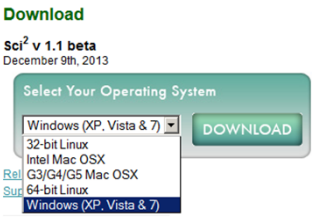
The Sci2 Tool:

A Plug-and-Play Macroscope that implements the Visualization Framework

8

Software, Datasets, Plugins, and Documentation

- These slides
  http://cns.iu.edu/docs/presentations/2015-borner-issi-tutorial.pdf
- Sci2 Tool Manual v0.5.1 Alpha, updated to match v1.0 Alpha tool release
  http://sci2.wiki.cns.iu.edu
- Sci2 Tool v 1.1 beta
  http://sci2.cns.iu.edu
- Additional Datasets
  http://sci2.wiki.cns.iu.edu/2.5+Sample+Datasets
- Additional Plugins
  http://sci2.wiki.cns.iu.edu/3.2+Additional+Plugins



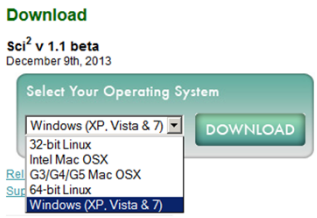
Make sure you have Java 1.6 (32-bit suffices) or higher installed or download from http://www.java.com/en/download. To check your Java version, open a terminal and run 'java -version'.

Some visualizations are saved as Postscript files. A free Postscript to PDF viewer is at http://ps2pdf.com and a free PDF Viewer at http://www.adobe.com/products/reader.html.

9

Install and Run Sci2

Sci2 Tool runs on Windows, Mac, and Linux.



Unzip.

Run /sci2/sci2.exe

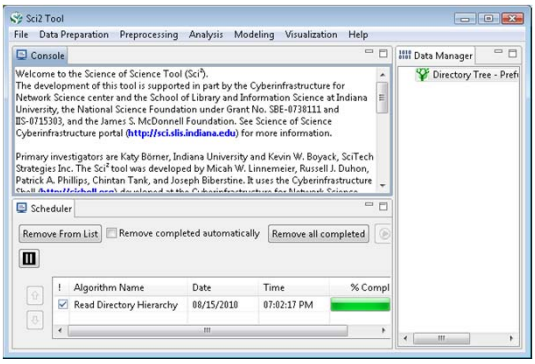
10

Sci2 Tool Interface Components

See also http://sci2.wiki.cns.iu.edu/2.2+User+Interface

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.



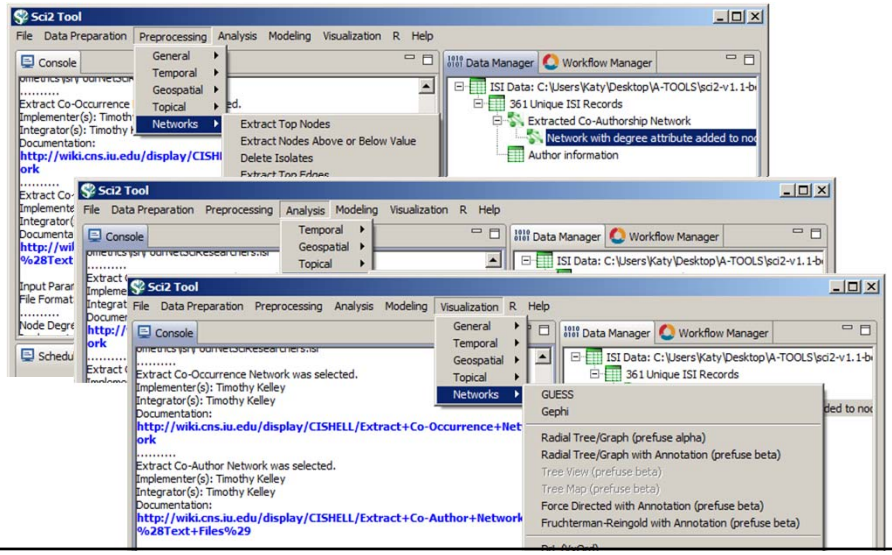
All workflows are recorded into a log file (see /sci2/logs/…), and can be re-run for easy replication. If errors occur, they are saved in a error log to ease bug reporting.

All algorithms are documented online; workflows are given in Sci2 Manual at http://sci2.wiki.cns.iu.edu

11

Sci2 Tool Interface Components

Download for free at http://sci2.cns.iu.edu



12

CNS Cyberinfrastructure for Network Science Center

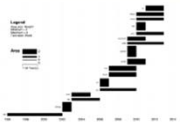
Load **One** File and Run **Many** Analyses and Visualizations

Times Cited	Publication Year	City of Publisher	Country	Journal Title (Full)	Title	Subject Category	Authors
12	2011	NEW YORK	USA	COMMUNICATIONS OF THE ACM	Plug-and-Play Macroscopes	Computer Science	Borner, K
18	2010	MALDEN	USA	CTS-CLINICAL AND TRANSLATIONAL SCIENCE	Advancing the Science of Team Science	Research & Experimental Medicine	Falk-Krzesinski, HJ|Borner, K|Contractor, N|Fiore, SM|Hall, KL|Keyton, J|Spring, B|Stokols, D|Trochim, W|Uzzi, B
13	2010	WASHINGTON	USA	SCIENCE TRANSLATIONAL MEDICINE	A Multi-Level Systems Perspective for the Science of Team Science	Cell Biology |Research & Experimental Medicine	Borner, K|Contractor, N|Falk-Krzesinski, HJ|Fiore, SM|Hall, KL|Keyton, J|Spring, B|Stokols, D|Trochim, W|Uzzi, B

Statistical Analysis–p. 44

Location	Count	# Citations
Netherlands	13	292
United States	9	318
Germany	11	36
United Kingdom	1	2

Temporal Burst Analysis–p. 48



Geospatial Analysis–p. 52

Geospatial Analysis–p. 52

13

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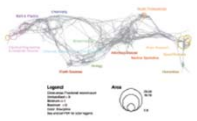
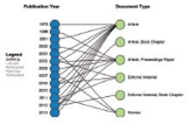
Topical Analysis–p. 56



Paper Citation Network–p. 60

Bi-Modal Network–p. 60



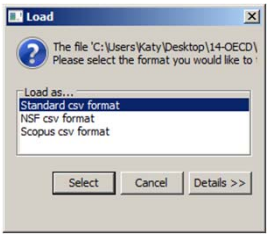
Co-author and many other bi-modal networks.

14

CNS Cyberinfrastructure for Network Science Center

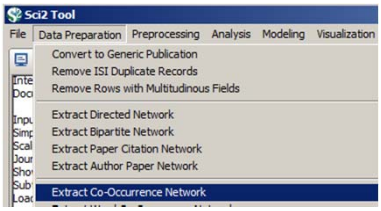
Load **One** File and Run **Many** Analyses and Visualizations

Download 20publications.csv from
http://wiki.cns.iu.edu/download/attachments/1245848/20publications.csv?version=1&modificationDate=1403450235951



In Sci2, use 'File > Load' and load file as 'Standard csv format'.

Run 'Data Preparation > Extract Co-Occurrence Network' with parameters:



Co-author network will appear in **Data Manager**.

15

CNS Cyberinfrastructure for Network Science Center

Load **One** File and Run **Many** Analyses and Visualizations

Run 'Analysis > Network Analysis Toolkit (NAT)' to get basic properties:

Nodes: 65
Isolated nodes: 0
Edges: 404
No self loops were discovered.
Average degree: 12.4308
The largest connected component consists of 65 nodes.
Density (disregarding weights): 0.1942

Select 'Extracted Network on Column Authors' network in Data Manager and run 'Visualization > GUESS' to open GUESS with file loaded.

Initial layout is random:

In GUESS, apply 'Layout > GEM':

16

Sci2 Workflows

Light, Robert, David E. Polley, and Katy Börner. 2014. "Open Data and Open Code for Big Science of Science Studies". *Scientometrics* 101 (2): 1535-1551.

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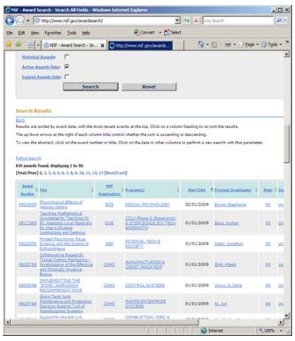
18

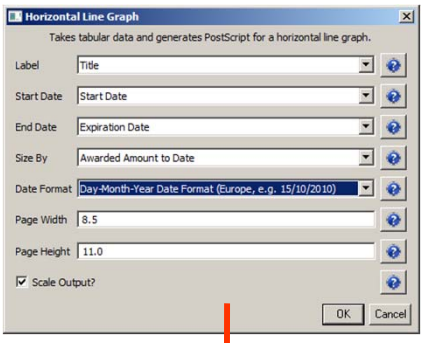
Horizontal line graph of NSF projects

See 5.2.1 Funding Profiles of Three Universities (NSF Data)

Download NSF data



Visualize as Horizontal Line Graph



Area size equals numerical value, e.g., award amount.

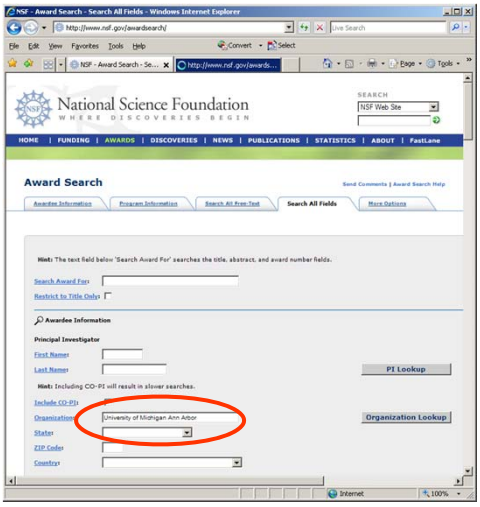
Text

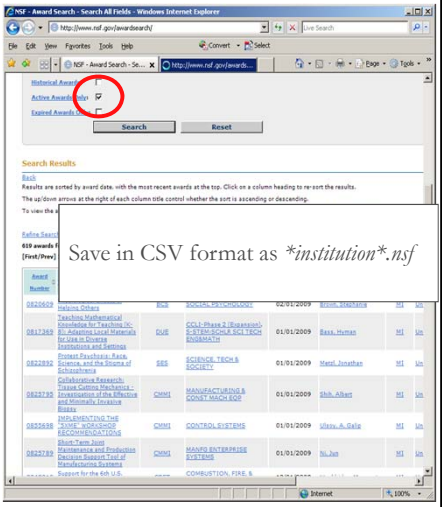
Start date End date

19

Horizontal line graph of NSF projects

NSF Awards Search via http://www.nsf.gov/awardsearch





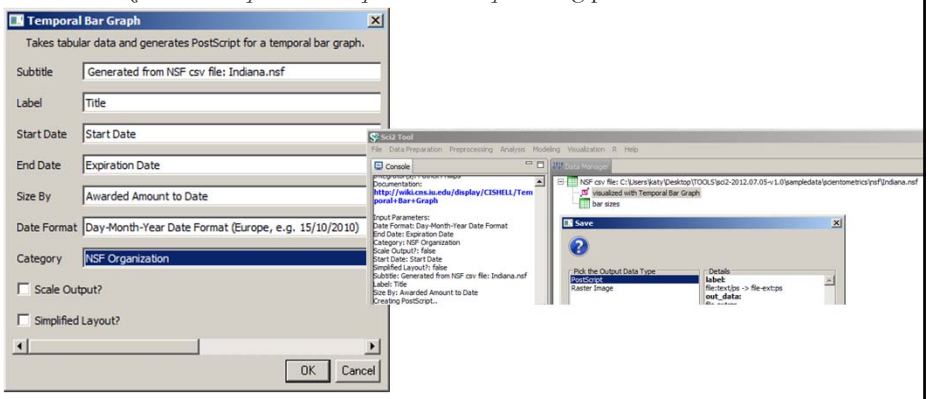
Save in CSV format as **institution*.nsf*

20

Temporal bar graph of NSF projects

Download and load a dataset of your choice or load one of the sample data files, e.g., *'sampledata/scientometrics/nsf/Indiana.nsf.'*

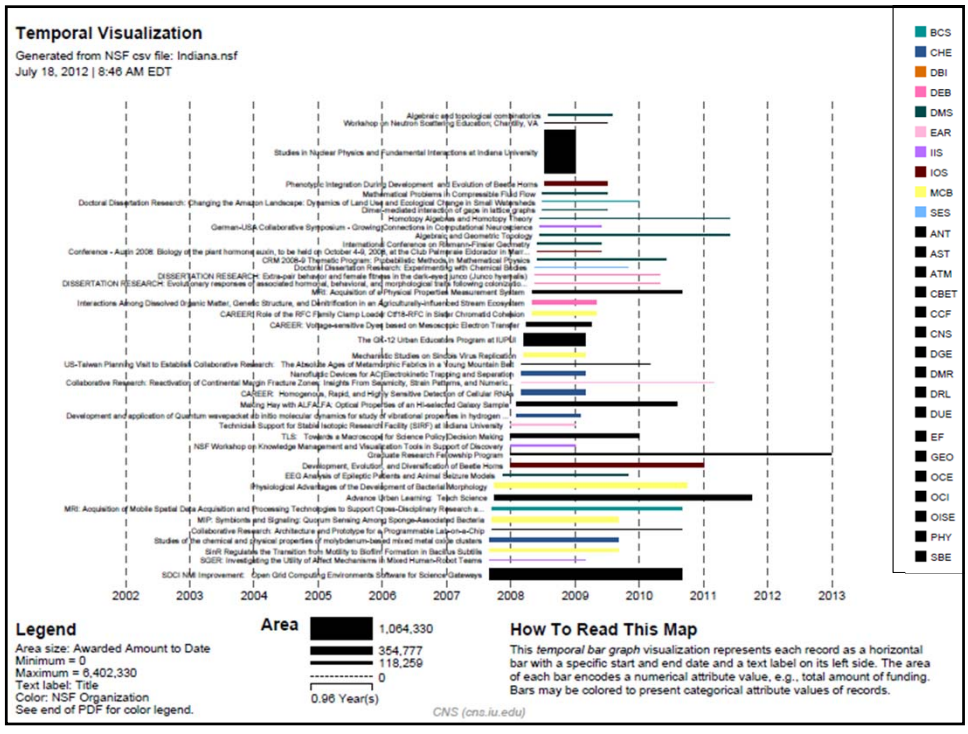
Run *'Visualization > Temporal > Temporal Bar Graph'* using parameters:

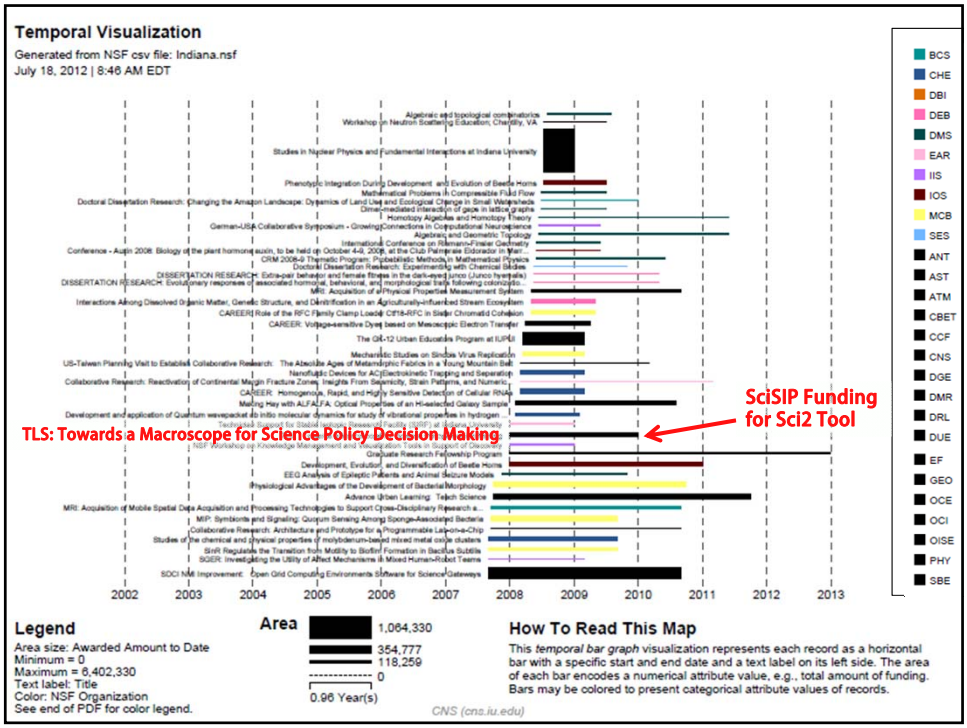


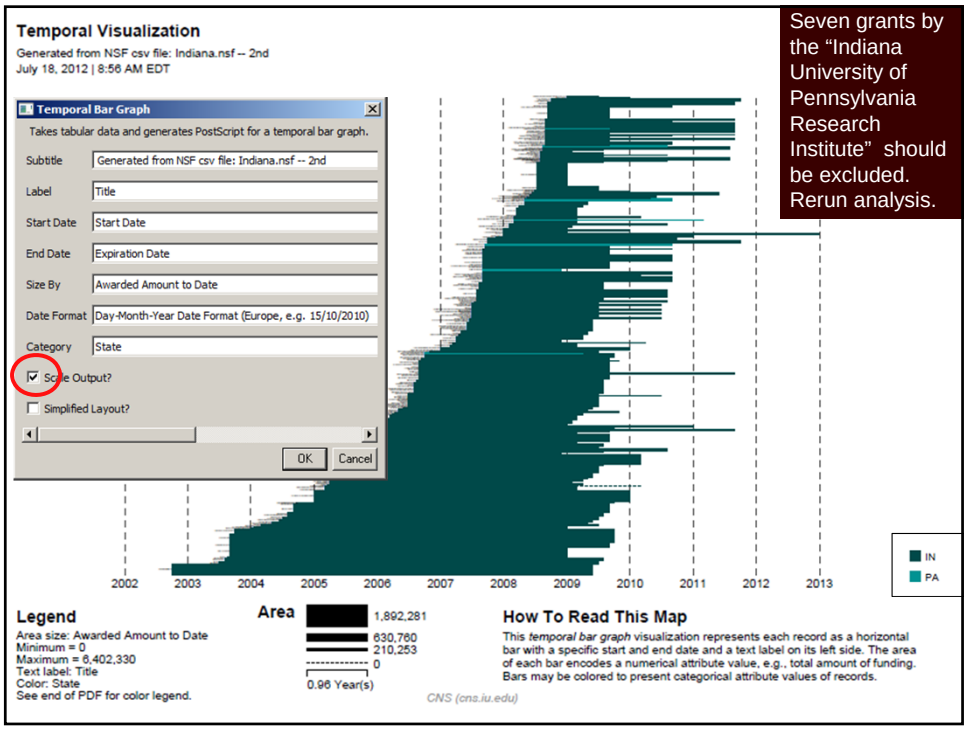
Save *'visualized with Horizontal Line Graph'* as ps or eps file. Convert into pdf and view.

Zoom to see details in visualizations of large datasets, e.g., all NSF awards ever made.

