



Redes y Sistemas Complejos

Cuarto Curso del Grado en Ingeniería Informática

Seminario 4: Ejemplos de Poda y Visualización de Redes: Redes Científicas

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REDES CIENTÍFICAS, CIENCIODRAMAS Y VISUALIZACIÓN



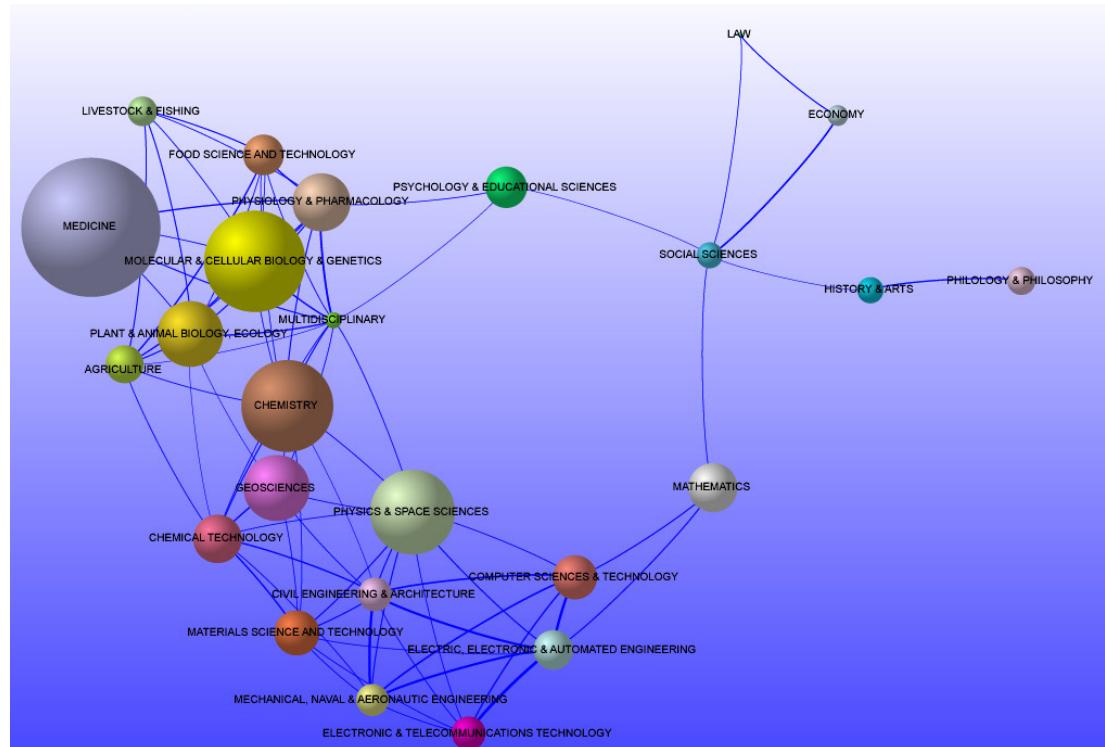
Planteamiento (1)

- La **investigación científica** es una actividad en la que se ponen de manifiesto multitud de relaciones, interacciones e influencias
- Estas **relaciones** se producen a diversos niveles: **investigadores, instituciones, disciplinas científicas, etc.**
- Pueden representarse y analizarse en forma de **redes sociales**
- El análisis de las interacciones y su evolución puede resultar útil a la hora de definir, **evaluar** o comparar **políticas científicas**
- También puede servir para **diagnosticar** el **estado de la ciencia** en un cierto ámbito (geográfico, temporal o temático) o **predecir** su evolución



Planteamiento (2)

Visualización de la Información y Análisis de Dominios: Cienciografía



Uno de los grandes objetivos es definir una metodología para el análisis y la visualización de grandes dominios científicos de tal forma que las interacciones entre autores y sus roles en el mundo científico queden reflejados mediante citas. Estas representaciones pueden emplearse como interfaces de recuperación de información



Cienciogramas

- Un cienciograma es una representación visual (mapa) del estado de la investigación científica de un dominio concreto (institución, región, país, continente o a nivel mundial) en un momento concreto
- Aplicaciones:
 - Análisis de la estructura de campos científicos y frentes de identificación
 - Representación de la evolución de la producción científica en dominios institucionales/de conocimiento
 - Evaluación cualitativa de la producción científica de instituciones/regiones/países y del impacto de políticas científicas
 - Comparación de los perfiles científicos de diferentes instituciones o áreas geográficas

Moya-Anegón, F., Vargas-Quesada, B., et al. (2004). A new technique for building maps of large scientific domains based on the co-citation of classes and categories. *Scientometrics* 61(1), 129–145



Redes científicas

- No se trata de representar “La Ciencia”, sino la producción científica
- ¿Cuál es el producto?
- ¿Quiénes son los “productores”? / ¿A qué nivel se agrega la producción?
- ¿Cuáles son las relaciones entre productos o productores?

Se analiza la producción en términos de publicaciones

El artículo científico es la unidad de producto



Información aportada

Neural Comput & Applic (2010) 19:807–823
DOI 10.1007/s00521-010-0380-x

SWARM ROBOTICS

Collective decision-making based on social odometry

Álvaro Gutiérrez · Alexandre Campo ·
Félix Monasterio-Huelin · Luis Magdalena ·
Marco Dorigo

Received: 1 June 2009/Accepted: 27 April 2010/Published online: 16 May 2010
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Abstract In this paper, we propose a swarm intelligence localization strategy in which robots have to locate different resource areas in a bounded arena and forage between them. The robots have no knowledge of the arena dimensions and of the number of resource areas. The strategy is based on peer-to-peer local communication without the need for any central unit. Social Odometry leads to a self-organized path selection. We show how collective decisions lead the robots to choose the closest resource site from a central place. Results are presented with simulated and real robots.

Keywords Swarm robotics · Self-organization · Collective decision · Local communication

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F. Monasterio-Huelin

- Revista, editorial
- Año
- Autores
- Palabras clave
- Afiliación

Referencias



Redes Científicas: Estableciendo relaciones

Relaciones de colaboración

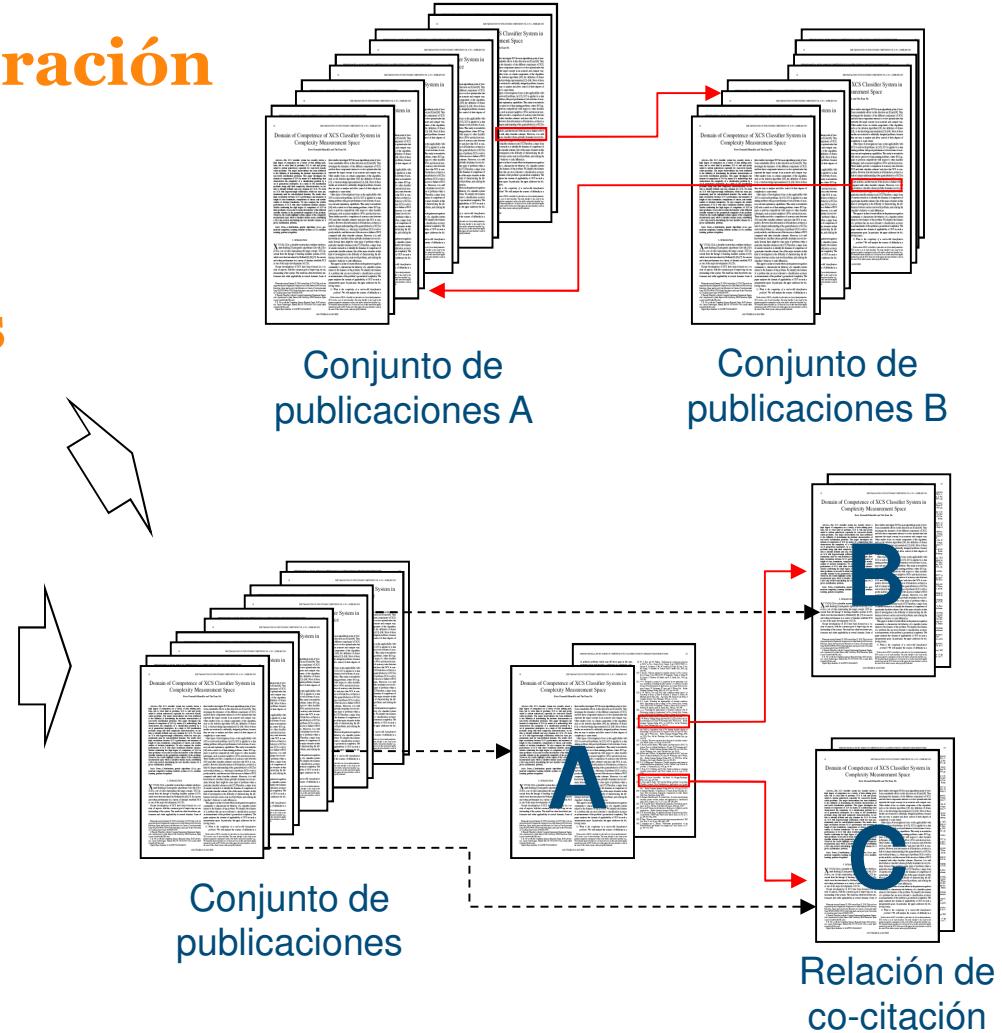
- Autores
- Instituciones

Relaciones temáticas

- Contenido
- Palabras clave
- Referencias
 - Relación de inter-citación
 - Relación de co-citación

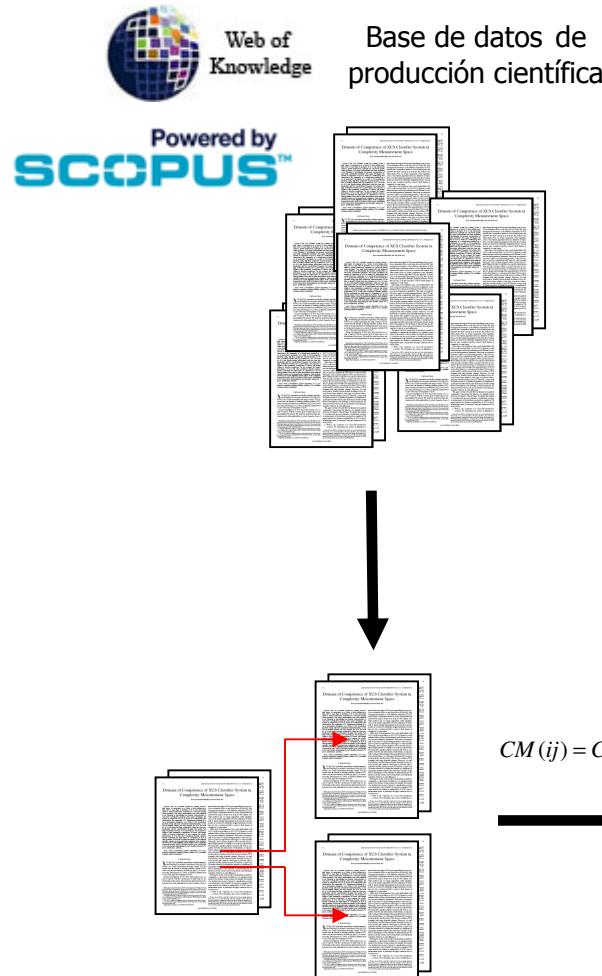
A diversos niveles

- Autores
- Revistas
- Áreas temáticas
- Dominios científicos

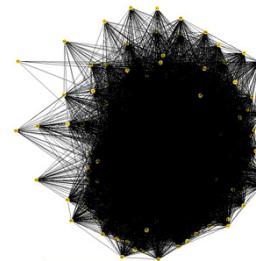




Representación (1)



Representación como
grafo ponderado
(red social)



Restringida a un cierto ámbito:

- Geográfico
- Temporal
- Temático

Agregada a un cierto nivel:

- Artículos
- Autores
- Revistas
- Categorías/disciplinas científicas

	A	B	C	D	E
A	8	2	0	4	3
B	2	6	1	3	2
C	0	1	5	2	1
D	4	3	2	9	0
E	3	2	1	0	7

- Definición de las unidades de análisis
- Extracción de las relaciones de co-citación
- Filtrado



Representación (2)

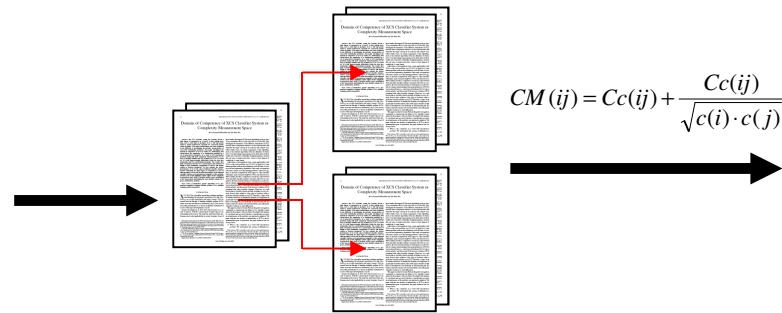
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Web of
Knowledge