21




Temporal Visualization
Generated from NSF csv file: Indiana.nsf
July 18, 2012 | 8:46 AM EDT
TLS: Towards a Macroscope for Science Policy Decision Making
SciSIP Funding for Sci2 Tool
BCS
CHE
DBI
DEB
DMS
EAR
IIS
IOS
MCB
SES
ANT
AST
ATM
CBET
CCF
CNS
DGE
DMR
DRL
DUE
EF
GEO
OCE
OCI
OISE
PHY
SBE
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Legend
Area size: Awarded Amount to Date
Minimum = 0
Maximum = 6,402,330
Text label: Title
Color: NSF Organization
See end of PDF for color legend.
Area
1,064,330
354,777
118,259
0
0.96 Year(s)
How To Read This Map
This temporal bar graph visualization represents each record as a horizontal bar with a specific start and end date and a text label on its left side. The area of each bar encodes a numerical attribute value, e.g., total amount of funding. Bars may be colored to present categorical attribute values of records.
CNS (cns.iu.edu)


Temporal Visualization
Generated from NSF csv file: Indiana.nsf -- 2nd
July 18, 2012 | 8:56 AM EDT
Seven grants by the "Indiana University of Pennsylvania Research Institute" should be excluded. Rerun analysis.
Temporal Bar Graph
Takes tabular data and generates PostScript for a temporal bar graph.
Subtitle
Generated from NSF csv file: Indiana.nsf -- 2nd
Label
Title
Start Date
Start Date
End Date
Expiration Date
Size By
Awarded Amount to Date
Date Format
Day-Month-Year Date Format (Europe, e.g. 15/10/2010)
Category
State
Scale Output?
Simplified Layout?
OK
Cancel
IN
PA
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Legend
Area size: Awarded Amount to Date
Minimum = 0
Maximum = 6,402,330
Text label: Title
Color: State
See end of PDF for color legend.
Area
1,892,281
630,760
210,253
0
0.96 Year(s)
How To Read This Map
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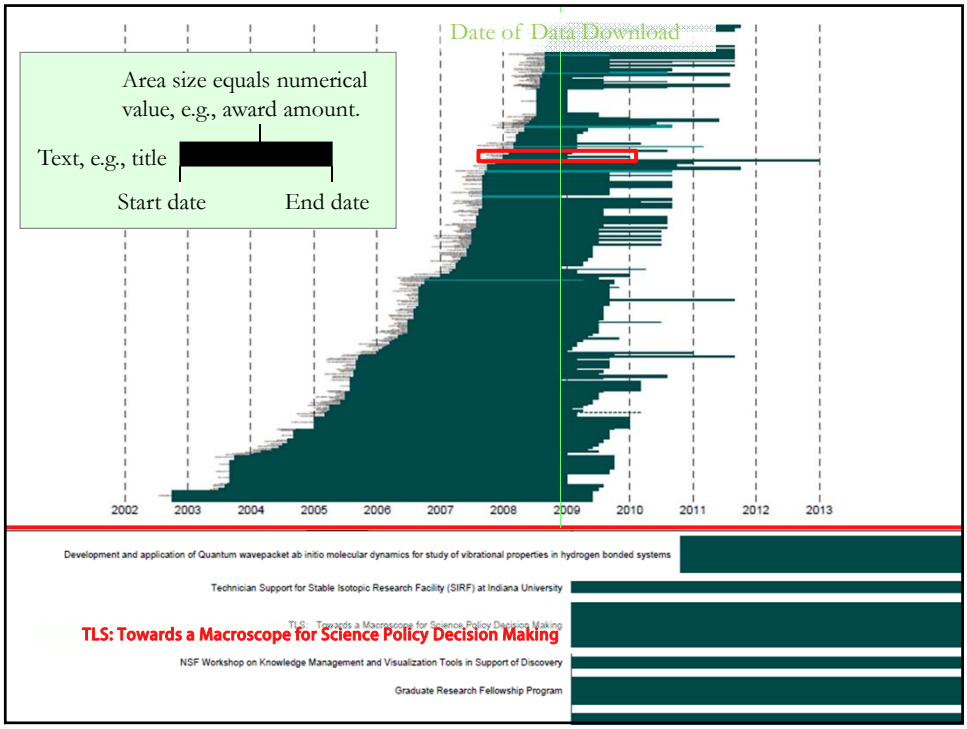
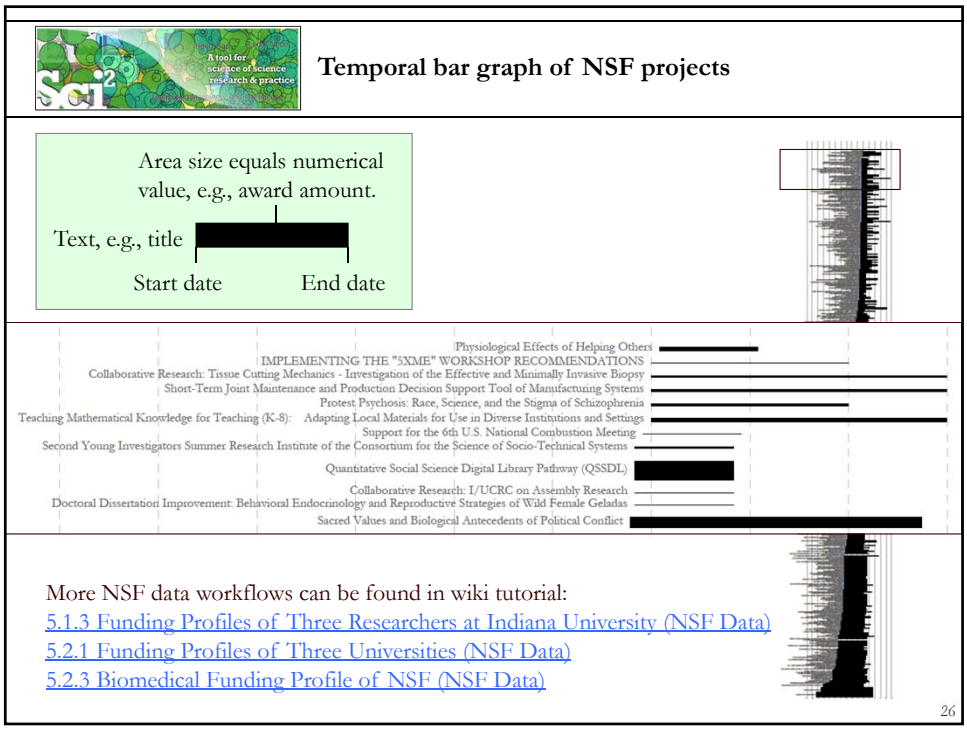
CNS (cns.iu.edu)


Date of Data Download
Area size equals numerical value, e.g., award amount.
Text, e.g., title
Start date
End date
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Development and application of Quantum wavepacket ab initio molecular dynamics for study of vibrational properties in hydrogen bonded systems
Technician Support for Stable Isotopic Research Facility (SIRF) at Indiana University
TLS: Towards a Macroscope for Science Policy Decision Making
NSF Workshop on Knowledge Management and Visualization Tools in Support of Discovery
Graduate Research Fellowship Program


Sci2
A tool for science of science research & practice
Temporal bar graph of NSF projects
Area size equals numerical value, e.g., award amount.
Text, e.g., title
Start date
End date
Physiological Effects of Helping Others
IMPLEMENTING THE "5XME" WORKSHOP RECOMMENDATIONS
Collaborative Research: Tissue Cutting Mechanics - Investigation of the Effective and Minimally Invasive Biopsy
Short-Term Joint Maintenance and Production Decision Support Tool of Manufacturing Systems
Protest Psychosis: Race, Science, and the Stigma of Schizophrenia
Teaching Mathematical Knowledge for Teaching (K-8): Adapting Local Materials for Use in Diverse Institutions and Settings
Support for the 6th U.S. National Combustion Meeting
Second Young Investigators Summer Research Institute of the Consortium for the Science of Socio-Technical Systems
Quantitative Social Science Digital Library Pathway (QSSDL)
Collaborative Research: I/UCRC on Assembly Research
Doctoral Dissertation Improvement: Behavioral Endocrinology and Reproductive Strategies of Wild Female Geladas
Sacred Values and Biological Antecedents of Political Conflict
More NSF data workflows can be found in wiki tutorial:
5.1.3 Funding Profiles of Three Researchers at Indiana University (NSF Data)
5.2.1 Funding Profiles of Three Universities (NSF Data)
5.2.3 Biomedical Funding Profile of NSF (NSF Data)
26

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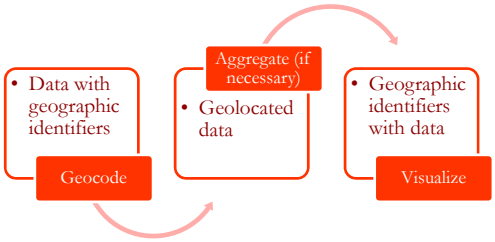
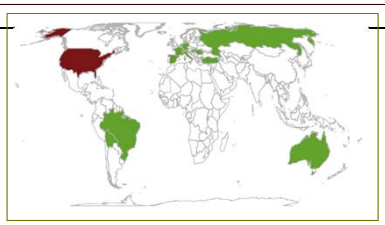
27

Geocoding and Geospatial Maps

http://wiki.cns.iu.edu/display/CISHELL/Bing+Geocoder





Region names + numeric data
(Choropleth Map)

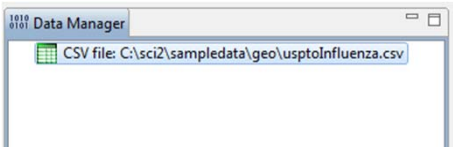
Geocoordinates + numeric data
(Proportional Symbol Map)

28

Load File with Address and Times Cited Fields

Run '*File* > *Load…*' and select the sample data table '*sampledata/geo/usptoInfluenza.csv*'
Create a map of influenza patents held by different countries.

	A	B	C	D	E
1	Country	Latitude	Longitude	Patents	Times Cited
2	Hungary	47.16116	19.504959	0.083333333	4
3	Belgium	50.500992	4.47677	3.017857143	11
4	Germany	51.090839	10.45424	4.783333333	4
5	Canada	62.35873	-96.582092	5.539285714	21
6	Russia	59.461479	108.831779	0.266666667	2
7	Austria	47.69651	13.34577	4.2	17
8	Netherlands	52.108089	5.33033	1	2
9	Switzerland	46.813091	8.22414	0.507575758	6
10	Taiwan	23.599751	121.023811	2	3
11	Australia	-24.916201	133.393112	1.617857143	23
12	United States	39.83	-98.58	73.9983889	220
13	France	46.712448	1.71832	2.201165501	9
14	South Africa	-28.483219	24.676991	0.333333333	1
15	Japan	37.487598	139.838287	15.99166667	39
16	Israel	31.389299	35.36124	3.5	3
17	United Kingdom	54.313919	-2.23218	3.85	12



29

Bing Geocoder

CIShell Manual / … / Algorithms

Edit Watch Share Tools

Bing Geocoder

Created by Mayur Masrani, last modified by Adam Simpson on Aug 14, 2013

Description

This algorithm converts place names or addresses into Latitude, Longitude co-ordinates. It accepts international addresses, countries, States of United States of America and ZIP codes of United States of America. All co-ordinates are obtained by querying Bing geocoder service. Internet access must be available during geocoding.

Pros & Cons

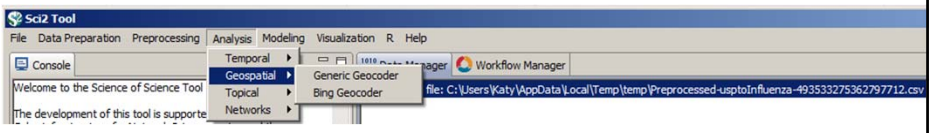
1. The performance is slower than the Geocoder and may vary due to the network latency since the queries are requested through internet service.
2. Bing Geocoder supports address geocoding with international coverage which is not supported by Geocoder.
3. To use Bing Geocoder, user has to obtain an API Keys from Bing Maps. Save your api keys and provide it when requested by the Bing Geocoder. Since each api key is allowed to geocode 50,000 locations per 24 hours, the user is encouraged to test on a small set of data first.

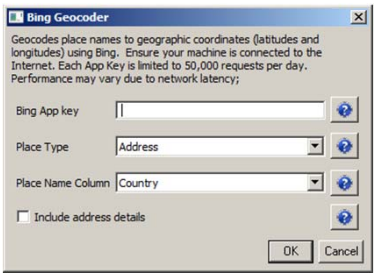
http://wiki.cns.iu.edu/display/CISHELL/Bing+Geocoder

30

Using Bing Geocoder

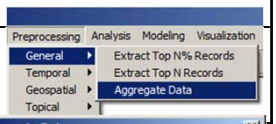
Run *'Analysis > Geospatial > Bing Geocoder'*

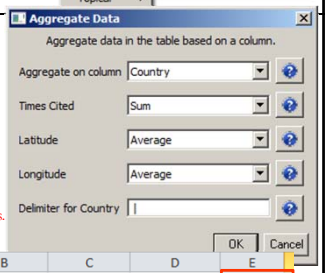




Enter your Bing app key.
You can obtain one from here

Aggregate by Country



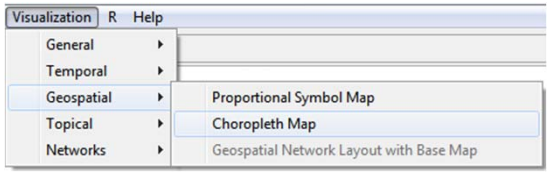


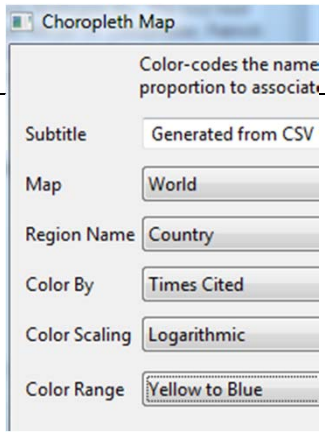
Aggregate Data was selected.
Implementer(s): Chintan Tank
Documentation: **http://wiki.cns.iu.edu/display/CISHELL/Aggregate+Data**
Input Parameters:
Aggregate on column: Country
Delimiter for Country: |
Longitude: AVERAGE
Latitude: AVERAGE
Times Cited: SUM
Aggregated by '': All rows of Latitude column were skipped due to no non-null, non-empty values.
Aggregated by '': All rows of Longitude column were skipped due to no non-null, non-empty values.
Frequency of unique "Country" values added to "Count" column.

	A	B	C	D
1	Times Cited	Latitude	Longitude	Country
2	7	42.02946091	-87.68838501	United States
3	0			
4	0			
5	2	42.34999466	-71.08765411	United States
6	14	41.70074844	-86.23918915	United States
7	15	41.70074844	-86.23918915	United States
8	29	41.89422607	-87.61901855	United States
9	32	41.70074844	-86.23918915	United States
10	7	41.70074844	-86.23918915	United States
11	5	41.70074844	-86.23918915	United States
12	2	41.11500168	-85.73377991	United States
13	10	47.50622177	19.06481934	Hungary
14	44	41.70074844	-86.23918915	United States
15	0	47.50622559	19.06481934	Hungary
16	19	41.70074844	-86.23918915	United States

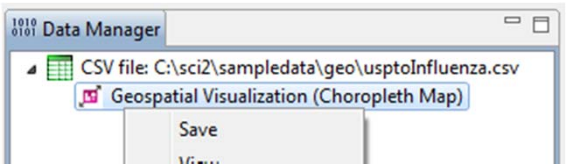
	A	B	C	D	E
1	Times Cited	Latitude	Longitude	Country	Count
2	14680	[41.10645f]	[-82.45309f]	United States	194
3	1802				57
4	398	[47.506226f]	[19.06482f]	Hungary	14
5	101	[37.25198f]	[127.08451f]	South Korea	4
6	18	[32.08439f]	[34.81297f]	Israel	1
7	57	[46.768517f]	[23.585135f]	Romania	2
8	55	[47.06615f]	[7.2015657f]	Switzerland	2
9	455	[47.977184f]	[2.2232702f]	France	12
10	92	[52.15457f]	[4.49463f]	Netherlands	5
11	21	[49.944717f]	[84.528114f]	Russia	2
12	1112	[41.545982f]	[1.7138832f]	Spain	13
13	1381	[43.352654f]	[12.727126f]	Italy	46
14	188	[-22.494667f]	[-45.4818f]	Brazil	3
15	56	[51.24459f]	[10.360385f]	Germany	2
16	0	[-16.49901f]	[-68.14626f]	Bolivia	1

Choropleth Map



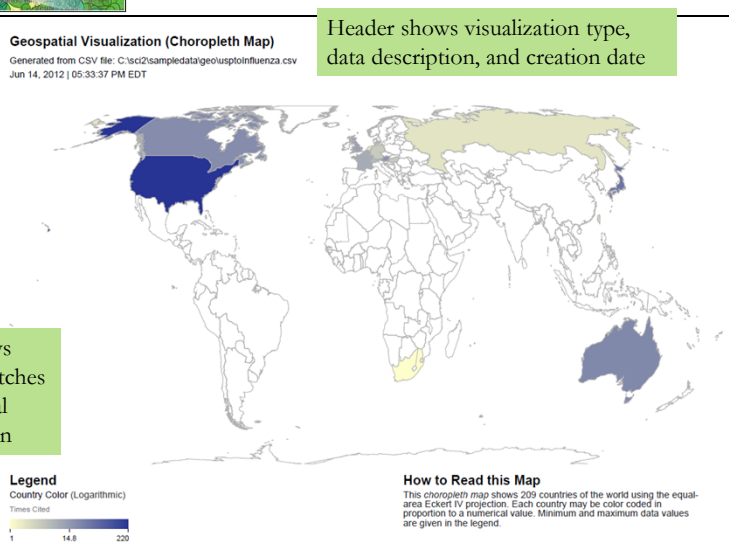


Right-click and **Save** map as PostScript file. Use PostScript Viewer or convert to pdf to view.



33

Reading the Choropleth Map

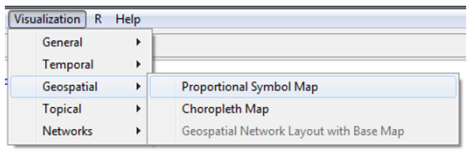


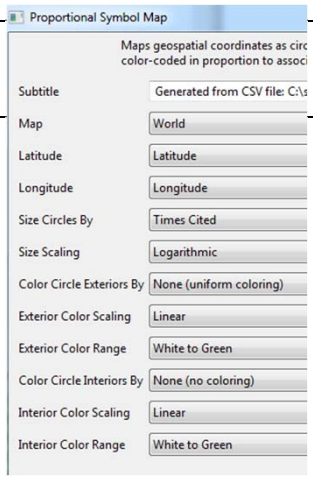
Header shows visualization type, data description, and creation date

Legend shows how data matches up with visual representation

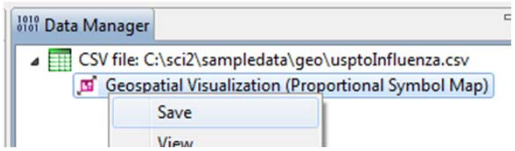
34

Proportional Symbol Map



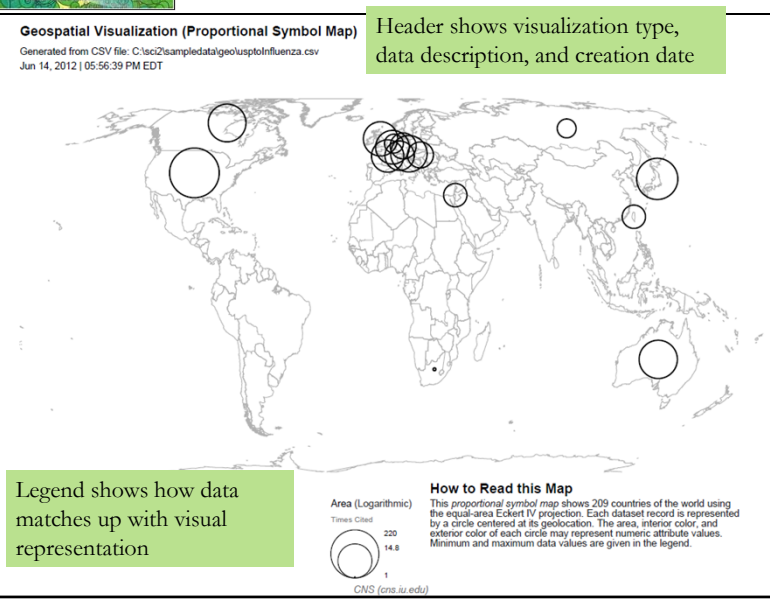


Right-click and **Save** map as PostScript file. Use PostScript Viewer or convert to pdf to view.