Base de Datos de
producción científica

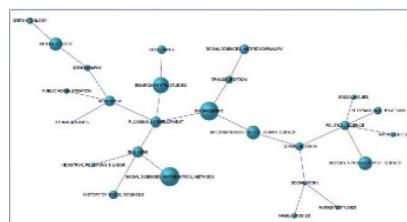


$$CM(ij) = Cc(ij) + \frac{Cc(ij)}{\sqrt{c(i) \cdot c(j)}}$$

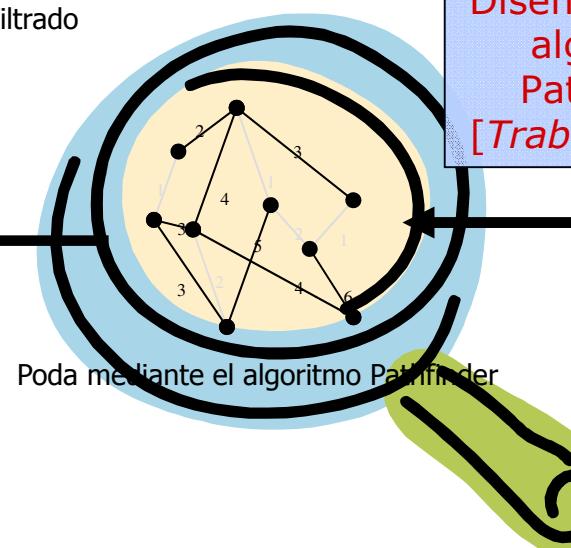
	A	B	C	D	E
A	8.2	2.0	9.7	1.4	8.7
B	1.1	5.9	8.5	9.4	6.2
C	9.8	3.3	0.9	2.2	7.3
D	9.3	4.4	8.0	6.8	6.4
E	2.7	7.5	4.0	3.5	1.0

Creación de una matriz de co-citación

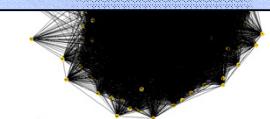
- Definición de las unidades de análisis
- Extracción de las relaciones de co-citación
- Filtrado



Visualización con un algoritmo de
distribución de grafos (Kamada-Kawai)
(Interfaz gráfica en SVG)



Diseño de variantes eficientes del
algoritmo Pathfinder: Fast-
Pathfinder y MST-Pathfinder
[Trabajos de Quirin et al. (2009)]



Representación como grafo ponderado
(red social)



Representación (3)

RECOPILACIÓN DE INFORMACIÓN	UNIDADES DE ANÁLISIS	UNIDADES DE MEDIDA	REDUCCIÓN Y DISTRIBUCIÓN ESPACIAL DE LA INFORMACIÓN	REPRESENTACIÓN GRÁFICA
BÚSQUEDAS SCOPUS ISI INSPEC Eng. Index Medline Research Index Patentes Etc. ENRIQUECIDA Por citas Por términos	MÁS COMUNES Paises Clases Categorías Revistas Documentos Autores Términos Palabras	VALORES/FRECUENCIAS Atributos (p.e. términos) Citas Co-citas Agrupaciones por año UMBRALES Por valor	REDUCCIÓN DEL ESPACIO Análisis de Clusters Análisis Factorial (FA) y Análisis de Componentes Principales (PCA) Multi-dimensional Scaling (MDS) Pathfinder networks (PFNETS) Mapas auto-organizativos (SOM) Incluyendo SOM, ET-maps, etc Blockmodeling DISTRIBUCIÓN ESPACIAL DE LA INFORMACIÓN Kamada-Kawai Fruchterman-Reingold	INTERACCIÓN Browsing Vista panorámica Zoom Filtrado Consultas ANALISIS

Moya-Anegón, F., Vargas-Quesada, B., et al. (2004). A new technique for building maps of large scientific domains based on the co-citation of classes and categories. Scientometrics 61(1), 129–145

Moya-Anegón, F. de, Vargas-Quesada, B., et al. (2007). Visualizing the marrow of science. Journal of the American Society for Information Science and Technology, 58(14), 2167–2179

Vargas-Quesada, B., & Moya-Anegón, F. (2007). Visualizing the science structure. New York: Springer



Ejemplo

Análisis para un país (USA) y un año (2003)

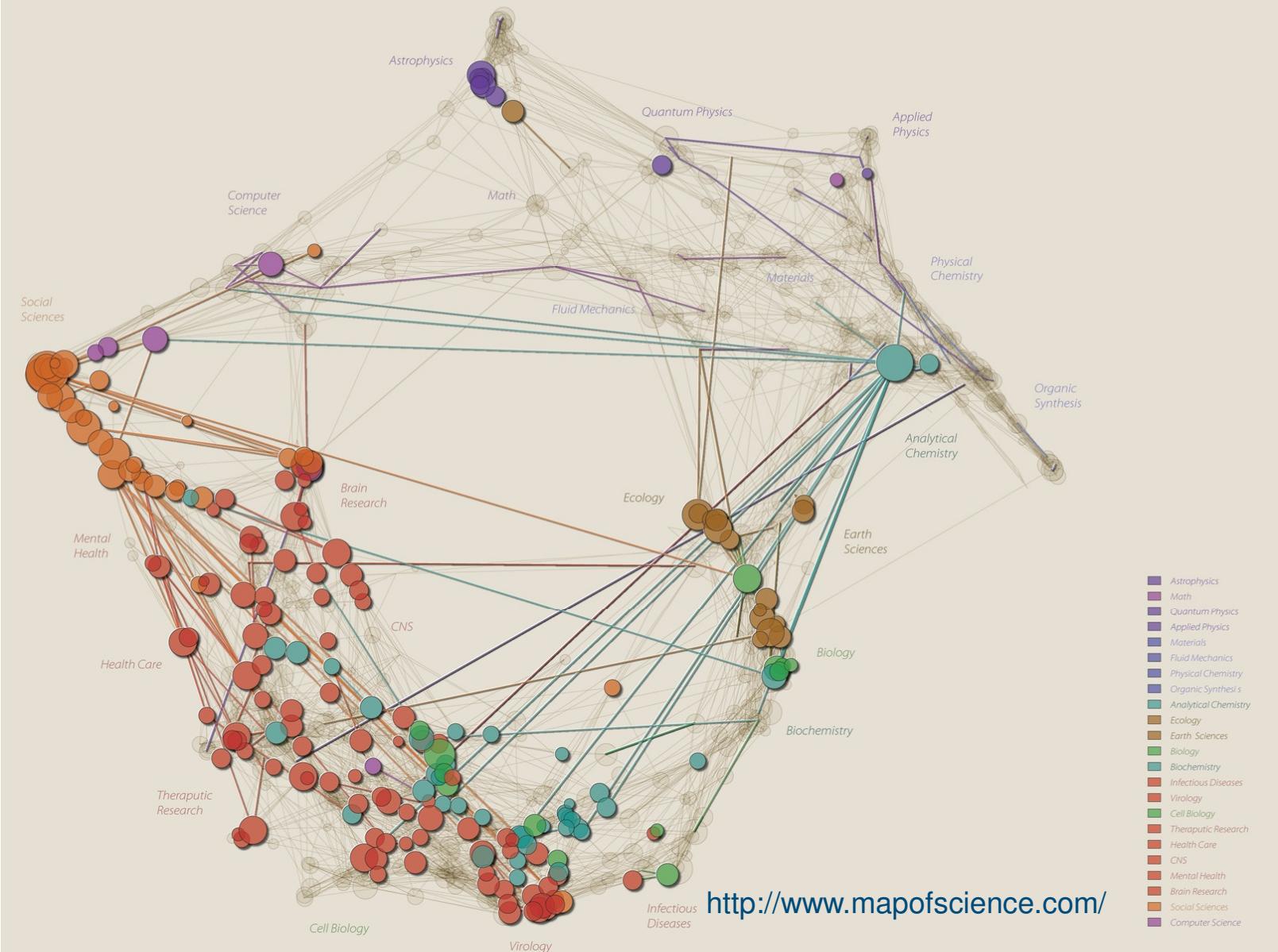
- Presencia de las diversas disciplinas
- Disciplinas sobrerrepresentadas
- Interacción entre disciplinas

A partir de frecuencias de inter- y co-citación a nivel de revistas



Ejemplo

The United States of America





Ejemplo II

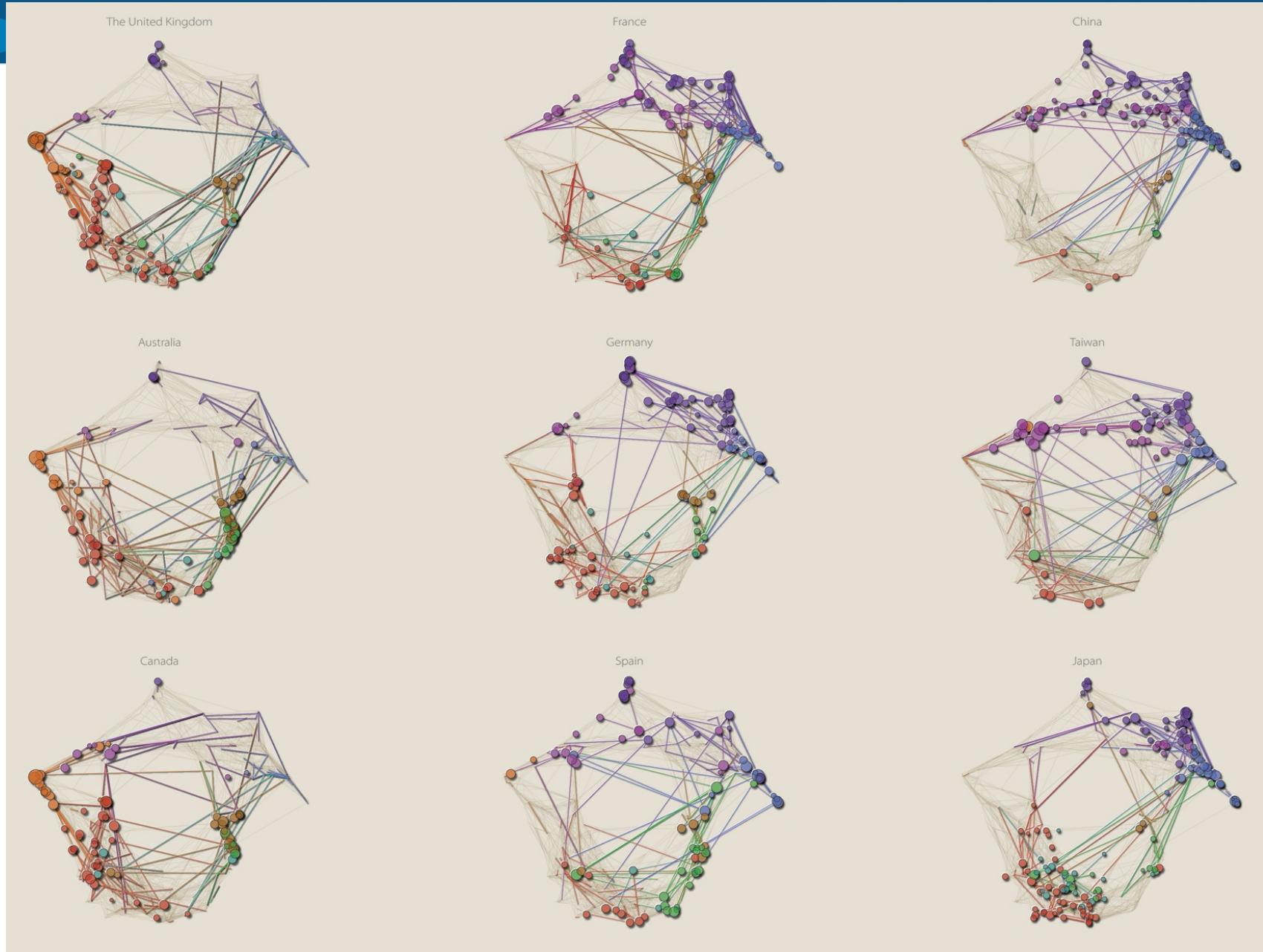
Comparación con otros países en idéntico periodo