35

Reading the Proportional Symbol Map



Header shows visualization type, data description, and creation date

Legend shows how data matches up with visual representation

36

Relevant Sci2 Manual entry

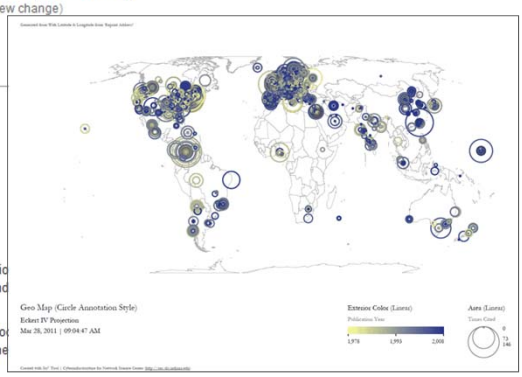
Edit Add Tools

5.2.4 Mapping Scientometrics (ISI Data)

9 Added by Ted Polley, last edited by Ted Polley on Nov 14, 2011 (view change)

5.2.4.1 Document Co-Citation

Scientometrics.isi	
Time frame:	1978-2008
Region(s):	Miscellaneous
Topical Area(s):	Scientometrics
Analysis Type(s):	Document Co-Citation Network



Scientometrics is a discipline which uses statistical and computatio
science. Here we use ISI data from the journal "Scientometrics" and
Awards Search.

Download Scientometrics.isi. Load the file using '*File > Load*' and lo
document co-citation analysis, as the scale is large enough that the
similarity within the domain of scientometrics.

New ISI File Format

Web of Science made a change to their output format in September, 2011. Older versions of Sci2 tool may refuse to load these new files, with an error like "Invalid ISI format file selected."

http://wiki.cns.iu.edu/display/SCI2TUTORIAL/5.2.4+Mapping+Scientometrics+%28ISI+Data%29

37

CNS Cyberinfrastructure for Network Science Center

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- ONE dataset, MANY analyses and visualizations

10:00 Sci2 Tool Workflows
- Temporal Analysis: Horizontal line graph of NSF projects
- Geospatial Analysis: US and world maps
- **Geospatial Analysis: Geomap with network overlays**
- Topical Analysis: Visualize research profiles
- Network Analysis: Co-occurrence networks and bimodal networks
- Network Analysis: Evolving collaboration networks

11:00 Networking Break

11:15 Visualization Framework
11:45 IVMOOC – MANY more Workflows
12:15 Plug-and-Play Macroscopes
12:30 Outlook and Q&A
13:00 Adjourn

38

Geomap with Gephi Network Overlay

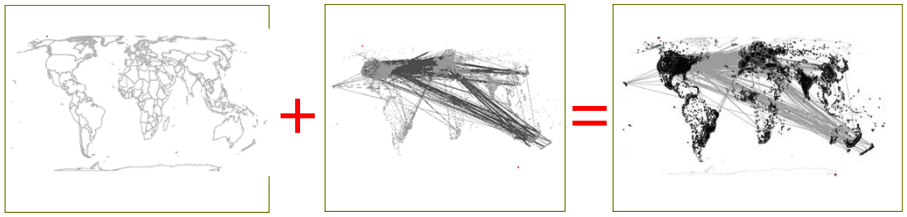
See 4.7.6 on http://sci2.wiki.cns.iu.edu

File with geolocations and linkage info, e.g., an isi biblio-graphy file. →

Use Bing Geocoder to identify Latitude, Longitude for each geolocation
Extract attributes per geolocation, e.g., total times cited (TC)
Extract linkages and their attributes, e.g., number of co-occurences
See sample /geo/LaszloBarabasiGeo.net with co-occurrence of "Research Addresses" and full counting of TC per geolocation.

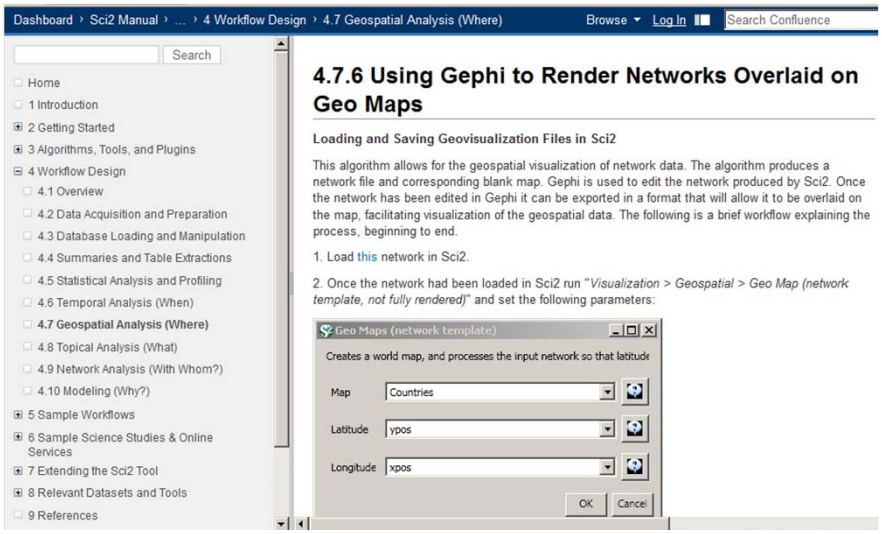
↓

Read into Sci2 Tool to generate geomap and network file → Layout network in Gephi → Combine geomap and network in Photoshop



39

Relevant Sci2 Manual entry

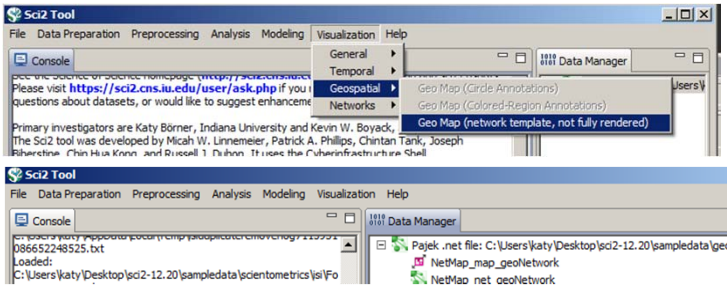


http://sci2.wiki.cns.iu.edu/display/SCI2TUTORIAL/4.7+Geospatial+Analysis+%28Where%29#4.7GeospatialAnalysis%28Where%29-4.7.6UsingGephitoRenderNetworksOverlaidonGeoMaps

40

Use Sci2 Tool to Generate Geomap and Network File

Read prepared .net file and run:



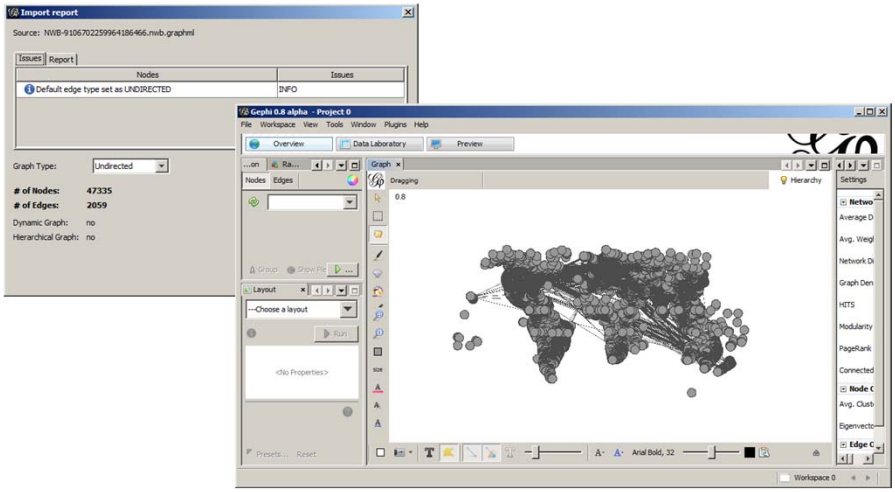
Save map file as Postscript file and use Adobe or other view to read. It looks like:

Save .net file as GraphML (Prefuse) and rename to .graphml so that Gephi can read it.

41

Use Gephi to Generate Network Layout

Start gephi. Use *New Project* > *Open a graph file* to read .graphml file that Sci2 generated.

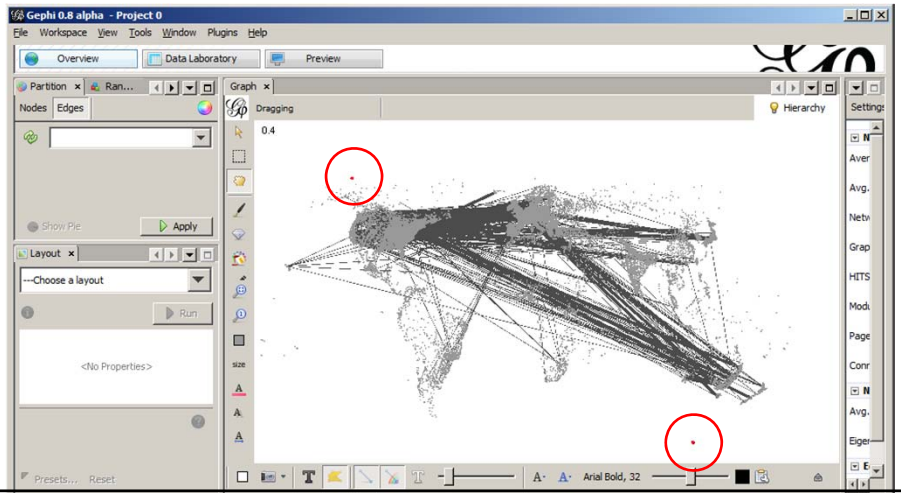


Follow instructions in online tutorial on **Manipulating the Network File in Gephi**

42

Use Gephi to Generate Network Layout

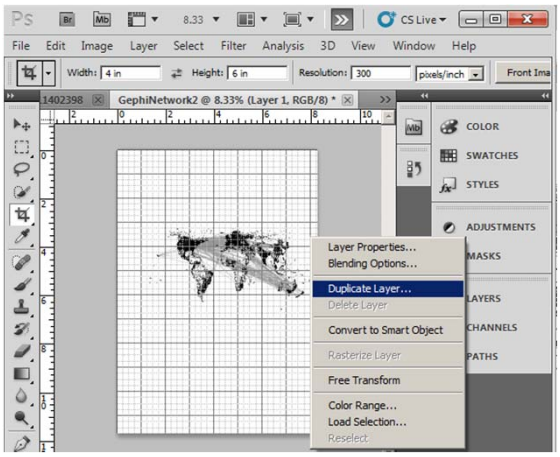
Color or size code the "Near Alaska" and "Near Antarctica" anchor nodes to ease alignment of geomap and network overlay, see instructions in online tutorial on **Manipulating the Network File in Gephi.** Save result using *File > Export > SVG/PDF file.*



43

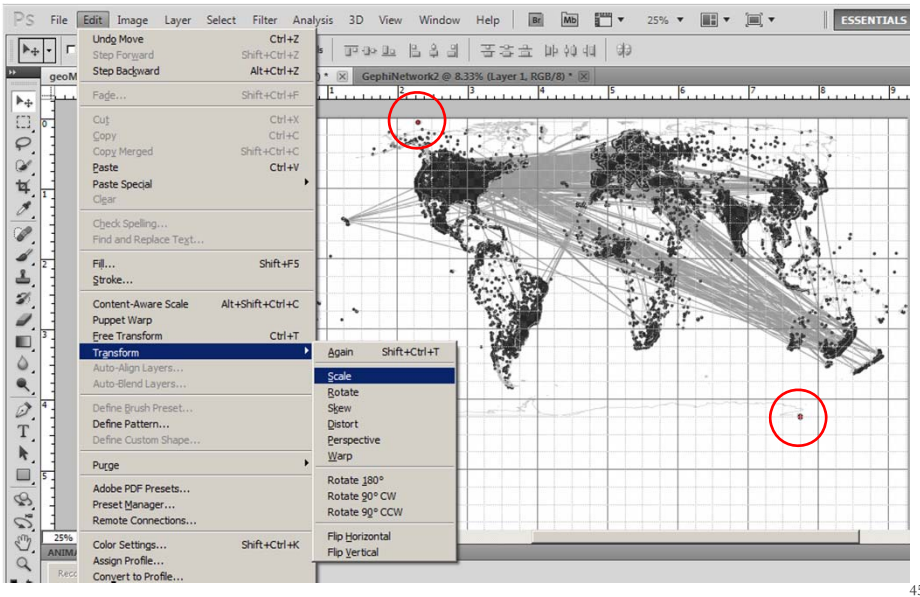
Use Photoshop to Overlay Network on Geomap

Load geomap and network files into Photoshop. Select 'network' layer an use 'Right click, Duplicate Layer' to copy network over to 'geomap' file as a second layer.
Use Edit > Transform > Scale' and align using the "Near Antarctica" anchor nodes, see instructions in online tutorial on **Creating the Visualization in Photoshop.**



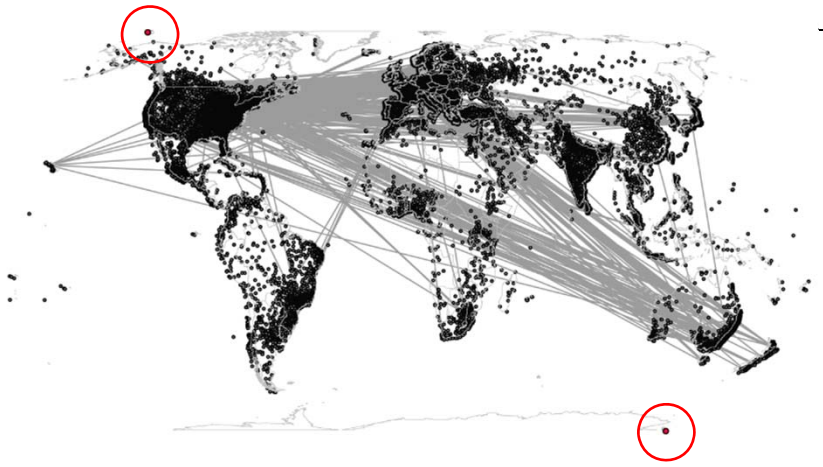
44

Use Photoshop to Overlay Network on Geomap



45

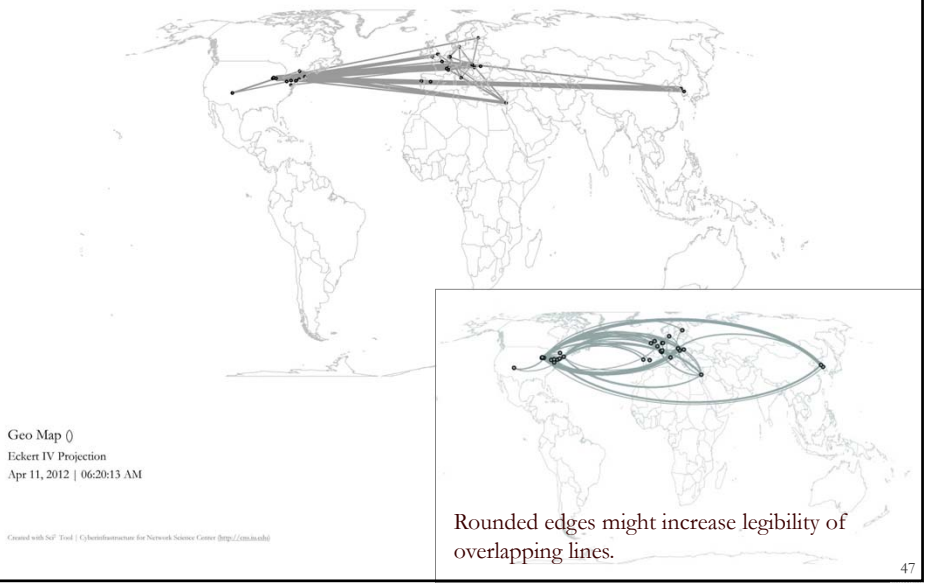
Delete anchor nodes and save in preferred format.



Geo Map ()
Eckert IV Projection
Apr 06, 2012 | 03:19:51 AM

46

Practice these steps using "LaszloBarabasi-collaborations.net" linked from Sci2 wiki:
4.7.6 Using Gephi to Render Networks Overlaid on GeoMaps



Rounded edges might increase legibility of overlapping lines.

47

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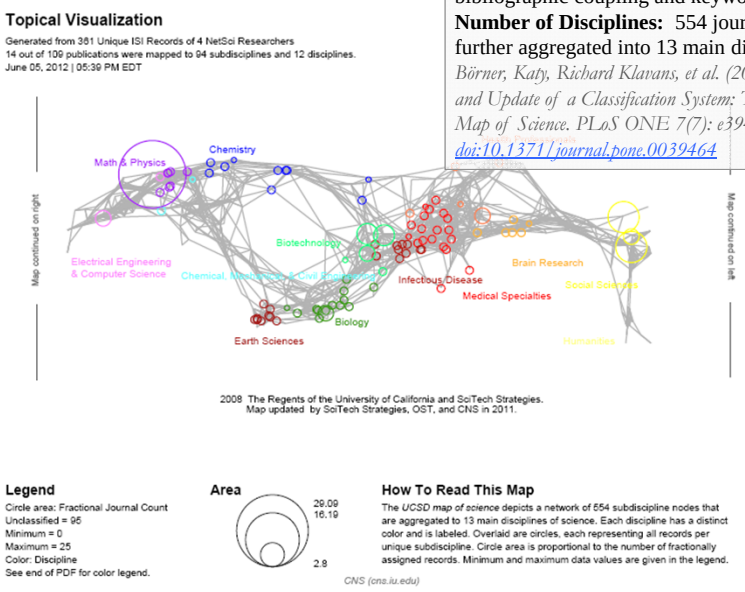
48

Topical Analysis: Research Profiles

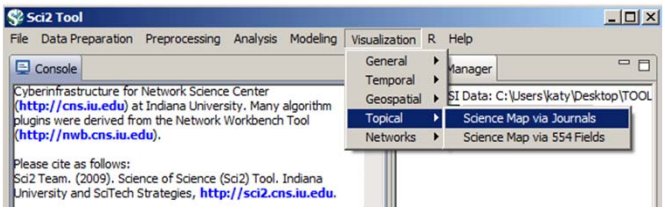
Data: WoS and Scopus paper level data for 2001–2010, about 25,000 separate journals, proceedings, and series.
Similarity Metric: Combination of bibliographic coupling and keyword vectors.
Number of Disciplines: 554 journal clusters further aggregated into 13 main disciplines.
Börner, Katy, Richard Klavans, et al. (2012) Design and Update of a Classification System: The UCSD Map of Science. PLoS ONE 7(7): e39464. doi:10.1371/journal.pone.0039464



49

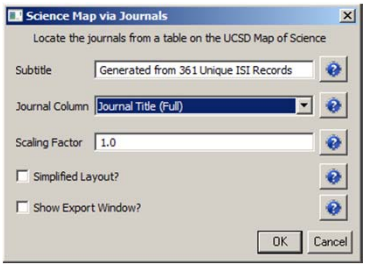
Research Profiles—Publication Data

Load an ISI (*.isi), Bibtex (*.bib), Endnote Export Format (*.enw), Scopus csv (*.scopus) file such as */sci2/sampledata/scientometrics/isi/FourNetSciResearchers.isi*



Run '*Visualization > Topical > Science Map via Journals*' using parameters given to the right.