Utilizando vistas gráficas similares

Análisis realizado sobre un conjunto de unos 800.000 artículos



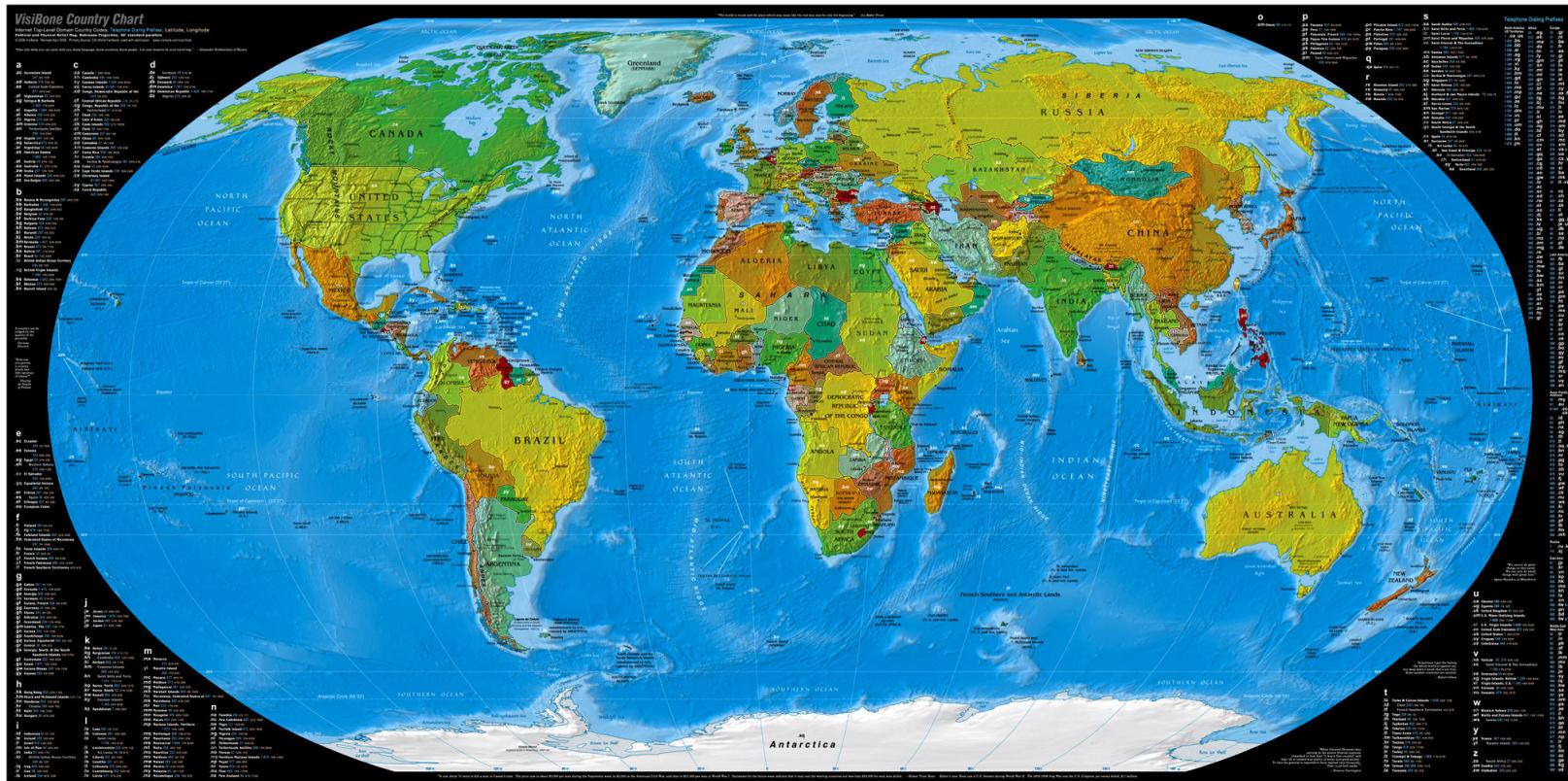
Ejemplo II



ANÁLISIS Y VISUALIZACIÓN DE GRANDES DOMINIOS CIENTÍFICOS



Cienciogramas de Grandes Dominios Científicos (1)





Cienciogramas de Grandes Dominios Científicos (2)

ISI Web of Knowledge

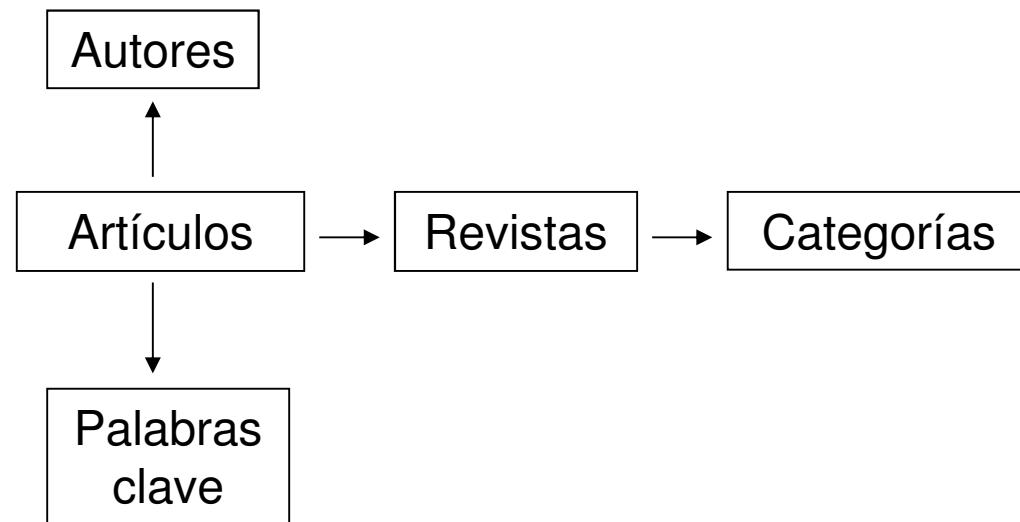


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Adquisición de la información



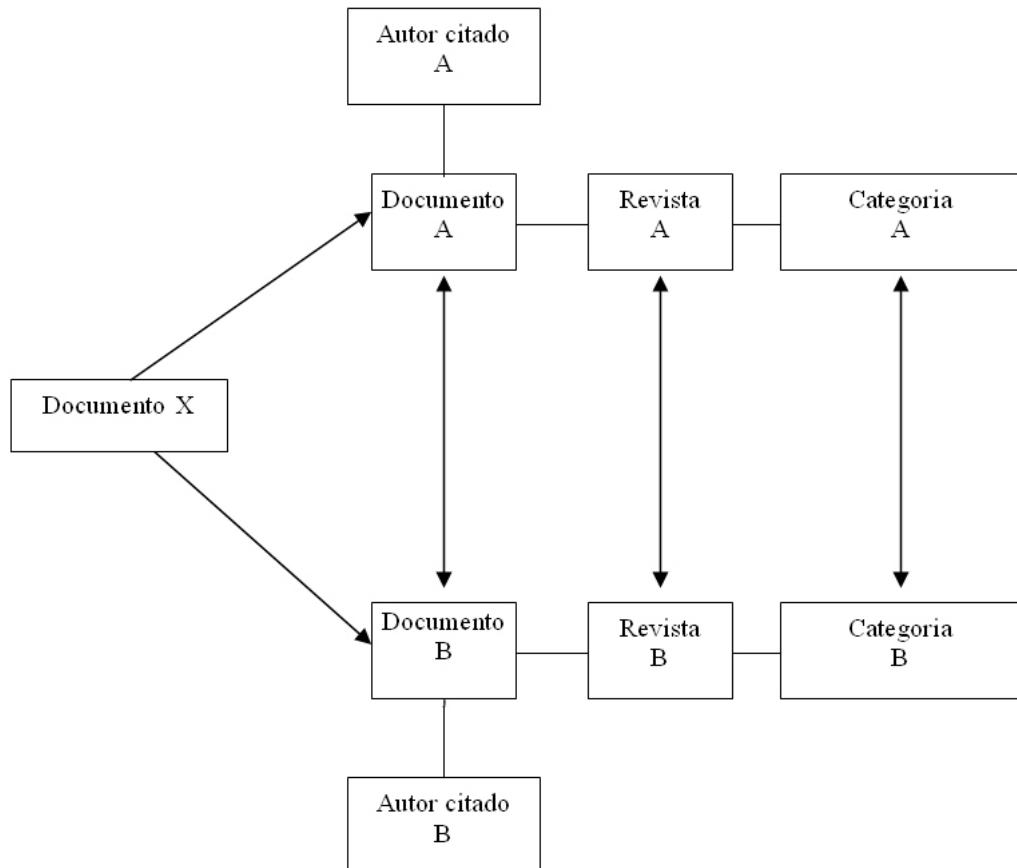
Cienciogramas de Grandes Dominios Científicos (3)