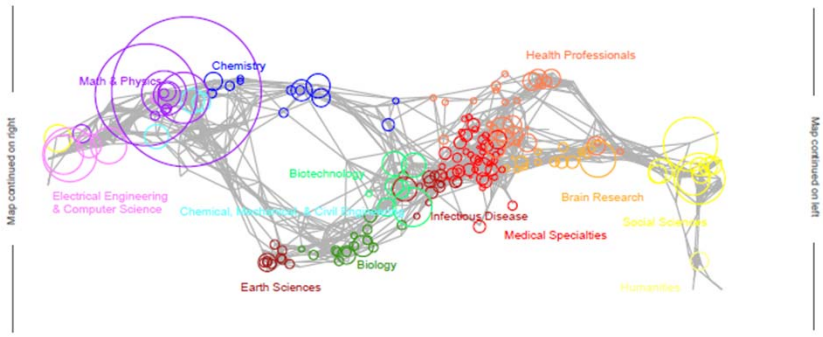
Postscript file will appear in *Data Manager*. Save and open with a Postscript Viewer.



50

Topical Visualization

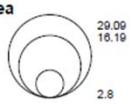
Generated from 361 Unique ISI Records
90 out of 112 publications were mapped to 182 subdisciplines and 13 disciplines.
June 24, 2012 | 04:04 PM EDT



Legend

Circle area: Fractional Journal Count
Unclassified = 22
Minimum = 0
Maximum = 98
Color: Discipline
See end of PDF for color legend.

Area



How To Read This Map

The UCSD map of science depicts a network of 554 subdiscipline nodes that are aggregated to 13 main disciplines of science. Each discipline has a distinct color and is labeled. Overlaid are circles, each representing all records per unique subdiscipline. Circle area is proportional to the number of fractionally assigned records. Minimum and maximum data values are given in the legend.

CNS (cns.iu.edu)

Topical Visualization

Generated from 361 Unique ISI Records
90 out of 112 publications were mapped to 182 subdisciplines and 13 disciplines.
June 24, 2012 | 04:04 PM EDT

Biology
1 BMC EVOLUTIONARY BIOLOGY
1 NATURWISSENSCHAFTEN

Biotechnology
1 BMC BIOINFORMATICS
2 FEBS JOURNAL
1 GENOME RESEARCH
1 INTERNATIONAL MICROBIOLOGY
1 NATURE BIOTECHNOLOGY
3 NATURE GENETICS
1 NATURE REVIEWS GENETICS
1 NUCLEIC ACIDS RESEARCH
2 PROTEOMICS

Brain Research
5 JOURNAL OF MATHEMATICAL PSYCHOLOGY

Chemical, Mechanical, & Civil Engineering
1 JOURNAL OF CERAMIC PROCESSING RESEARCH
2 MATERIALS SCIENCE AND ENGINEERING A-STRUCTURAL MATERIA...
1 PHYSICS WORLD
1 SCIENTIFIC AMERICAN

Chemistry
1 COMPUTER PHYSICS COMMUNICATIONS
2 JOURNAL OF CHEMICAL INFORMATION AND COMPUTER SCIENCES
1 JOURNAL OF THE INDIAN INSTITUTE OF SCIENCE
1 PURE AND APPLIED CHEMISTRY

Earth Sciences
1 CURRENT SCIENCE

Electrical Engineering & Computer Science
1 ASIST 2003: PROCEEDINGS OF THE 66TH ASIST ANNUAL MEETING,...
1 CANADIAN JOURNAL OF INFORMATION AND LIBRARY SCIENCE-REV...
5 IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION
1 INFORMATION TECHNOLOGY AND LIBRARIES
5 JOURNAL OF INFORMATION SCIENCE
3 JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE
5 JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENC...
2 LIBRARY QUARTERLY
1 LIBRI
1 PROCEEDINGS OF THE AMERICAN SOCIETY FOR INFORMATION SC...

Health Professionals
1 ANNALS OF BIOMEDICAL ENGINEERING
1 BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION
1 CROATIAN MEDICAL JOURNAL
2 JOURNAL OF APPLIED PHYSIOLOGY
1 JOURNAL OF PUBLIC HEALTH DENTISTRY
1 METHODS OF INFORMATION IN MEDICINE
1 PLASTIC AND RECONSTRUCTIVE SURGERY
1 TEXAS MEDICINE
1 UNFALLCHIRURG
1 WIENER KLINISCHE WOCHENSCHRIFT

Humanities
1 BULLETIN OF THE ATOMIC SCIENTISTS

Infectious Diseases
1 FEMS MICROBIOLOGY LETTERS
1 JOURNAL OF BACTERIOLOGY

Math & Physics
1 ADVANCES IN APPLIED PROBABILITY

CNS (cns.iu.edu)

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June 24, 2012 | 04:04 PM EDT

Math & Physics

10 APPLIED PHYSICS LETTERS
1 BRAZILIAN JOURNAL OF PHYSICS
3 CHAOS SOLITONS & FRACTALS
1 COMPLEXITY
1 COMPUTATIONAL MATERIALS SCIENCE
11 EUROPEAN PHYSICAL JOURNAL B
12 EUROPHYSICS LETTERS
2 INTERNATIONAL JOURNAL OF MODERN PHYSICS B
6 JOURNAL OF PHYSICS A-MATHEMATICAL AND GENERAL
1 JOURNAL OF STATISTICAL MECHANICS-THEORY AND EXPERIMENT
1 JOURNAL OF STATISTICAL PHYSICS
1 JOURNAL OF THE KOREAN PHYSICAL SOCIETY
1 MATERIALS SCIENCE AND ENGINEERING B-SOLID STATE MATERIAL...
3 NATURE PHYSICS
3 NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SEC...
12 PHYSICA A
5 PHYSICAL REVIEW A
2 PHYSICAL REVIEW B
45 PHYSICAL REVIEW LETTERS
2 REVIEWS OF MODERN PHYSICS

Medical Specialties

1 ANNALS OF INTERNAL MEDICINE
1 REVISTA DE INVESTIGACION CLINICA

Social Sciences

1 ADMINISTRATIVE SCIENCE QUARTERLY
1 AMERICAN BEHAVIORAL SCIENTIST
1 AMERICAN SOCIOLOGICAL REVIEW
1 ANNALS OF THE AMERICAN ACADEMY OF POLITICAL AND SOCIAL S...
1 ARBOR-CIENCIA PENSAMIENTO Y CULTURA
3 BRITISH JOURNAL OF MATHEMATICAL & STATISTICAL PSYCHOLOGY
1 JOURNAL OF CLASSIFICATION

Social Sciences

2 JOURNAL OF MATHEMATICAL SOCIOLOGY
3 JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION
2 PSYCHOLOGICAL BULLETIN
5 PSYCHOMETRIKA
1 RECHERCHE
5 SCIENTOMETRICS
1 SOCIAL FORCES
6 SOCIAL NETWORKS
3 SOCIOLOGICAL METHODS & RESEARCH

Multiple Categories

1 BRITISH MEDICAL JOURNAL
2 JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION
1 JOURNAL OF THEORETICAL BIOLOGY
18 NATURE
44 PHYSICAL REVIEW E
5 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE ...
6 SCIENCE

Unclassified

1 ALGORITHMS AND MODELS FOR THE WEB-GRAPHS, PROCEEDINGS
2 AMERICAN DOCUMENTATION
2 ASIST 2002: PROCEEDINGS OF THE 65TH ASIST ANNUAL MEETING, ...
1 BIOLOGIYA MORYA-MARINE BIOLOGY
1 BULLETIN OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE
1 CHEMIKER-ZEITUNG
3 CHEMTECH
1 COMBINATORIAL AND ALGORITHMIC ASPECTS OF NETWORKING
7 CURRENT COMMENTS
3 CURRENT CONTENTS/LIFE SCIENCES
1 FEDERATION PROCEEDINGS
5 FRACTALS-AN INTERDISCIPLINARY JOURNAL ON THE COMPLEX GE...
1 FRONTIERS OF LIBRARIANSHIP-SYRACUSE UNIVERSITY

CNS (cns.iu.edu)

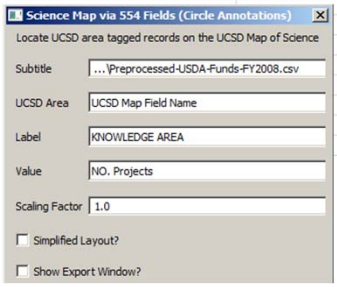
Research Profiles—Existing Classifications

In addition to using **journal names** to
- Map career trajectories
- Identify evolving expertise areas
- Compare expertise profiles

Existing classifications can be aligned and used to generate science map overlays.

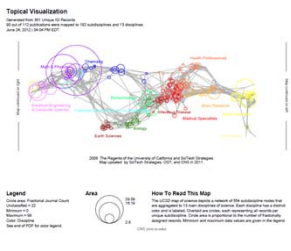
B	C	D	E	F	G
KNOWLEDGE AREA	NO. Projects	USDA Staff Years	STATE APPR	TOTAL FUNDS	UCSD Map Field Name
101 Appraisal of Soil Resources					315
102 Soil, Plant, Water, Nutrient Relationships					227
103 Management of Saline and Sodic Soils and Salinity					158
104 Protect Soil from Harmful Effects of Natural Elements					120
111 Conservation and Efficient Use of Water					245
112 Watershed Protection and Management					245
121 Management of Range Resources					520
122 Management and Control of Forest and Range Fires					520
123 Management and Sustainability of Forest Resources					231
124 Urban Forestry					231
125 Agroforestry					231

Run *Visualization > Topical > Science Map via 554 Fields* using parameters given to the right.
Postscript file will appear in *Data Manager*.
Save and open with a Postscript Viewer.

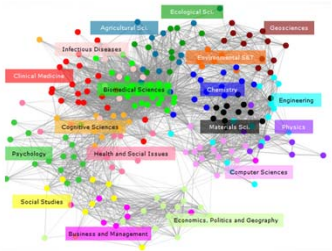


54

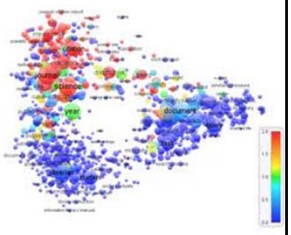
Align Science Basemaps using the Sci2 Tool



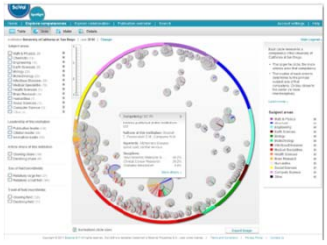
UCSD Map



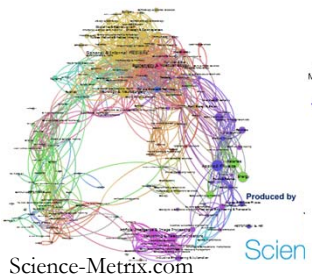
Loet et al science maps ISI categories



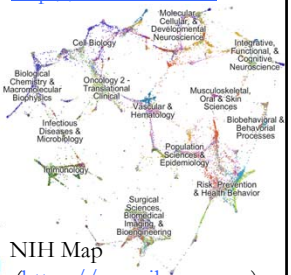
http://vosviewer.com



Elsevier's SciVal Map



Science-Metrix.com



NIH Map
(https://app.nihmaps.org)

55

CNS Cyberinfrastructure for Network Science Center

Tutorial Overview

9:00 Welcome and Overview of Tutorial and Attendees
9:30 The Sci2 Tool
- Download and run the Sci2 Tool
- ONE dataset, MANY analyses and visualizations

10:00 Sci2 Tool Workflows
- Temporal Analysis: Horizontal line graph of NSF projects
- Geospatial Analysis: US and world maps
- Geospatial Analysis: Geomap with network overlays
- Topical Analysis: Visualize research profiles
- **Network Analysis: Co-occurrence networks and bimodal networks**
- Network Analysis: Evolving collaboration networks

11:00 Networking Break

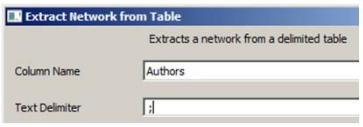
11:15 Visualization Framework
11:45 IVMOOC – MANY more Workflows
12:15 Plug-and-Play Macroscopes
12:30 Outlook and Q&A
13:00 Adjourn

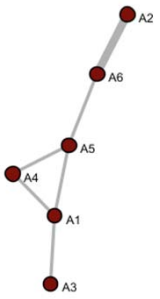
56

General Network Extraction: Weighted, Undirected Co-Occurrence Network

	A	B	C	D
1	Paper	Authors	References	Year
2	P1	A1		1970
3	P2	A2;A6	P1	1980
4	P3	A1;A3	P1;P2	1990
5	P4	A1;A4;A5	P2	1995
6	P5	A5;A6	P1;P2;P3;P4	1995
7	P6	A2;A6	P5	2000

Author co-occurrence network





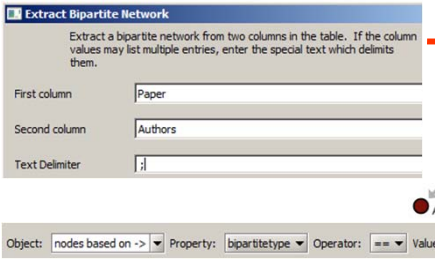
*Vertices 6
1 A1
2 A6
3 A2
4 A3
5 A5
6 A4
*Edges 6
2 3 2
1 4 1
1 5 1
5 6 1
1 6 1
2 5 1

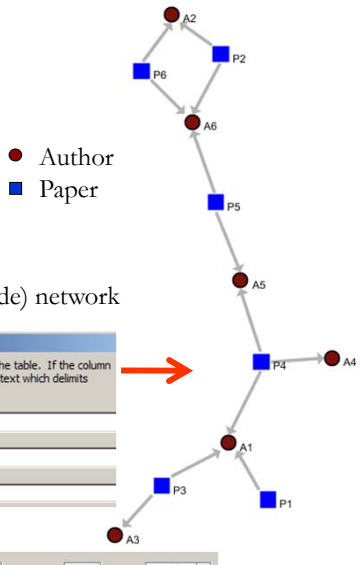
57

General Network Extraction: Unweighted, Directed Bipartite Network

	A	B	C	D
1	Paper	Authors	References	Year
2	P1	A1		1970
3	P2	A2;A6	P1	1980
4	P3	A1;A3	P1;P2	1990
5	P4	A1;A4;A5	P2	1995
6	P5	A5;A6	P1;P2;P3;P4	1995
7	P6	A2;A6	P5	2000

Paper-author bipartite (2-mode) network



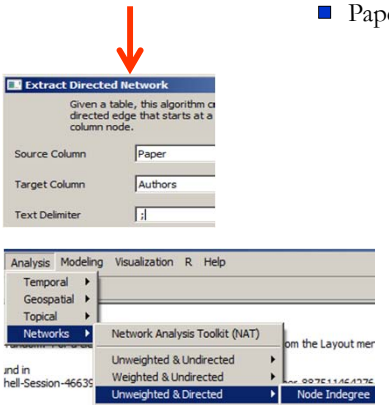


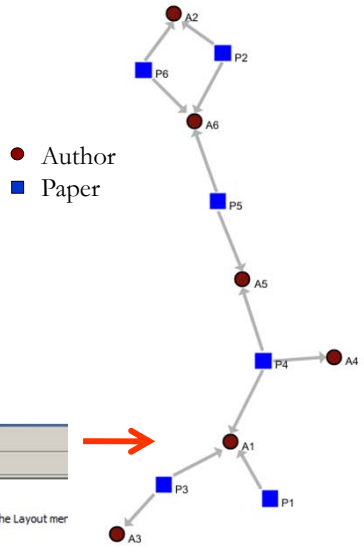
*Vertices 12
1 P1 bipartitetype "Paper"
2 A1 bipartitetype "Authors"
3 P2 bipartitetype "Paper"
4 A2 bipartitetype "Authors"
5 A6 bipartitetype "Authors"
6 P3 bipartitetype "Paper"
7 A3 bipartitetype "Authors"
8 P4 bipartitetype "Paper"
9 A4 bipartitetype "Authors"
10 A5 bipartitetype "Authors"
11 P5 bipartitetype "Paper"
12 P6 bipartitetype "Paper"
*Arcs
1 2
3 4
3 5
6 2
6 7
8 2
8 10
8 9
11 5
11 10
12 4
12 5

58

General Network Extraction: Unweighted, Directed Network

	A	B	C	D
1	Paper	Authors	References	Year
2	P1	A1		1970
3	P2	A2;A6	P1	1980
4	P3	A1;A3	P1;P2	1990
5	P4	A1;A4;A5	P2	1995
6	P5	A5;A6	P1;P2;P3;P4	1995
7	P6	A2;A6	P5	2000



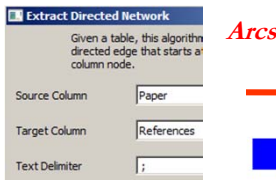


*Vertices 12
1 P1 indegree 0
2 A1 indegree 3
3 P2 indegree 0
4 A2 indegree 2
5 A6 indegree 3
6 P3 indegree 0
7 A3 indegree 1
8 P4 indegree 0
9 A4 indegree 1
10 A5 indegree 2
11 P5 indegree 0
12 P6 indegree 0
*Arcs
1 2
3 4
3 5
6 2
6 7
8 10
8 2
8 9
11 10
11 5
12 4
12 5

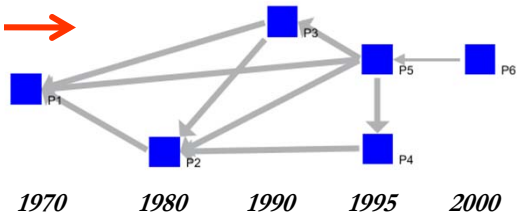
59

General Network Extraction: Unweighted, Directed Paper-Citation Network

	A	B	C	D
1	Paper	Authors	References	Year
2	P1	A1		1970
3	P2	A2;A6	P1	1980
4	P3	A1;A3	P1;P2	1990
5	P4	A1;A4;A5	P2	1995
6	P5	A5;A6	P1;P2;P3;P4	1995
7	P6	A2;A6	P5	2000



Arcs from papers to references

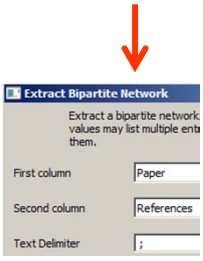


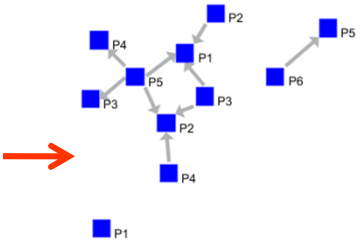
*Vertices 6
1 P1
2 P2
3 P3
4 P4
5 P5
6 P6
*Arcs
2 1
3 1
3 2
4 2
5 4
5 3
5 1
5 2
6 5

60

General Network Extraction: Unweighted, Directed Bi-Partite Network

	A	B	C	D
1	Paper	Authors	References	Year
2	P1	A1		1970
3	P2	A2;A6	P1	1980
4	P3	A1;A3	P1;P2	1990
5	P4	A1;A4;A5	P2	1995
6	P5	A5;A6	P1;P2;P3;P4	1995
7	P6	A2;A6	P5	2000





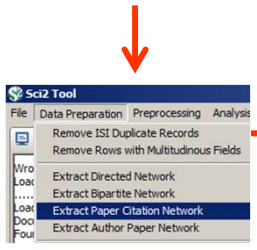
WRONG!!!