Unidades de Análisis



Cienciogramas de Grandes Dominios Científicos (4)



$$CM(ij) = Cc(ij) + \frac{Cc(ij)}{\sqrt{c(i) \cdot c(j)}}$$

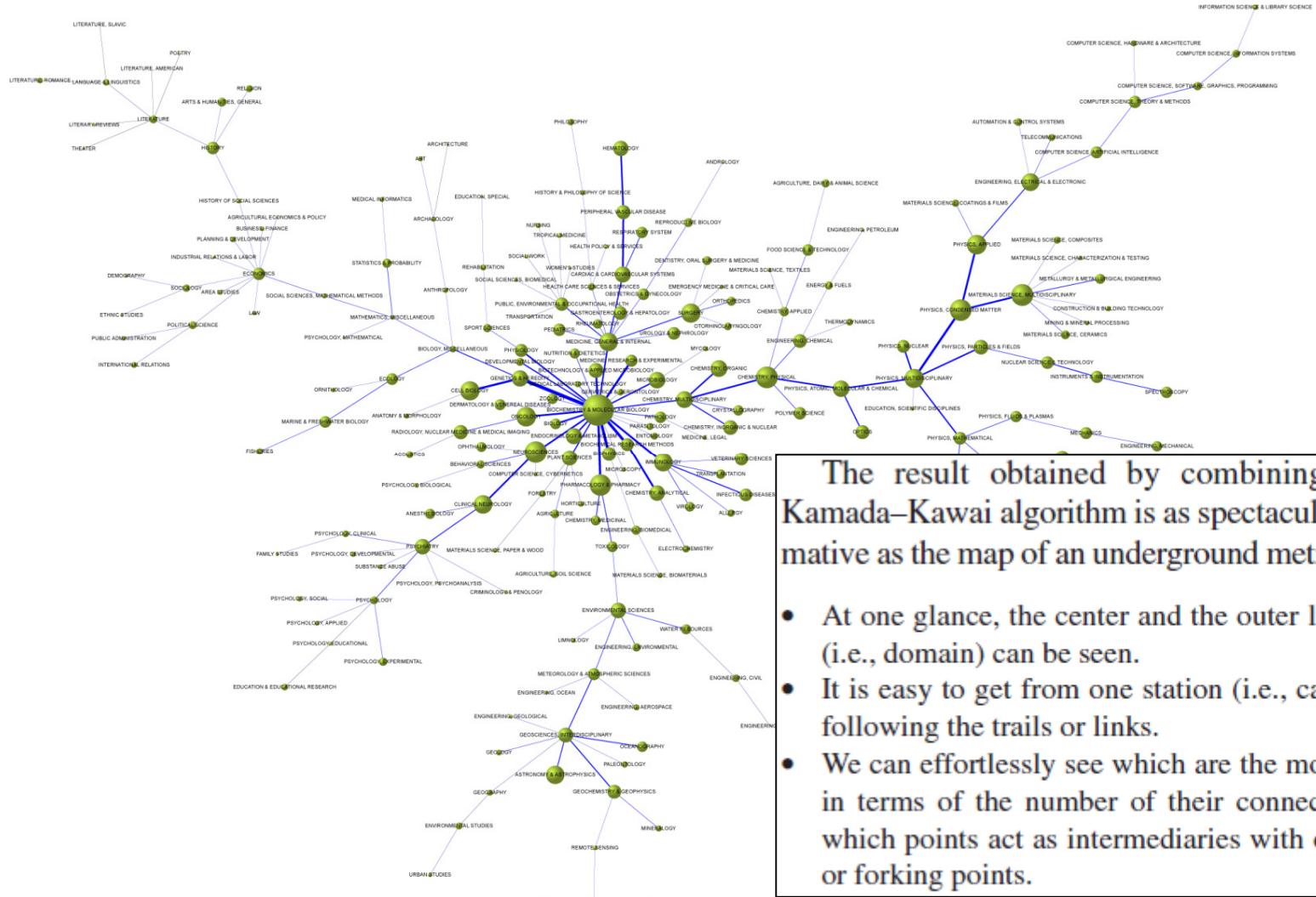
$Cc(ij)$ Frecuencia de co-citación

$c(i)$ Frecuencia de citación

Unidades de Medida



Cienciogramas de Grandes Dominios Científicos (5)



The result obtained by combining PFNET with the Kamada–Kawai algorithm is as spectacular and visually informative as the map of an underground metro or railroad system:

- At one glance, the center and the outer limits of the system (i.e., domain) can be seen.
 - It is easy to get from one station (i.e., category) to another, following the trails or links.
 - We can effortlessly see which are the most important nodes in terms of the number of their connections and, in turn, which points act as intermediaries with other lines, as hubs or forking points.



Cienciogramas de Grandes Dominios Científicos (6)