*Vertices 11
1 P1 bipartitetype "Paper"
2 P2 bipartitetype "Paper"
3 P1 bipartitetype "References"
4 P3 bipartitetype "Paper"
5 P2 bipartitetype "References"
6 P4 bipartitetype "Paper"
7 P5 bipartitetype "Paper"
8 P4 bipartitetype "References"
9 P3 bipartitetype "References"
10 P6 bipartitetype "Paper"
11 P5 bipartitetype "References"
*Arcs
2 3
4 3
4 5
6 5
7 3
7 9
7 5
7 8
10 11

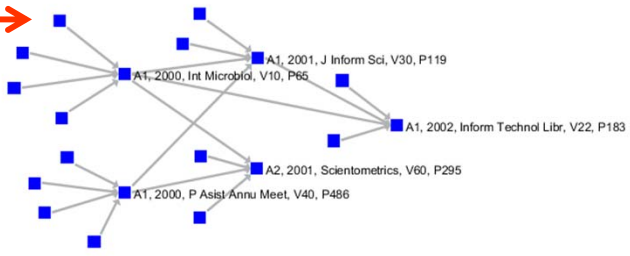
61

ISI Paper-Citation Network Extraction

	A	B	C	D	E
1	Authors	Cited References	Publication Year	Title	Cite Me As
2	A1|A2	BENSMAN SJ, 1998, LIBR RESOUR TECH SER, V42, P147|BRO	2000	T1	A1, 2000, INT MICROBIOL, V10, P65
3	A1	BENSMAN SJ, 1999, LIBR RESOUR TECH SER, V42, P147|BRO	2000	T2	A1, 2000, P ASIST ANNU MEET, V40, P486
4	A2|A3	GARFIELD E, 1985, ESSAYS INFORMATION S, V8, P403|GILBE	2001	T3	A2, 2001, SCIENTOMETRICS, V60, P295
5	A1	ASIMOV A, 1963, GENETIC CODE|LEDERBERG J, 1972, NATU	2001	T4	A1, 2001, J INFORM SCI, V30, P119
6	A1|A2	AVERY OT, 1944, J EXP MED, V79, P137|SMALL H, 1985, J INF	2002	T5	A1, 2002, INFORM TECHNOL LIBR, V22, P183



Arcs from references to papers—
in the direction of information flow



2000 *2001* *2002*

62

CNS Cyberinfrastructure for Network Science Center

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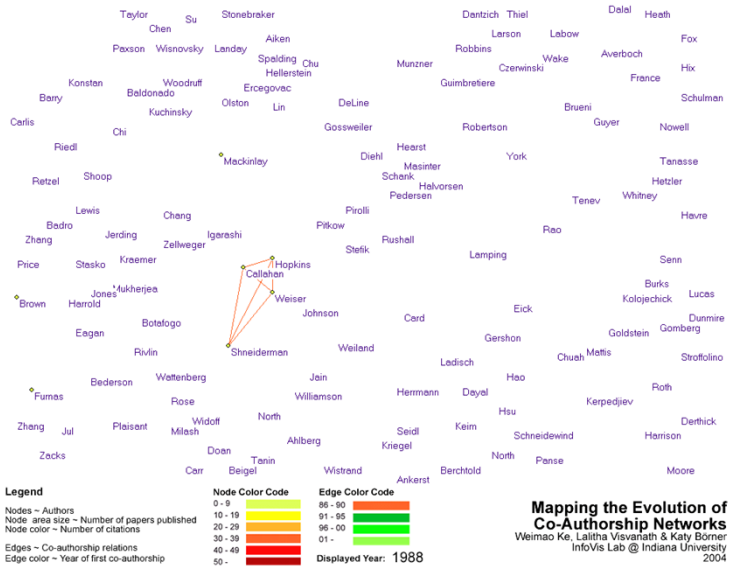
12:30 Outlook and Q&A
13:00 Adjourn

63

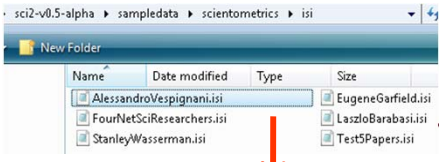
Evolving collaboration networks



64

Evolving Collaboration Networks

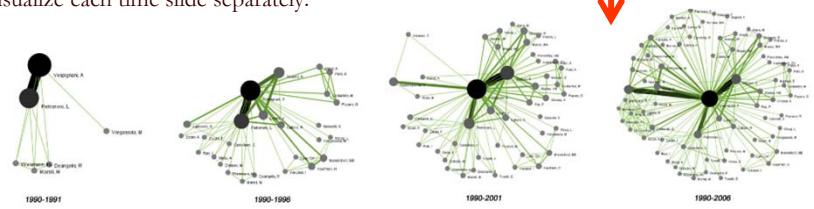
Load isi formatted file



As csv, file looks like:

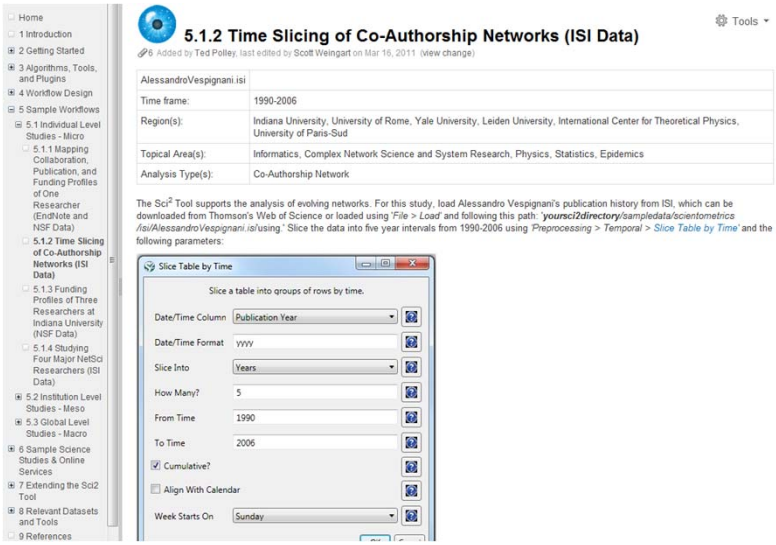
	A	B	C	D	E	F	G
1	Abstract	Authors	Authors (Full Names)	Beginning	Book Serie	Book Serie	Cited Pate
2	The systematic study of	Colizza, V|Barrat, A|Barthelemy, M|Vespignani, A		2015			
3	Uncovering the hidden r	Colizza, V|Flammini, A|Serrano, MA|Vespignani, A		110			
4	Computer viruses can s	Vespignani, A		135			
5	Mapping the Internet ge	Dall'Asta, L|Alvarez-Hamelin, I|Barrat, A|Vazquez, A|Vespignani, A		140		LECTURE NOTES IN	

Visualize each time slide separately:



65

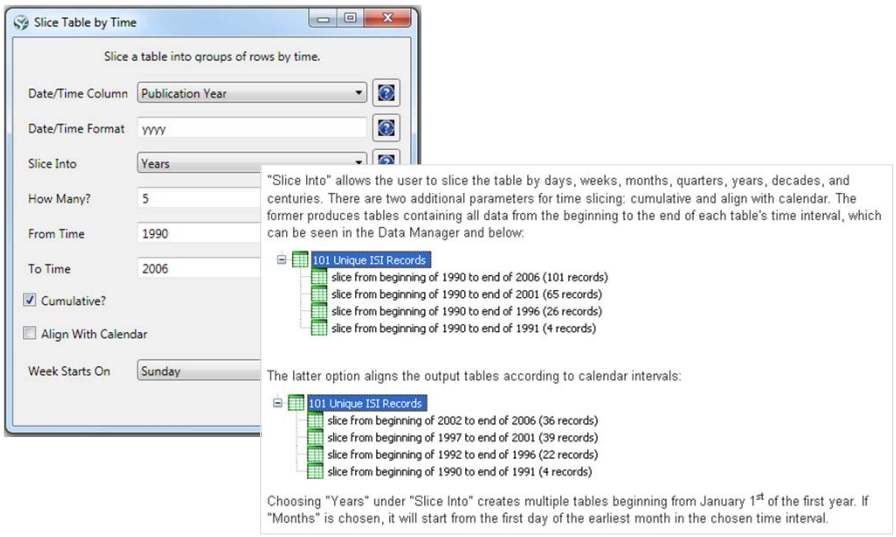
Relevant Sci2 Manual entry



http://sci2.wiki.cns.iu.edu/5.1.2+Time+Slicing+of+Co-Authorship+Networks+(ISI+Data)

66

Slice Table by Time



http://sci2.wiki.cns.iu.edu/5.1.2+Time+Slicing+of+Co-Authorship+Networks+(ISI+Data)

67

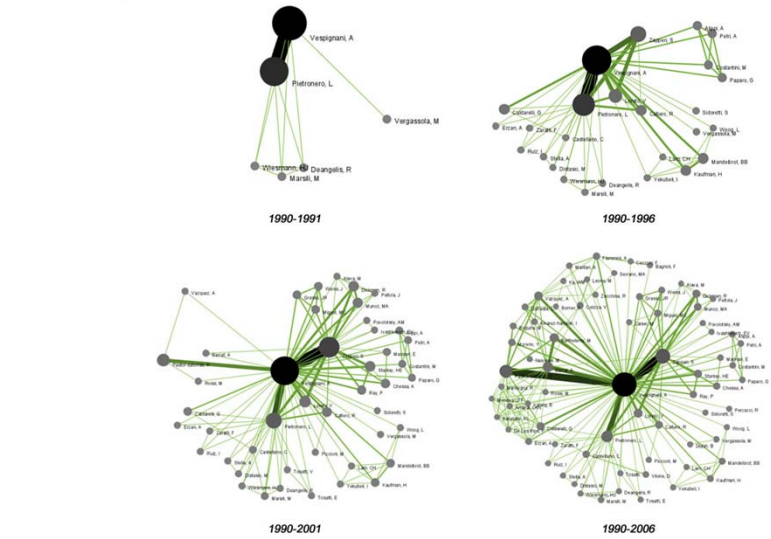
Visualize Each Network, Keep Node Positions

1. To see the evolution of Vespignani's co-authorship network over time, check '*cumulative*'.
2. Extract co-authorship networks one at a time for each sliced time table using *'Data Preparation > Extract Co-Author Network'*, making sure to select "ISI" from the pop-up window during the extraction.
3. To view each of the Co-Authorship Networks over time using the same graph layout, begin by clicking on longest slice network (the *'Extracted Co-Authorship Network*' under *'slice from beginning of 1990 to end of 2006 (101 records)')* in the data manager. Visualize it in GUESS using *'Visualization > Networks > GUESS'*.
4. From here, run *'Layout > GEM*' followed by *'Layout > Bin Pack*'. Run *'Script > Run Script …*' and select '*yoursci2directory/scripts/GUESS/co-author-nw.py'*.
5. In order to save the x, y coordinates of each node and to apply them to the other time slices in GUESS, select *'File > Export Node Positions*' and save the result as '*yoursci2directory/NodePositions.csv*'. Load the remaining three networks in GUESS using the steps described above and for each network visualization, run *'File > Import Node Positions'* and open *'yoursci2directory/NodePositions.csv'*.
6. To match the resulting networks stylistically with the original visualization, run *'Script > Run Script …'* and select *'yoursci2directory/scripts/GUESS/co-author-nw.py', followed by 'Layout > Bin Pack',* for each.

http://sci2.wiki.cns.iu.edu/5.1.2+Time+Slicing+of+Co-Authorship+Networks+(ISI+Data)

68

Visualize Each Network, Keep Node Positions



http://sci2.wiki.cns.iu.edu/5.1.2+Time+Slicing+of+Co-Authorship+Networks+(ISI+Data)

69

Relevant CIShell plugin

CIShell **Slice Table by Time** Tools

Added by Aretha Alencar, last edited by Ted Polley on Jan 12, 2011 (view change)

Description

Slice Table By Time is an algorithm to chop a table up into new tables, based on a date/time column. It takes the column with the date/time data, a string describing the format of that column, the intervals that the data should be sliced into, whether or not the slices are cumulative, whether or not the slices should be aligned with the calendar, and what day the week is considered to start on (which only matters if the slices are aligned with the calendar) as parameters.

The column to use for date/time values should have a single value for each row of data. It is used by the algorithm to choose which slice(s) the row should end up in. In order to determine what date/time is represented by that row, you must provide the algorithm with a descriptive format, in the second parameter. For instance, a four digit year would be represented by yyyy (the default value). See http://joda-time.sourceforge.net/api-release/org/joda/time/format/DateTimeFormat.html for details of all the various formatting options.

The next dropdown has the available intervals to slice the table into. These include milliseconds, seconds, minutes, hours, days, weeks, fortnights, months, quarters, years, decades, and centuries. A future version of the algorithm may include the ability to select how many of these intervals should be grouped together at once.

The checkbox that follows determines if the slices will be cumulative. If the slices are not cumulative, every row in the original table is in one and only one resulting slice. However, if the slices are cumulative, every row in the original table is in the slice it is for and every slice for a period after that.

The checkbox that follows determines if the slices will be aligned with the calendar. For instance, if the first row is for June 7th, 2006 and yearly slices are chosen, then the default behavior will be to have the first slice be from June 7th, 2006 to June 6th, 2007. However, if the slices are aligned with the calendar, the first slice will be from January 1st, 2006 to December 31st, 2006. Alignment does not affect the output for intervals of fortnights, quarters, decades, or milliseconds.

If the slices are aligned with the calendar and are weekly, then the day the week starts is used to determine how they are aligned.

Pros & Cons

The output of the slice algorithm is in separate tables, so a longitudinal analysis will require working with each slice separately, which can be awkward. There will likely be future versions of the time slice algorithm that annotate the original table with the slice the rows belong to.

Applications

When doing longitudinal analysis of data, it can be useful to consider it in chunks, such as to calculate how statistics have changed over time. Alternatively, only a particular time period might be of interest, and this algorithm can extract it from data for a larger time range.

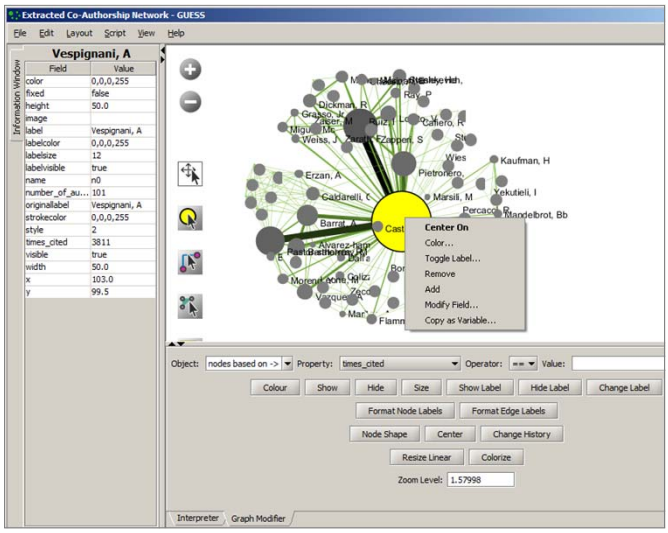
Implementation Details

This algorithm uses the Joda Time library extensively, which provides significantly improved capabilities compared to the default Java algorithms for dates and times.

http://cishell.wiki.cns.iu.edu/Slice+Table+by+Time

70

Network Visualization with GUESS



Pan:

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

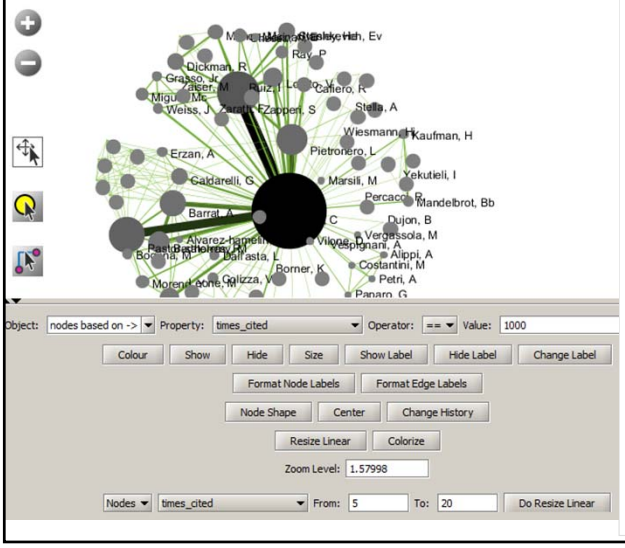
Zoom:

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 node/edge to modify Color, Shape, etc.

Network Visualization with GUESS



Graph Modifier:

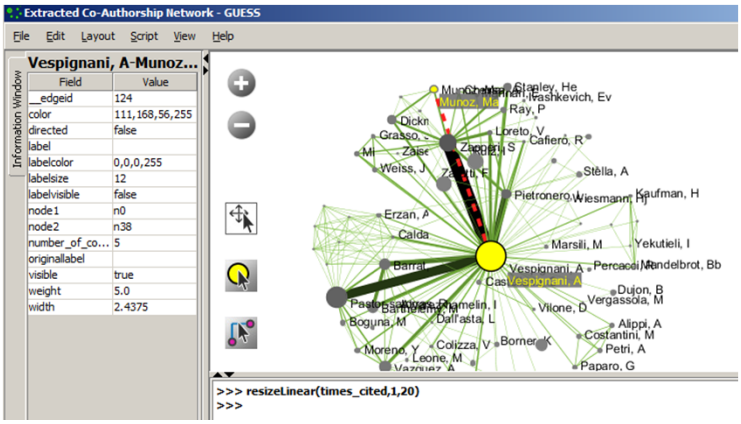
Select "all nodes" in the Object drop-down menu and click 'Show Label' button.

Select 'Resize Linear > Nodes > times_cited' 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.'

Network Visualization with GUESS



Interpreter uses Jython a combination of Java and Python.