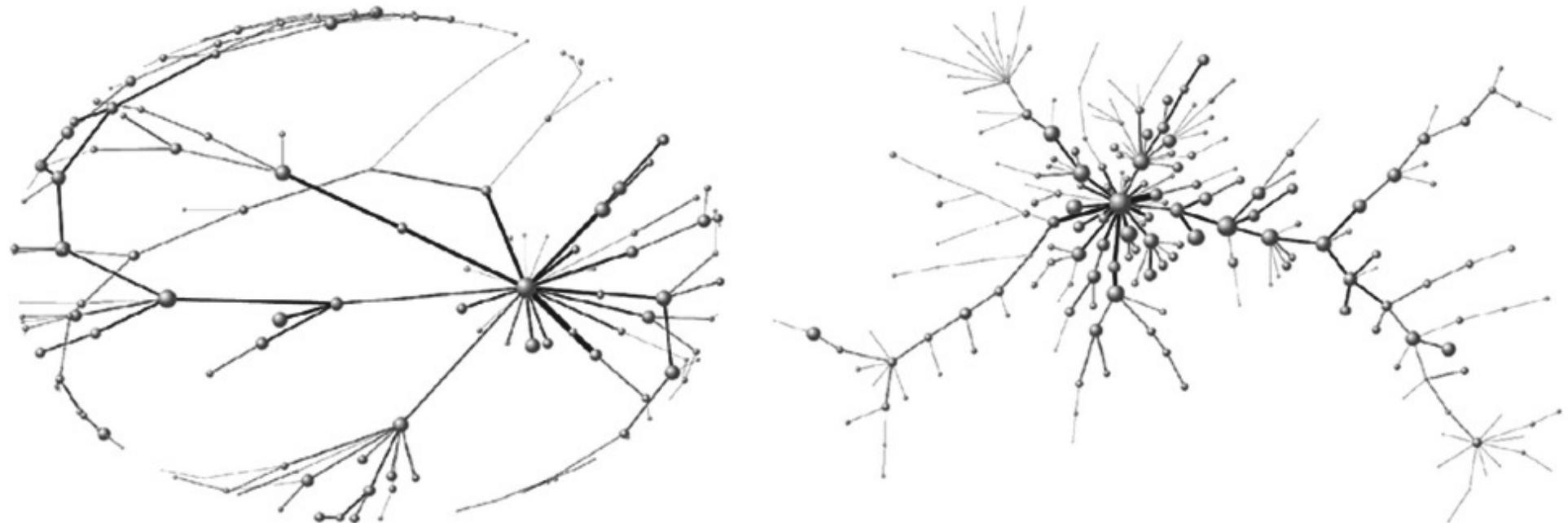
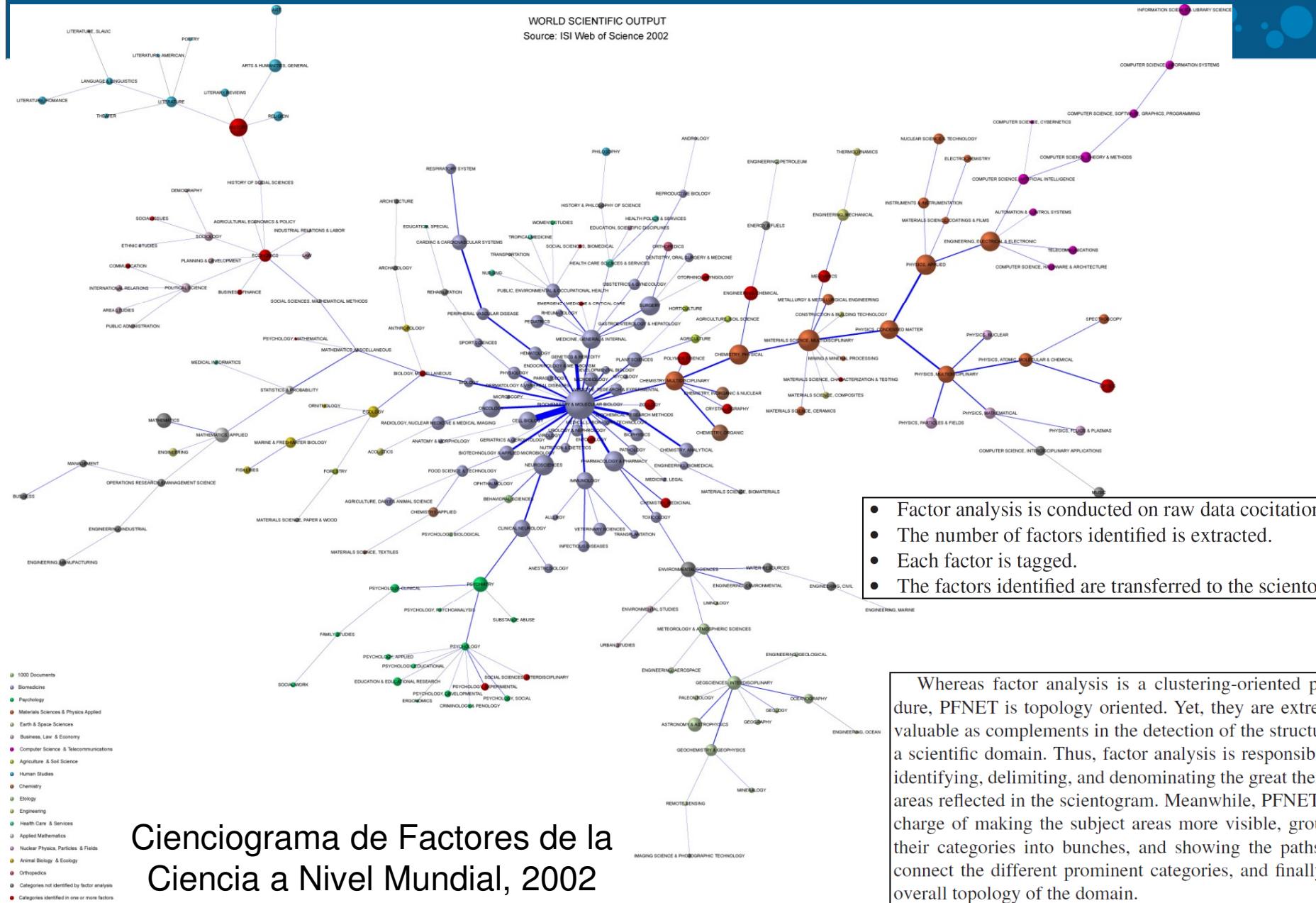


FIG. 1. Scientograms obtained using the algorithms of Fruchterman and Reingold (1991), and Kamada and Kawai (1989), respectively.

Representación Gráfica de la Información: La distribución de F&R no es apropiada

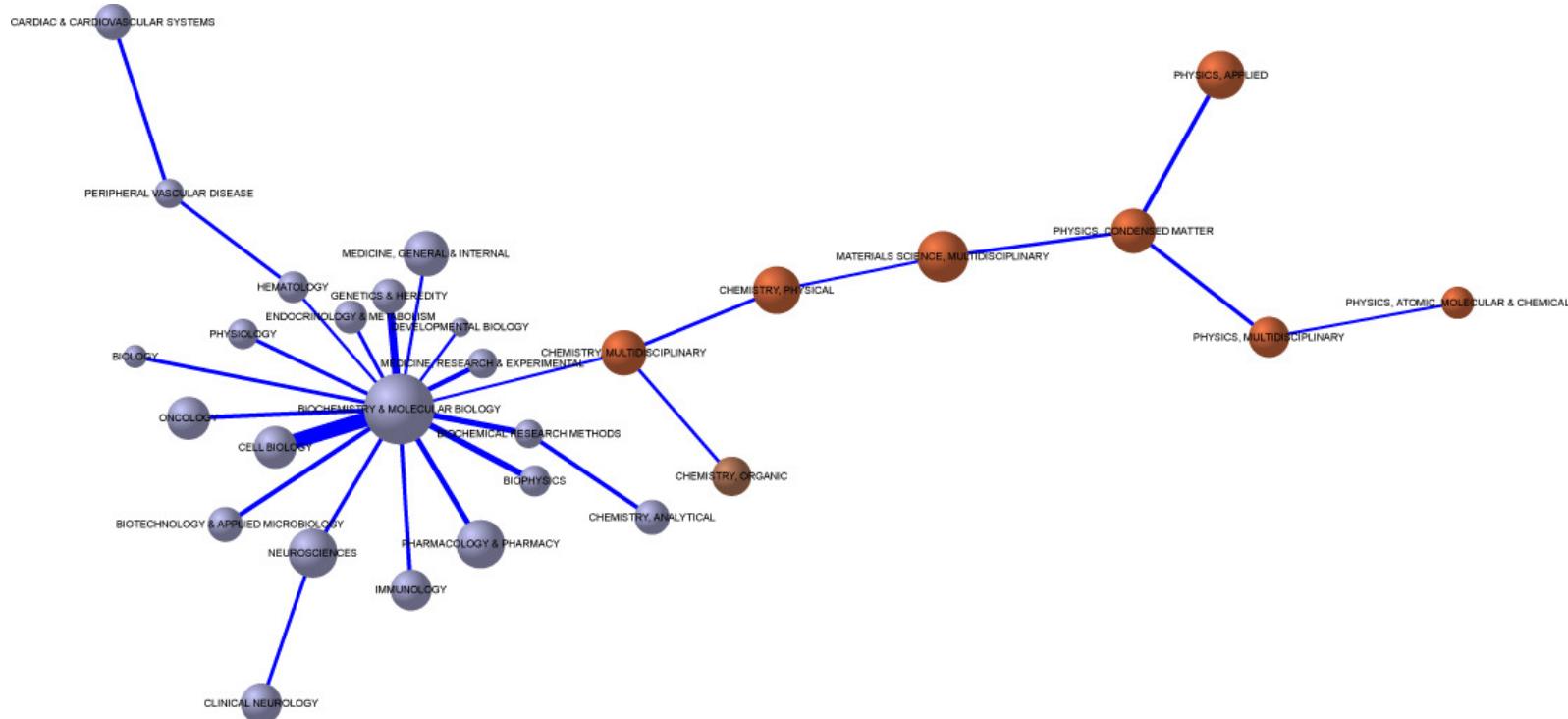


Cienciogramas de Grandes Dominios Científicos (7)