Try
resizeLinear(times_cited,1,20)
colorize(times_cited, white, red)

73

BREAK

CNS Cyberinfrastructure for Network Science Center

Tutorial Overview

9:00 Welcome and Overview of Tutorial and Attendees
9:30 The Sci2 Tool
- Download and run the Sci2 Tool
- ONE dataset, MANY analyses and visualizations

10:00 Sci2 Tool Workflows
- Temporal Analysis: Horizontal line graph of NSF projects
- Geospatial Analysis: US and world maps
- Geospatial Analysis: Geomap with network overlays
- Topical Analysis: Visualize research profiles
- Network Analysis: Co-occurrence networks and bimodal networks
- Network Analysis: Evolving collaboration networks

11:00 Networking Break

11:15 Visualization Framework

11:45 IVMOOC – MANY more Workflows
12:15 Plug-and-Play Macroscopes
12:30 Outlook and Q&A

13:00 Adjourn

75

Visualization Framework

76

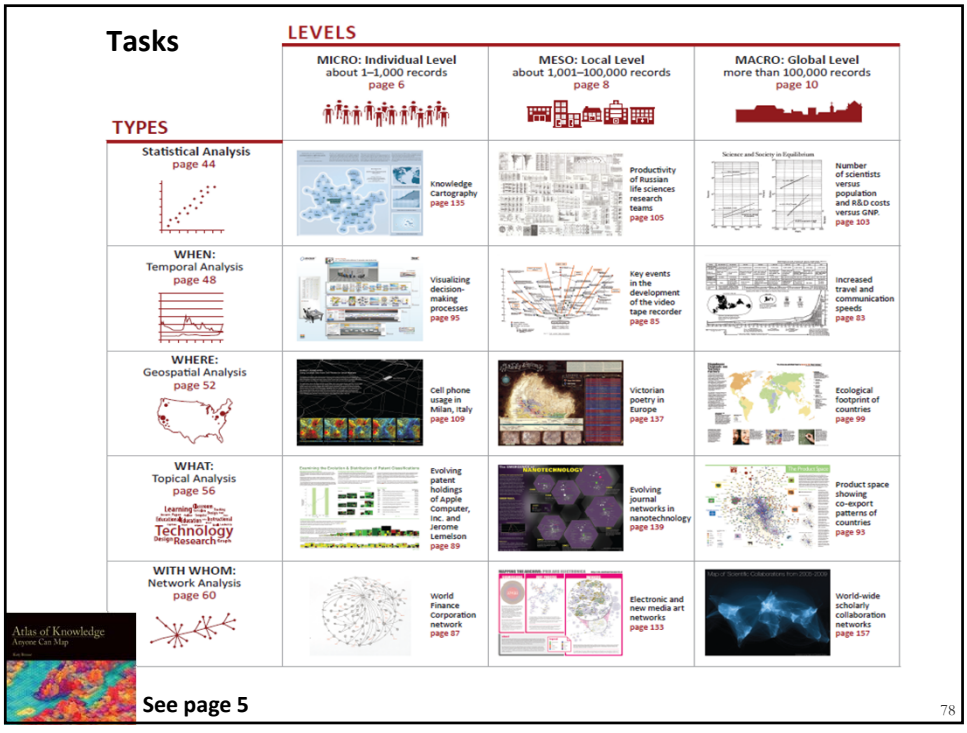
Theoretically Grounded and Practically Useful Visualization Framework

developed to empower the broadest spectrum of users to read and make data visualizations that are useful and meaningful to them.

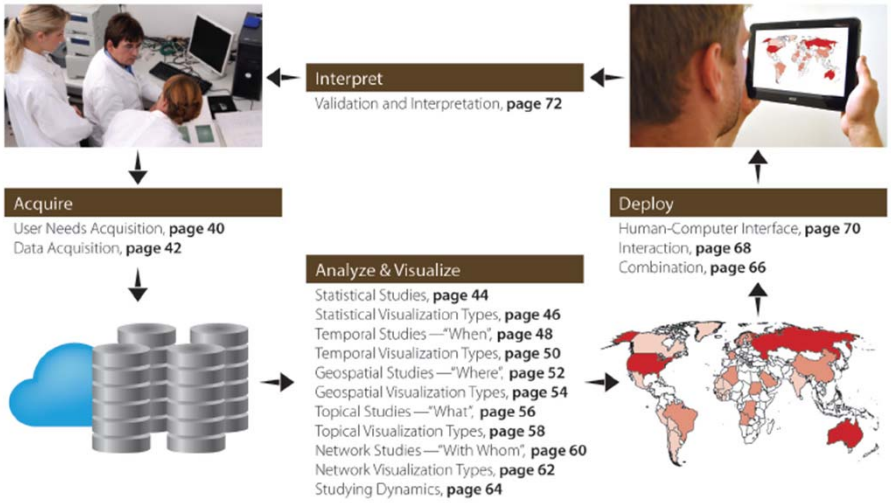
The visualization framework was used to

- design the aforementioned study and
- develop plug-and-play macroscope tools that improve the data visualization literacy of researchers, practitioners, IVMOOC students, museum visitors, and others.

Börner, Katy. 2015. *Atlas of Knowledge: Anyone Can Map.* The MIT Press.
http://scimaps.org/atlas2



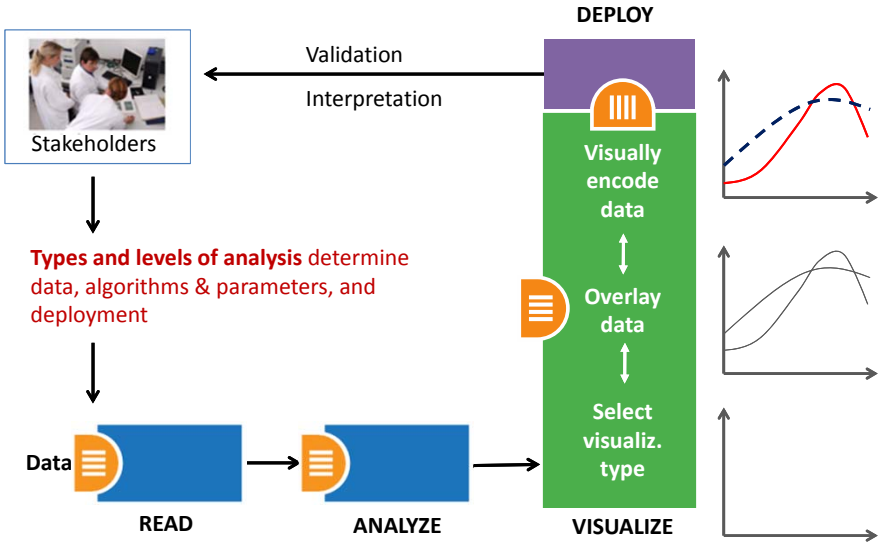
Workflow Design



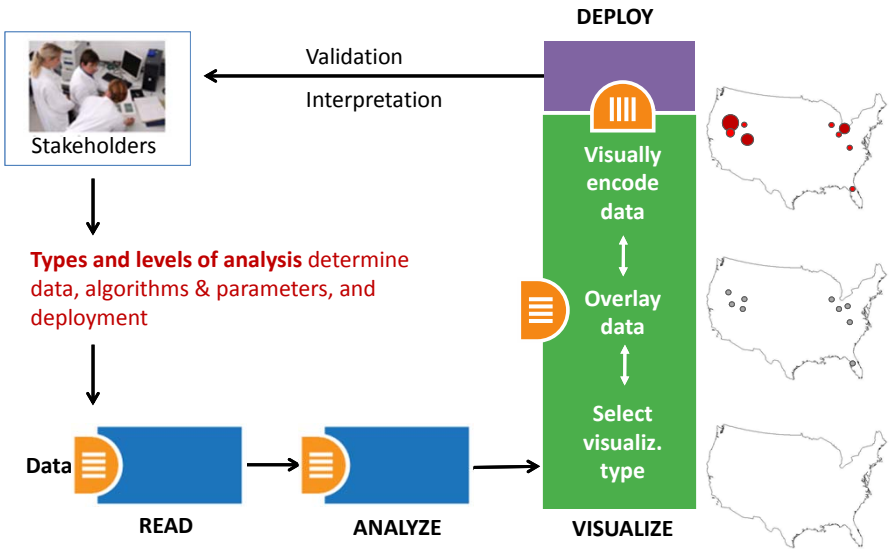
Börner, Katy. 2015. *Atlas of Knowledge: Anyone Can Map*. The MIT Press.
http://scimaps.org/atlas2

79

Needs-Driven Workflow Design



Needs-Driven Workflow Design



Types

Insight Need Types page 26	Data Scale Types page 28	Visualization Types page 30	Graphic Symbol Types page 32	Graphic Variable Types page 34	Interaction Types page 26
• categorize/cluster • order/rank/sort • distributions (also outliers, gaps) • comparisons • trends (process and time) • geospatial • compositions (also of text) • correlations/relationships	• nominal • ordinal • interval • ratio	• table • chart • graph • map • network layout	• geometric symbols point line area surface volume • linguistic symbols text numerals punctuation marks • pictorial symbols images icons statistical glyphs	• spatial position • retinal form color optics motion	• overview • zoom • search and locate • filter • details-on-demand • history • extract • link and brush • projection • distortion

Börner, Katy. 2015. *Atlas of Knowledge: Anyone Can Map*. The MIT Press.
http://scimaps.org/atlas2

82

Types

Basic Task Types								
Bertin, 1967	Wehrend & Lewis, 1996	Few, 2004	Yau, 2011	Rendgen & Wiedemann, 2012	Frankel, 2012	Tool: Many Eyes	Tool: Chart Chooser	Börner, 2014
selection	categorize			category				categorize/ cluster
order	rank	ranking					table	order/rank/ sort
	distribution	distribution					distribution	distributions (also outliers, gaps)
	compare	nominal comparison & deviation	differences		compare and contrast	compare data values	comparison	comparisons
		time series	patterns over time	time	process and time	track rises and falls over time	trend	trends (process and time)
		geospatial	spatial relations	location		generate maps		geospatial
quantity		part-to-whole	proportions		form and structure	see parts of whole, analyze text	composition	compositions (also of text)
association	correlate	correlation	relationships	hierarchy		relations between data points	relationship	correlations/ relationships

83

Insight Need Types page 26	Data Scale Types page 28	Visualization Types page 30	Graphic Symbol Types page 32	Graphic Variable Types page 34	Interaction Types page 26
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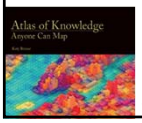

See page 24

Visualization Types (Reference Systems)

1. **Charts:** No reference system—e.g., Wordle.com, pie charts
2. **Tables:** Categorical axes that can be selected, reordered; cells can be color coded and might contain proportional symbols. Special kind of graph.
3. **Graphs:** Quantitative or qualitative (categorical) axes. Timelines, bar graphs, scatter plots.
4. **Geospatial maps:** Use latitude and longitude reference system. World or city maps.
5. **Network layouts:** Node position might depends on node attributes or node similarity. **Trees:** hierarchies, taxonomies, genealogies. **Networks:** social networks, migration flows.

Types

Insight Need Types page 26	Data Scale Types page 28	Visualization Types page 30	Graphic Symbol Types page 32	Graphic Variable Types page 34	Interaction Types page 26
• categorize/cluster • order/rank/sort • distributions (also outliers, gaps) • comparisons • trends (process and time) • geospatial • compositions (also of text) • correlations/relationships	• nominal • ordinal • interval • ratio	• table • chart • graph • map • network layout	• geometric symbols point line area surface volume • linguistic symbols text numerals punctuation marks • pictorial symbols images icons statistical glyphs	• spatial position • retinal form color optics motion	• overview • zoom • search and locate • filter • details-on-demand • history • extract • link and brush • projection • distortion

Börner, Katy. 2015. *Atlas of Knowledge: Anyone Can Map*. The MIT Press. http://scimaps.org/atlas2

86

Graphic Variable Types Versus Graphic Symbol Types

			Geometric Symbols		
			Point	Line	Area
Spatial	x	quantitative			
	y	quantitative			
	z	quantitative			
Retinal – Form	Size	quantitative	NA (Not Applicable)		
	Shape	qualitative	NA		
	Rotation	quantitative	NA		
	Curvature	quantitative	NA		
	Angle	quantitative	NA		
	Closure	quantitative	NA		
Retinal – Color	Value	quantitative			
	Hue	qualitative			
	Saturation	quantitative			

87

Graphic Variable Types Versus Graphic Symbol Types

			Geometric Symbols		
			Point	Line	Area
Spatial	x	quantitative			
	y	quantitative			
	z	quantitative			
Retinal – Form	Size	quantitative	NA (Not Applicable)		
	Shape	qualitative	NA		
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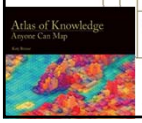
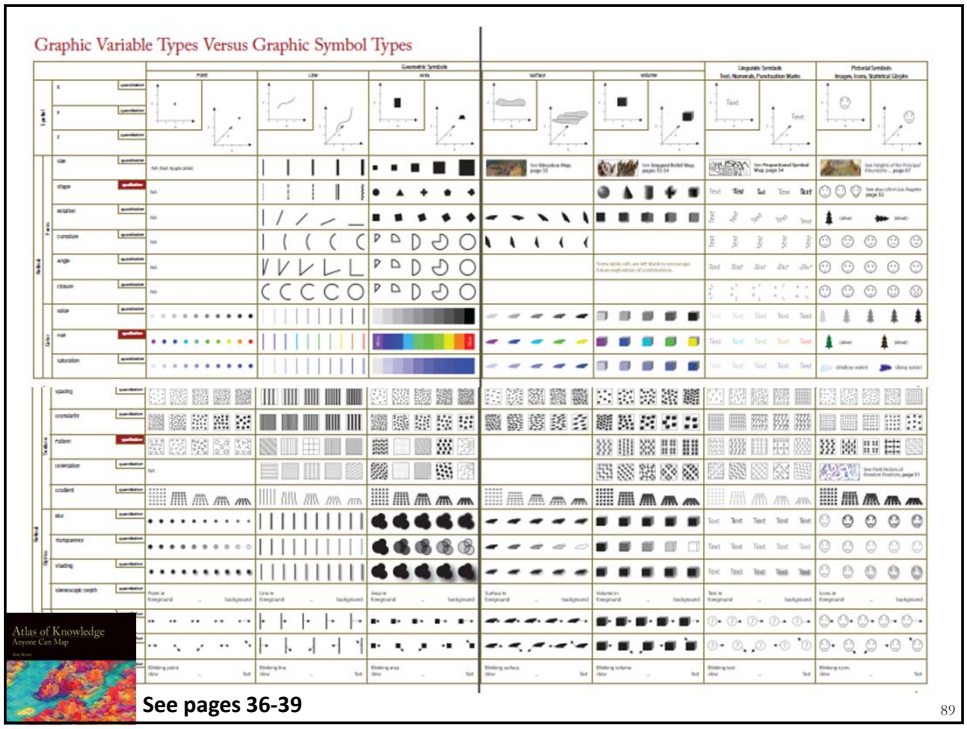
	Angle	quantitative	NA		
	Closure	quantitative	NA		
Retinal – Color	Value	quantitative			
	Hue	qualitative			
	Saturation	quantitative			



See page 36

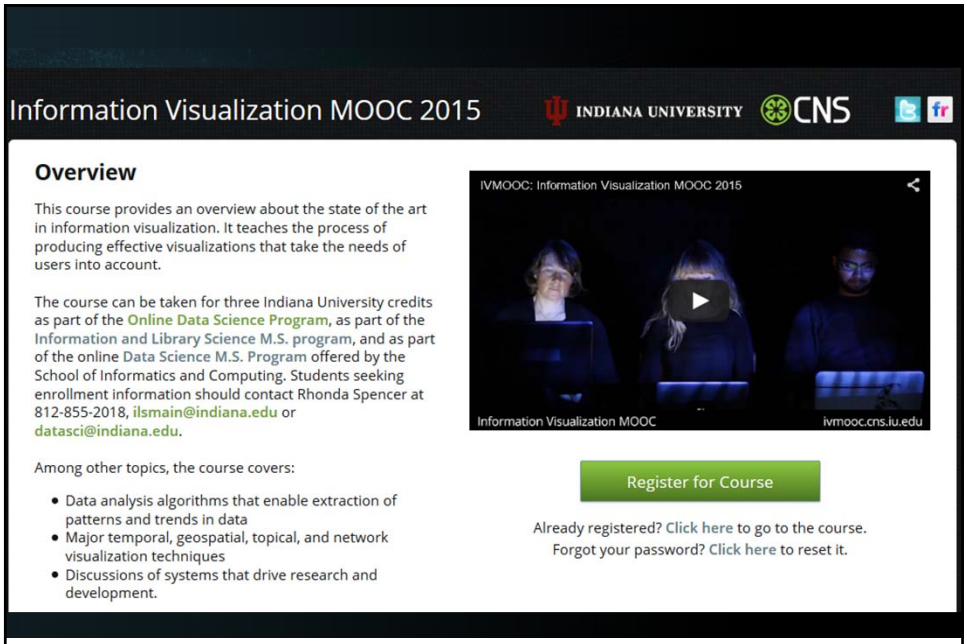
88



Information Visualization MOOC (IVMOOC)

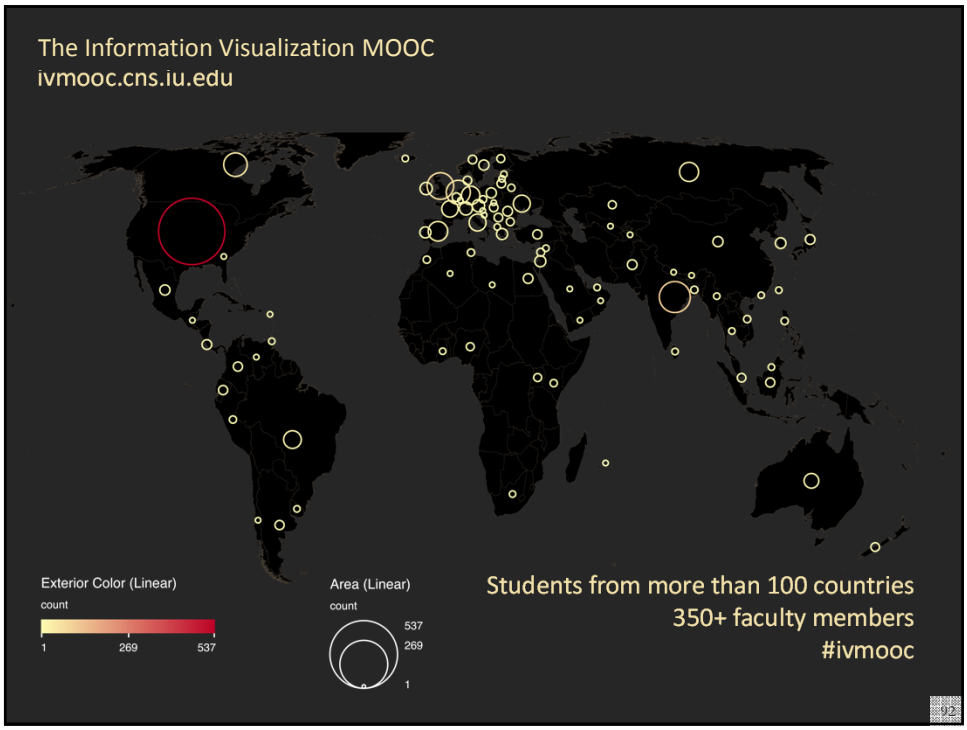
Teaches the

Visualization Framework and The Sci2 Tool



Register for free at http://ivmooc.cns.iu.edu. Class restarted in January 13, 2015.

91



92

Course Schedule

Part 1: Theory and Hands-On

- **Session 1** – Workflow Design and Visualization Framework
- **Session 2** – "When:" Temporal Data
- **Session 3** – "Where:" Geospatial Data
- **Session 4** – "What:" Topical Data

Mid-Term

- **Session 5** – "With Whom:" Trees
- **Session 6** – "With Whom:" Networks
- **Session 7** – Dynamic Visualizations and Deployment

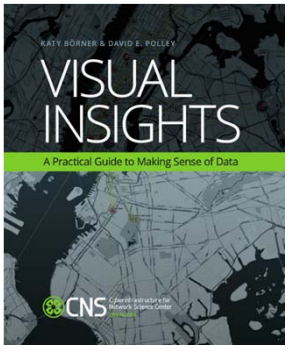
Final Exam

Part 2: Students work in teams on client projects.

Final grade is based on Class Participation (10%), Midterm (30%), Final Exam (30%), and Client Project(30%).

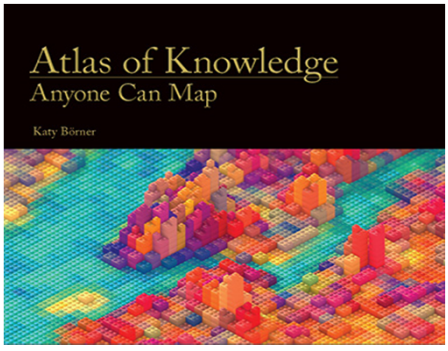
93

Books Used in the IVMOOC



Teaches timely knowledge:

Advanced algorithms, tools, and hands-on workflows.



Teaches timeless knowledge:

Visualization framework—exemplified using generic visualization examples and pioneering visualizations.

94

Visualization Frameworks

How to Classify Different Visualizations?

By

- User insight needs?
- User task types?

- Data to be visualized?
- Data transformation?

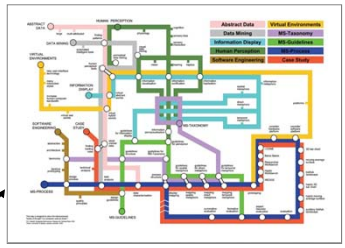
- Visualization technique?
- Visual mapping transformation?
- Interaction techniques?

- Or ?

Different Question Types

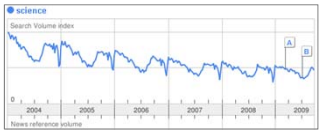
Terabytes of data

Descriptive & Predictive Models



Find your way

Find collaborators, friends

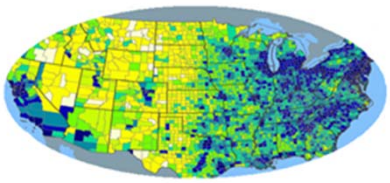


Identify trends

97

Different Levels of Abstraction/Analysis

Macro/Global
Population Level



Meso/Local
Group Level

Micro
Individual Level

Type of Analysis vs. Level of Analysis

	Micro/Individual (1-100 records)	***Meso/Local (101–10,000 records)***	***Macro/Global (10,000 < records)***
Statistical Analysis/Profiling	Individual person and their expertise profiles	Larger labs, centers, universities, research domains, or states	All of NSF, all of USA, all of science.
Temporal Analysis (When)	Funding portfolio of one individual	Mapping topic bursts in 20 years of *PNAS*	113 years of physics research
Geospatial Analysis (Where)	Career trajectory of one individual	Mapping a state's intellectual landscape	*PNAS* publications
Topical Analysis (What)	Base knowledge from which one grant draws.	Knowledge flows in chemistry research	VxOrd/Topic maps of NIH funding
Network Analysis (With Whom?)	NSF Co-PI network of one individual	Co-author network	NIH's core competency

99

Type of Analysis vs. Level of Analysis

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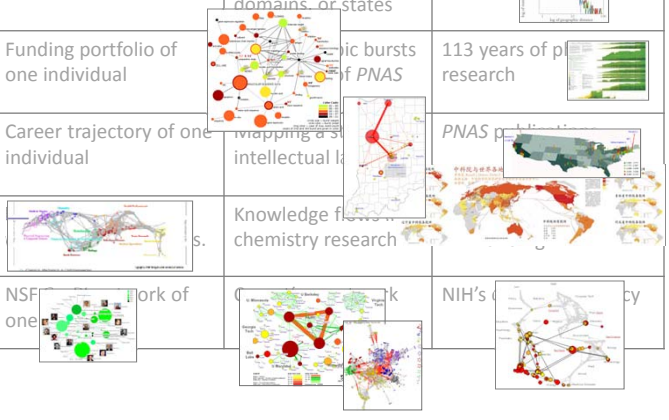


100

Clients

Information Visualization MOOC | INDIANA UNIVERSITY | CNS

List of Clients

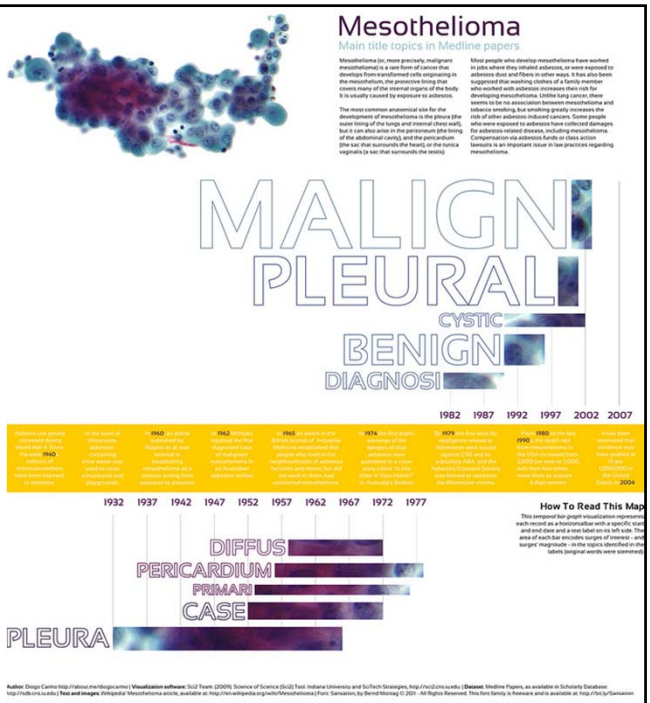
Project Title: Isis: 100 Years
Client Name: Jay Malone
Project goal/scientific or practical value: A visual representation Isis' contributors and locales over the past 100 years. Isis is the journal of the History of Science Society. This representation will provide a dynamic picture of how scholarship in the history of science has shifted over the past century.
Information on dataset(s) to be used: Citation information, author locale, and issue number for Isis publications.
Relevant publications, websites, etc: http://www.press.uchicago.edu/ucp/journals/journal/isis.html
Conditions under which students can publish results and/or add project results to their resume: Client would like to approve results.

Project Title: e-Xploration
Client Name: Luiy
Project goal/scientific or practical value: e-Xploration is an agent-based model for the ethnographic observation and the registry, analysis, and interpretation of social practices in virtual communities for intervention in the development of collaboration and cooperation. This project will analyze the interactions between subjects and objects in a platform collaborative community called OYCIB, a project based on e-Xploration (e-crick.net).
Information on dataset(s) to be used: I can provide a data base in .graphml format for the students. The file .graphml contains the interactions between subjects and objects in a platform collaborative community called OYCIB. In the level of practice, it is not necessary that students know agent-based models for using the database. But, in another level, for example: the collaborate level for the OYCIB development, it is necessary to have basic knowledge in AMS or MAS and another competences like PHP and MySQL.
Relevant publications, websites, etc: http://www.e-crick.net/logs
Conditions under which students can publish results and/or add project results to their resume: If any person or institution use my dataset or another info about eXploration (e-crick.net, oycib.net), I need to approve the results and appear as co-author.

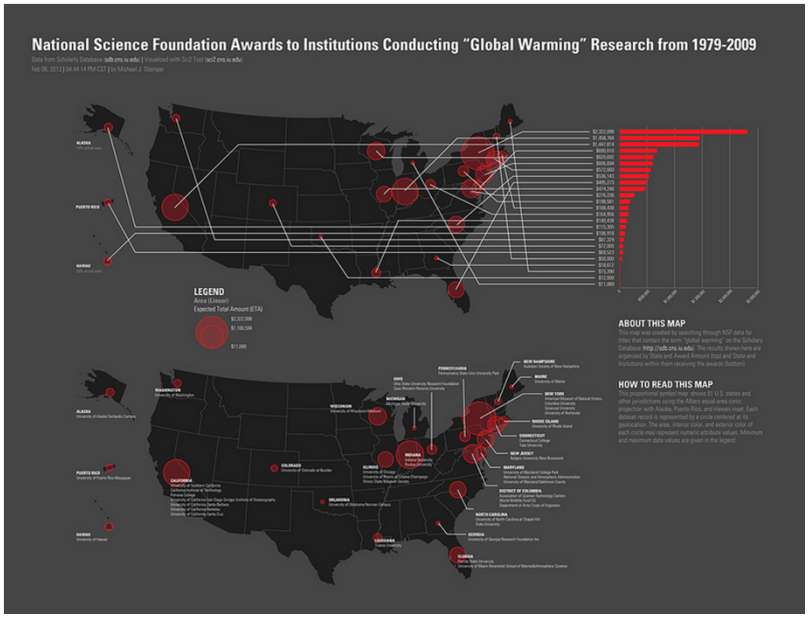
http://ivmooc.cns.iu.edu/clients.html

101

Diogo Carmo



102

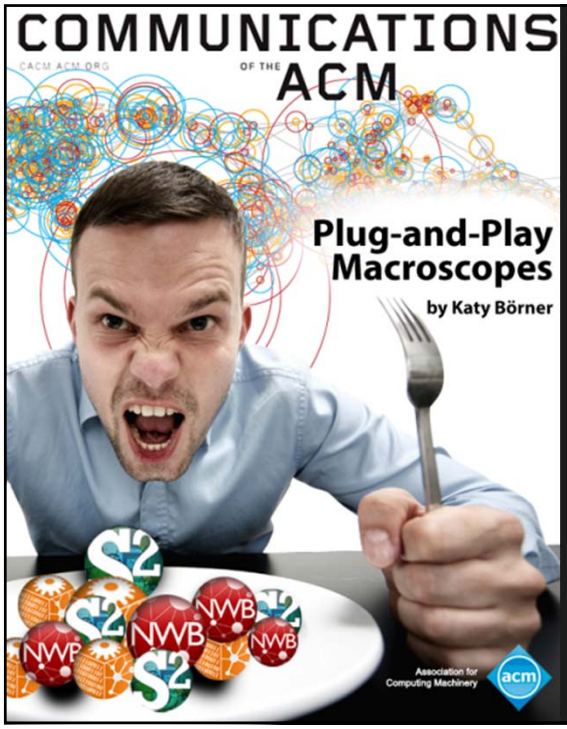


mjstamper_ivmooc

103

Plug-and-Play Macroscopes

104



Börner, Katy. (2011). Plug-and-Play Macroscopes. *Communications of the ACM, 54(3), 60-69.*

Video and paper are at http://www.scivee.tv/node/27704

105

Designing "Dream Tools"

Many of the best micro-, tele-, and macroscopes are designed by scientists keen to observe and comprehend what no one has seen or understood before. Galileo Galilei (1564–1642) recognized the potential of a spyglass for the study of the heavens, ground and polished his own lenses, and used the improved optical instruments to make discoveries like the moons of Jupiter, providing quantitative evidence for the Copernican theory.

Today, scientists repurpose, extend, and invent new hardware and software to create "macroscopes" that may solve both local and global challenges.

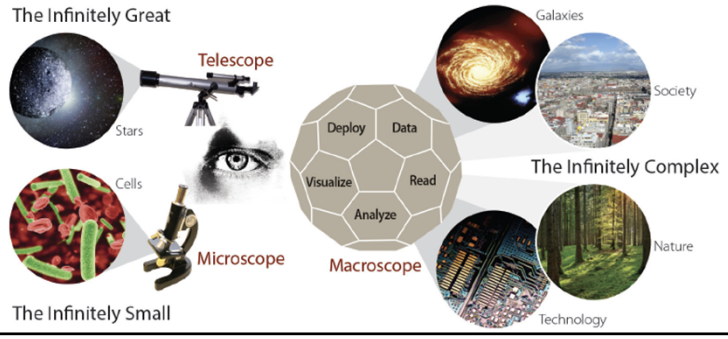
CNS Macroscope tools empower me, my students, colleagues, and more than 100,000 others that downloaded them.

106

Macroscopes

Decision making in science, industry, and politics, as well as in daily life, requires that we make sense of data sets representing the structure and dynamics of complex systems. Analysis, navigation, and management of these continuously evolving data sets require a new kind of data-analysis and visualization tool we call a macroscope (from the Greek macros, or "great," and skopein, or "to observe") inspired by de Rosnay's futurist science writings.

Macroscopes provide a "vision of the whole," helping us "synthesize" the related elements and enabling us to detect patterns, trends, and outliers while granting access to myriad details. Rather than make things larger or smaller, **macroscopes let us observe what is at once too great, slow, or complex for the human eye and mind to notice and comprehend.**



107

Plug-and-Play Macroscopes

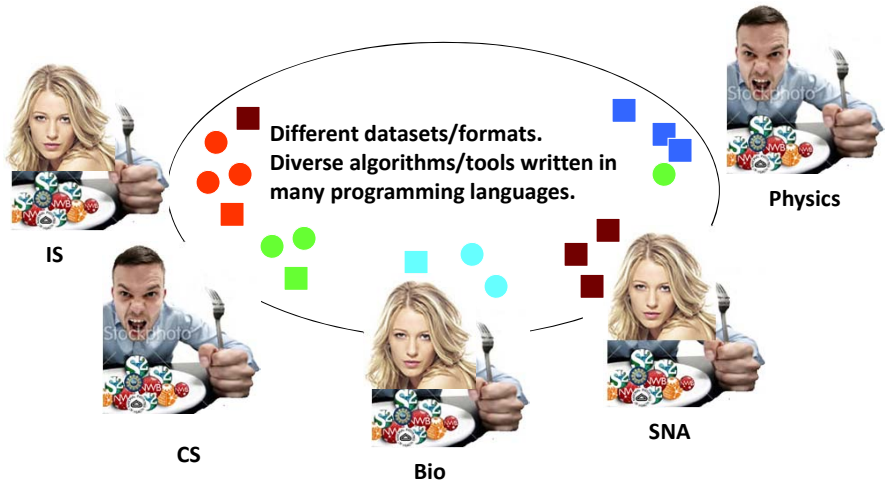
Inspire computer scientists to implement software frameworks that empower domain scientists to assemble their own continuously evolving macroscopes, adding and upgrading existing (and removing obsolete) plug-ins to arrive at a set that is truly relevant for their work—with little or no help from computer scientists.

While microscopes and telescopes are physical instruments, macroscopes resemble continuously changing bundles of software plug-ins. Macroscopes make it easy to select and combine algorithm and tool plug-ins but also interface plug-ins, workflow support, logging, scheduling, and other plug-ins needed for scientifically rigorous yet effective work.

They make it easy to share plug-ins via email, flash drives, or online. To use new plugins, simply copy the files into the plug-in directory, and they appear in the tool menu ready for use. No restart of the tool is necessary. Sharing algorithm components, tools, or novel interfaces becomes as easy as sharing images on Flickr or videos on YouTube. Assembling custom tools is as quick as compiling your custom music collection.

108

Changing Scientific Landscape—Personal Observations



109

Related Work

Google Code and SourceForge.net provide special means for developing and distributing software

- In August 2009, SourceForge.net hosted more than 230,000 software projects by two million registered users (285,957 in January 2011);
- In August 2009 ProgrammableWeb.com hosted 1,366 application programming interfaces (APIs) and 4,092 mashups (2,699 APIs and 5,493 mashups in January 2011)

Cyberinfrastructures serving large biomedical communities

- Cancer Biomedical Informatics Grid (caBIG) (http://cabig.nci.nih.gov)
- Biomedical Informatics Research Network (BIRN) (http://nbirn.net)
- Informatics for Integrating Biology and the Bedside (i2b2) (https://www.i2b2.org)
- HUBzero (http://hubzero.org) platform for scientific collaboration uses
- myExperiment (http://myexperiment.org) supports the sharing of scientific workflows and other research objects.

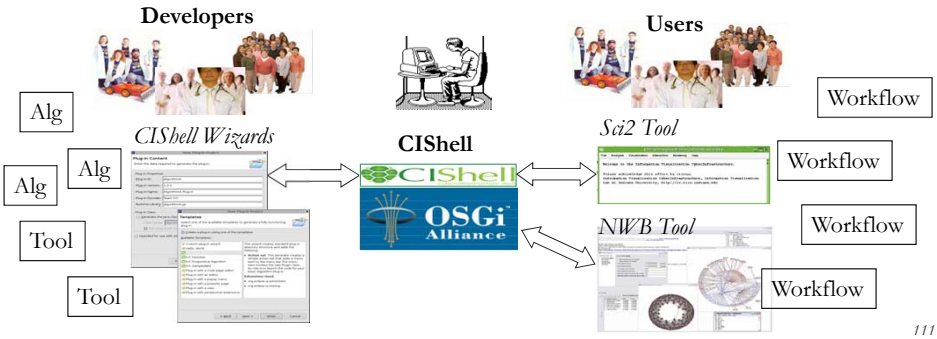
Missing so far is a common standard for

- the design of modular, compatible algorithm and tool plug-ins (also called "modules" or "components")
- that can be easily combined into scientific workflows ("pipeline" or "composition"),
- and packaged as custom tools.

110

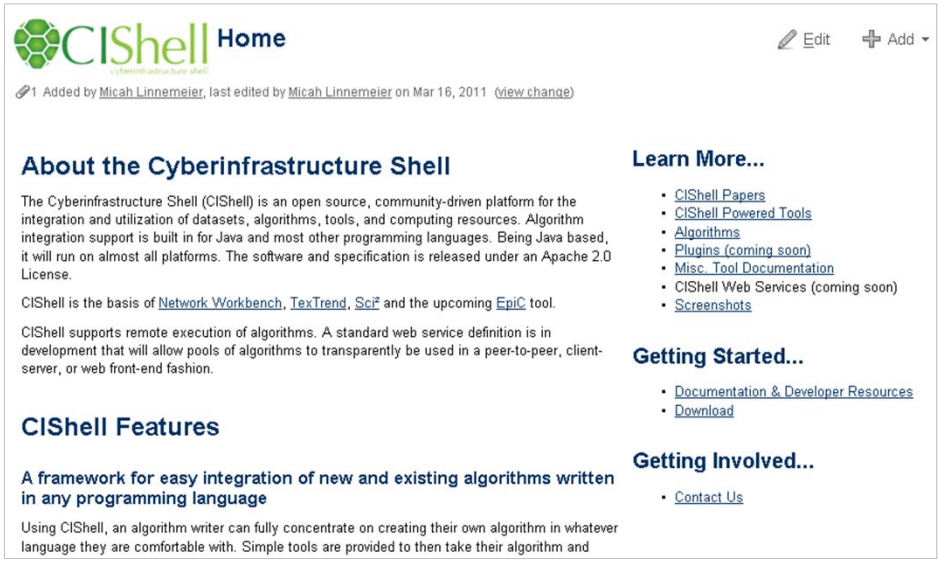
OSGi & CIShell

- CIShell (http://cishell.org) 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://osgi.org), a standardized, component oriented, computing environment for networked services widely used in industry since more than 10 years.
- Specifically, CIShell provides "sockets" into which existing and new datasets, algorithms, and tools can be plugged using a wizard-driven process.



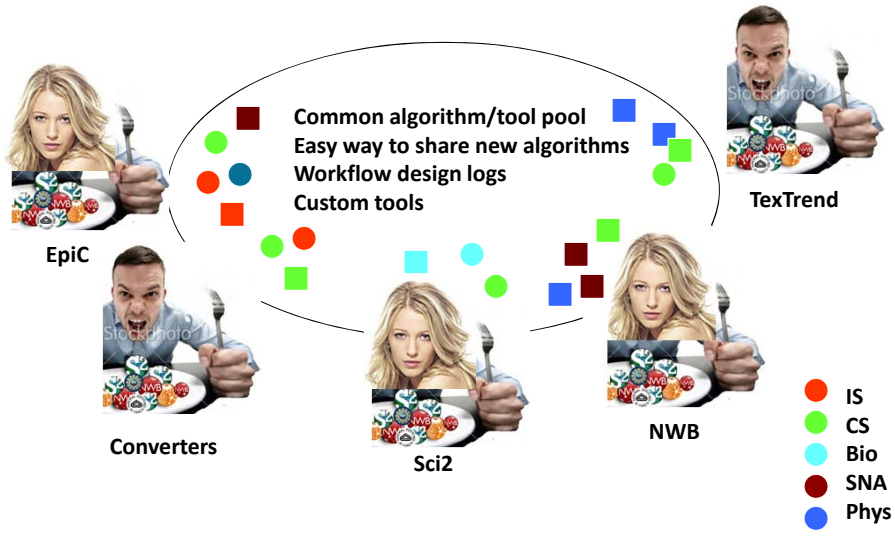
111

CIShell Portal and Developer Guide (*http://cishell.org*)



112

Changing Scientific Landscape—Personal Observations Cont.



113

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 (Sci² 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). **Bruce visits Mike Smoot in 2009**

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. **Micah, June 2010**

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.

114

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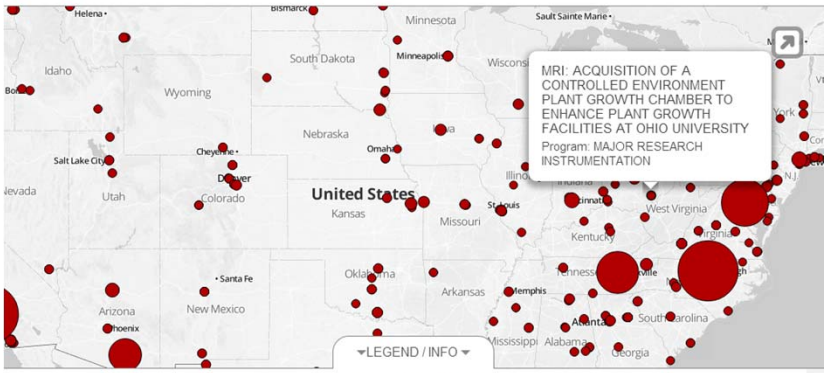
NETE® AV ANALYZER | VISUALIZER

Proportional Symbol Map

Relationship between Projects and External Organizations - Larry E. Humes, Bernice A. Pescosolido; Generated by NETE March 5, 2014 | 9:34 AM EST



Amount Awarded

$30.9M
$15.4M
$4,650

How To Read This Map

This proportional symbol map shows 52 U.S. states and other jurisdictions using the Albers equal-area conic projection with Alaska, Puerto Rico, and Hawaii inset. Each dataset record is represented by a circle centered at its geolocation. The area, interior color, and exterior color of each circle may represent numeric attribute values. Minimum and maximum data values are given in the legend.

115

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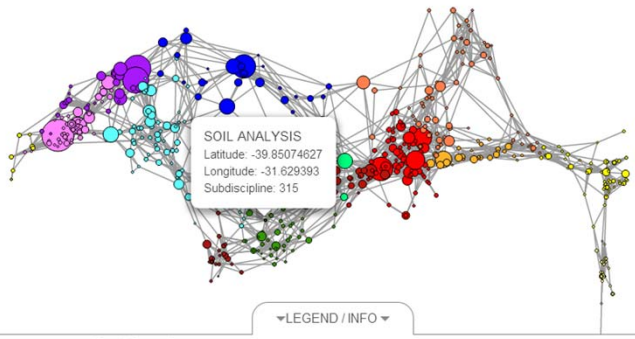
Topic Analysis - Map of Science

Generated from Publications for top 20 projects - Jeffrey R. Alberts, Larry E. Humes, Bernice A. Pescosolido and 9 others; Generated by NETE.



Total Awards

$69.8M
$34.1M
$16.4M

How To Read This Map

This map is a visual representation of 554 sub-disciplines within 13 disciplines of science and their relationships to one another, shown as points and lines connecting those points respectively. Over top this visualization is drawn the result of mapping a dataset's journals to the underlying sub-discipline(s) those journals contain. Mapped sub-disciplines are shown with size relative to the number of matching journals and color from the discipline.

116

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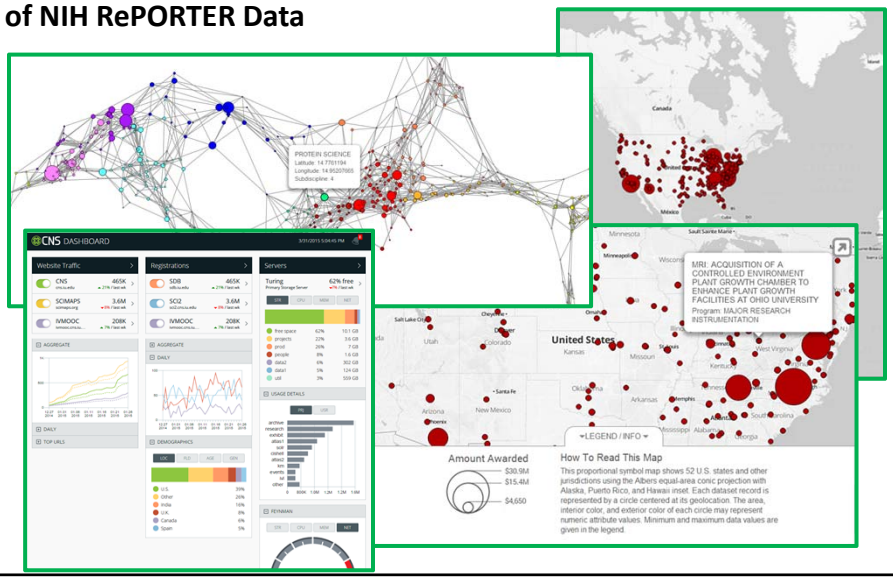
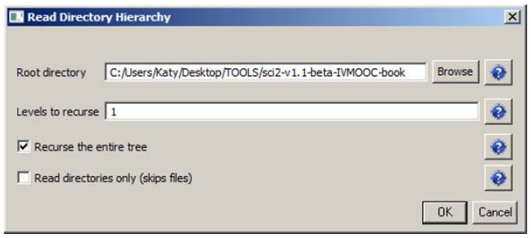
CIShell/Sci2 World and Science Visualizations of NIH RePORTER Data



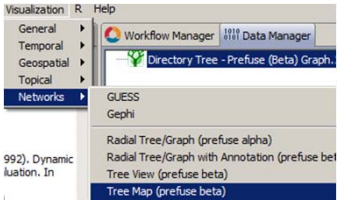
CNS Cyberinfrastructure for Network Science Center

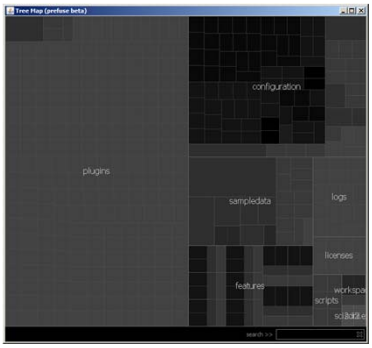
Re-Run Workflows

Run ‘File > Read Directory Hierarchy’ using parameters:



‘Visualize > Networks > Tree Map’:



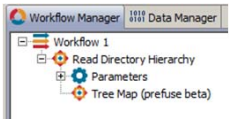


118

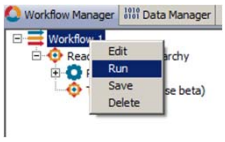
Re-Run Workflows

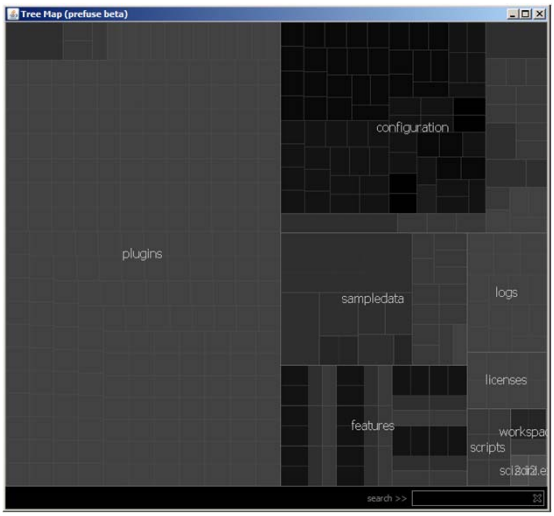
Delete file in **Data Manager**

In **Workflow Manager**

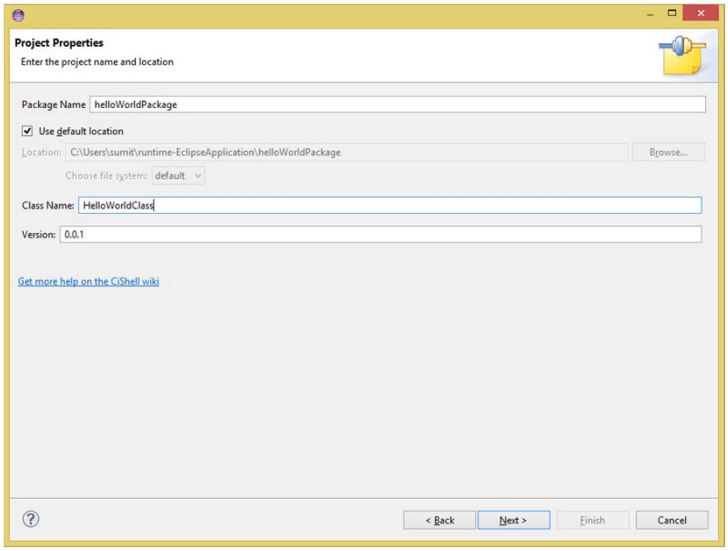


Right click Workflow and 'Run':



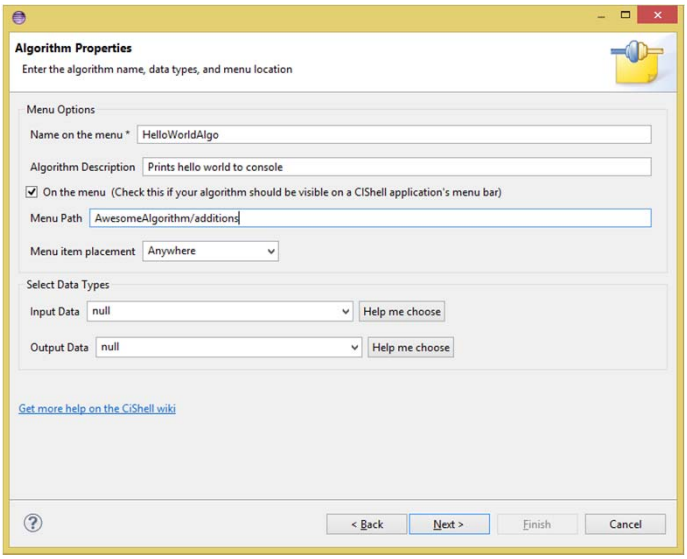


Adding a new algorithm to Sci2 is easy. Simply use the Wizard driven process:



Bonus: How to create a new Sci2 plugin

Adding a new algorithm to Sci2 is easy. Simply use the Wizard driven process:



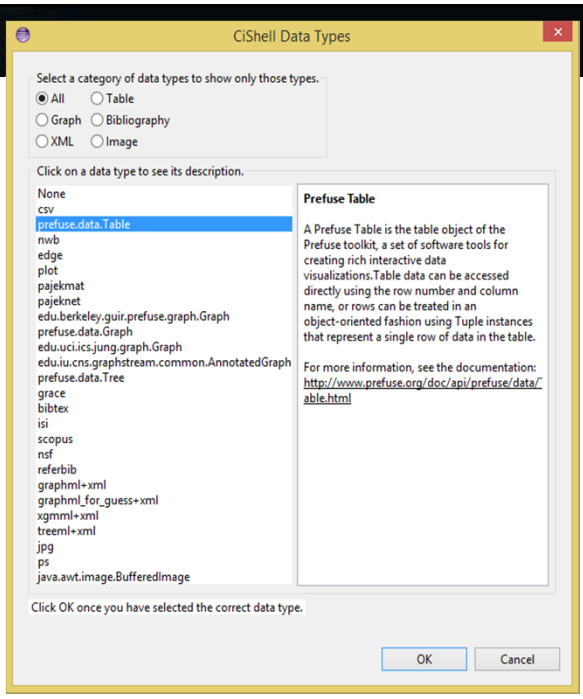
121

Adding a new algorithm to Sci2 is easy. Simply use the Wizard driven process.

See also

http://wiki.cns.iu.edu/display/CISHELL/Hello+World+Tutorial

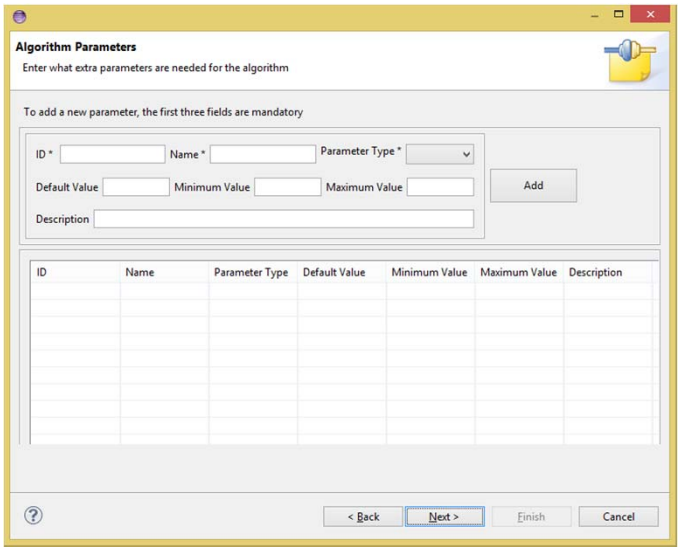
http://cishell.wiki.cns.iu.edu/Home



122

Bonus: How to create a new Sci2 plugin

Adding a new algorithm to Sci2 is easy. Simply use the Wizard driven process:



123

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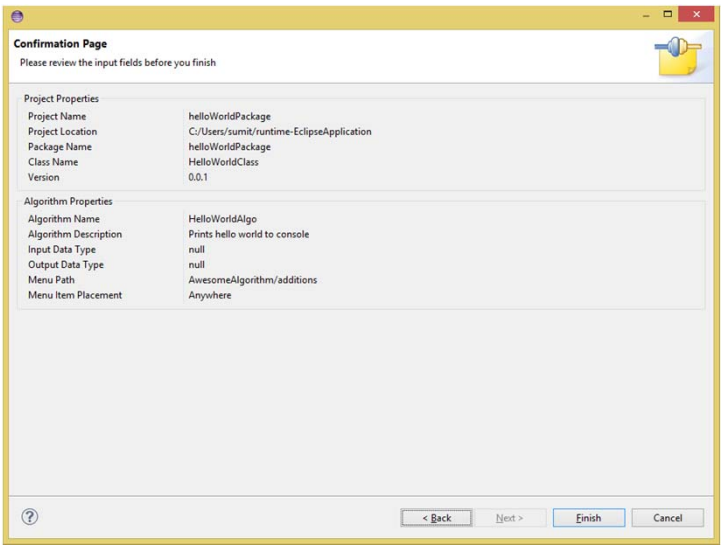
Bonus: How to create a new Sci2 plugin

Adding a new algorithm to Sci2 is easy. Simply use the Wizard driven process:



124

CNS Cyberinfrastructure for Network Science Center

Tutorial Overview

9:00 Welcome and Overview of Tutorial and Attendees
9:30 The Sci2 Tool
- Download and run the Sci2 Tool
- ONE dataset, MANY analyses and visualizations

10:00 Sci2 Tool Workflows
- Temporal Analysis: Horizontal line graph of NSF projects
- Geospatial Analysis: US and world maps
- Geospatial Analysis: Geomap with network overlays
- Topical Analysis: Visualize research profiles
- Network Analysis: Co-occurrence networks and bimodal networks
- Network Analysis: Evolving collaboration networks

11:00 Networking Break

11:15 Visualization Framework
11:45 IVMOOC – MANY more Workflows
12:15 Plug-and-Play Macroscopes
12:30 Outlook and Q&A
13:00 Adjourn

125

References

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Shiffrin, Richard M. and Börner, Katy (Eds.) (2004). **Mapping Knowledge Domains**. *Proceedings of the National Academy of Sciences of the United States of America*, 101(Suppl_1). http://www.pnas.org/content/vol101/suppl_1/

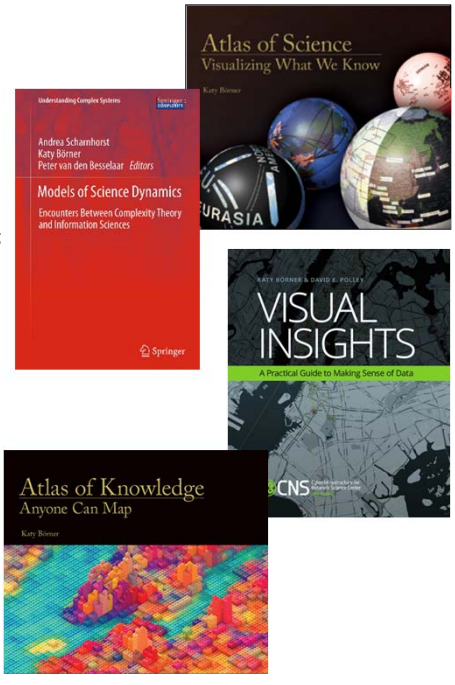
Börner, Katy (2010) **Atlas of Science: Visualizing What We Know**. The MIT Press. http://scimaps.org/atlas

Scharnhorst, Andrea, Börner, Katy, van den Besselaar, Peter (2012) **Models of Science Dynamics**. Springer Verlag.

Katy Börner, Michael Conlon, Jon Corson-Rikert, Cornell, Ying Ding (2012) **VIVO: A Semantic Approach to Scholarly Networking and Discovery**. Morgan & Claypool.

Katy Börner and David E Polley (2014) **Visual Insights: A Practical Guide to Making Sense of Data**. The MIT Press.

Börner, Katy (2015) **Atlas of Knowledge: Anyone Can Map**. The MIT Press. http://scimaps.org/atlas2



126

All papers, maps, tools, talks, press are linked from http://cns.iu.edu
These slides will soon be at http://cns.iu.edu/docs/presentations

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Mapping Science Exhibit Facebook: http://www.facebook.com/mappingscience

127