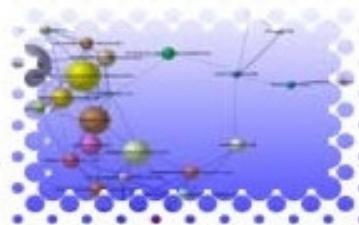
Cienciogramas de Grandes Dominios Científicos (8)



Backbone: La “médula” de la producción científica mundial, 2002

Atlas of Science

main project of SCImago Research Group



- **Regional scientific indicators**

For a correct navigation use Internet Explorer with the Adobe SVG Viewer plugin installed ([click here](#) to download the plugin) and turn off any pop-up killer software

Argentina
(1990-2005)

- Atlas of science
- Authors report

Brasil
(1990-2005)

- Atlas of science
- Authors report

Chile
(1990-2005)

- Atlas of science
- Authors report

Colombia
(1990-2005)

- Atlas of science
- Authors report

Cuba
(1990-2005)

- Atlas of science
- Authors report

Mexico
(1990-2005)

- Atlas of science
- Authors report

Portugal
(1990-2005)

- Atlas of science
- Authors report

Spain
(1990-2005)

- Atlas of science
- Authors report
- Institutions report
- Atlas of subdomains

Venezuela
(1990-2005)

- Atlas of science
- Authors report



Ejemplo: Atlas of Science

Interfaz de recuperación de información científica

Representación de la producción científica española

Año 2005

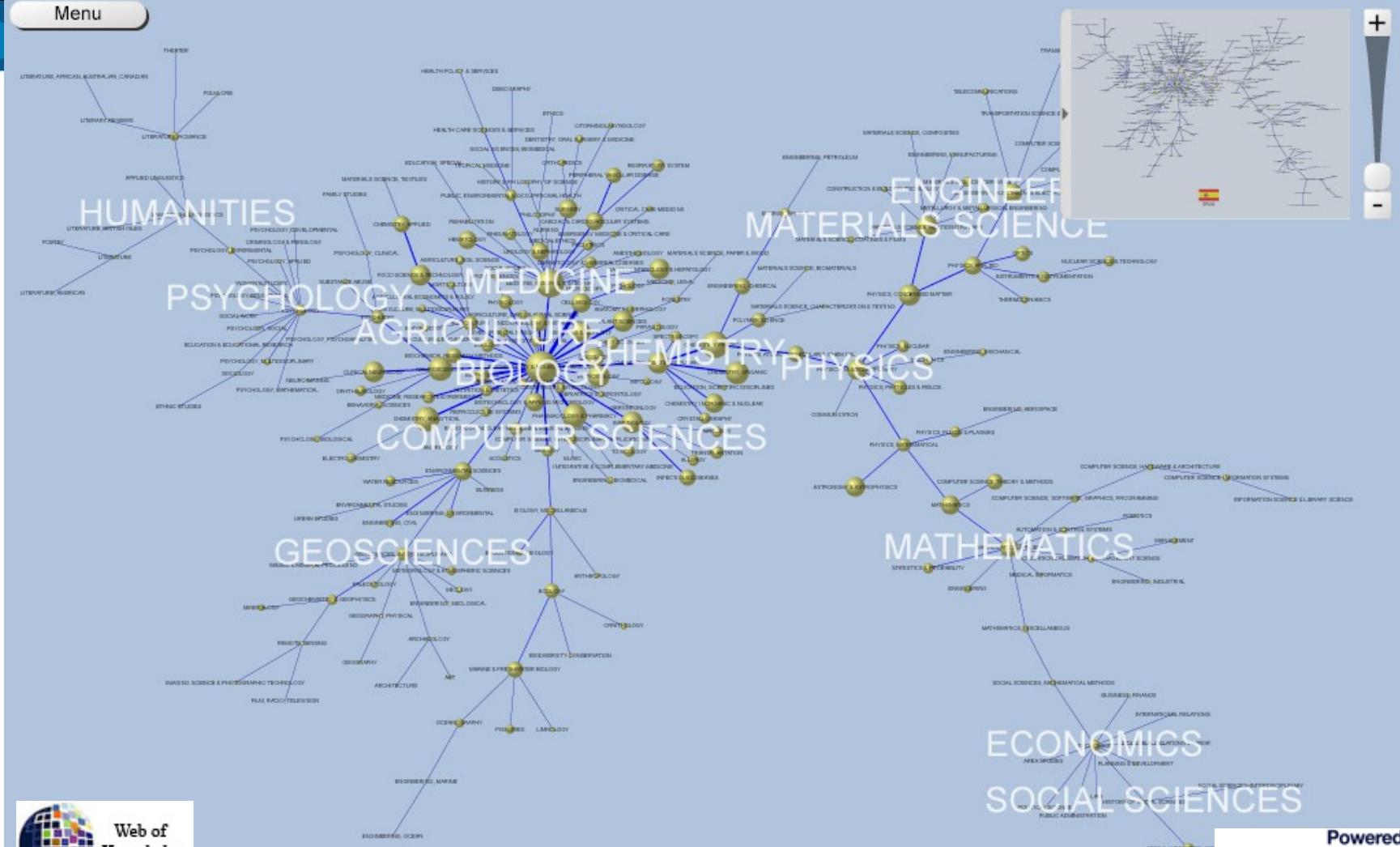
Basada en relaciones de co-citación

Agregada a nivel de disciplinas científicas utilizando las categorías establecidas por el Thomson-ISI Journal Citation Rank



Cienciograma de Categorías

Menu



Web of
Knowledge

<http://www.atlasofscience.net/>



Atlas of Science



SPAIN

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SCOPUS™

<http://www.scimagojr.com/>

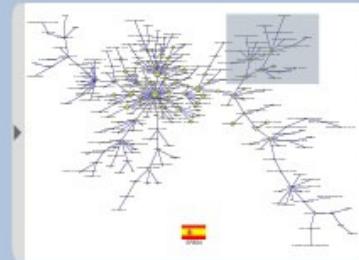
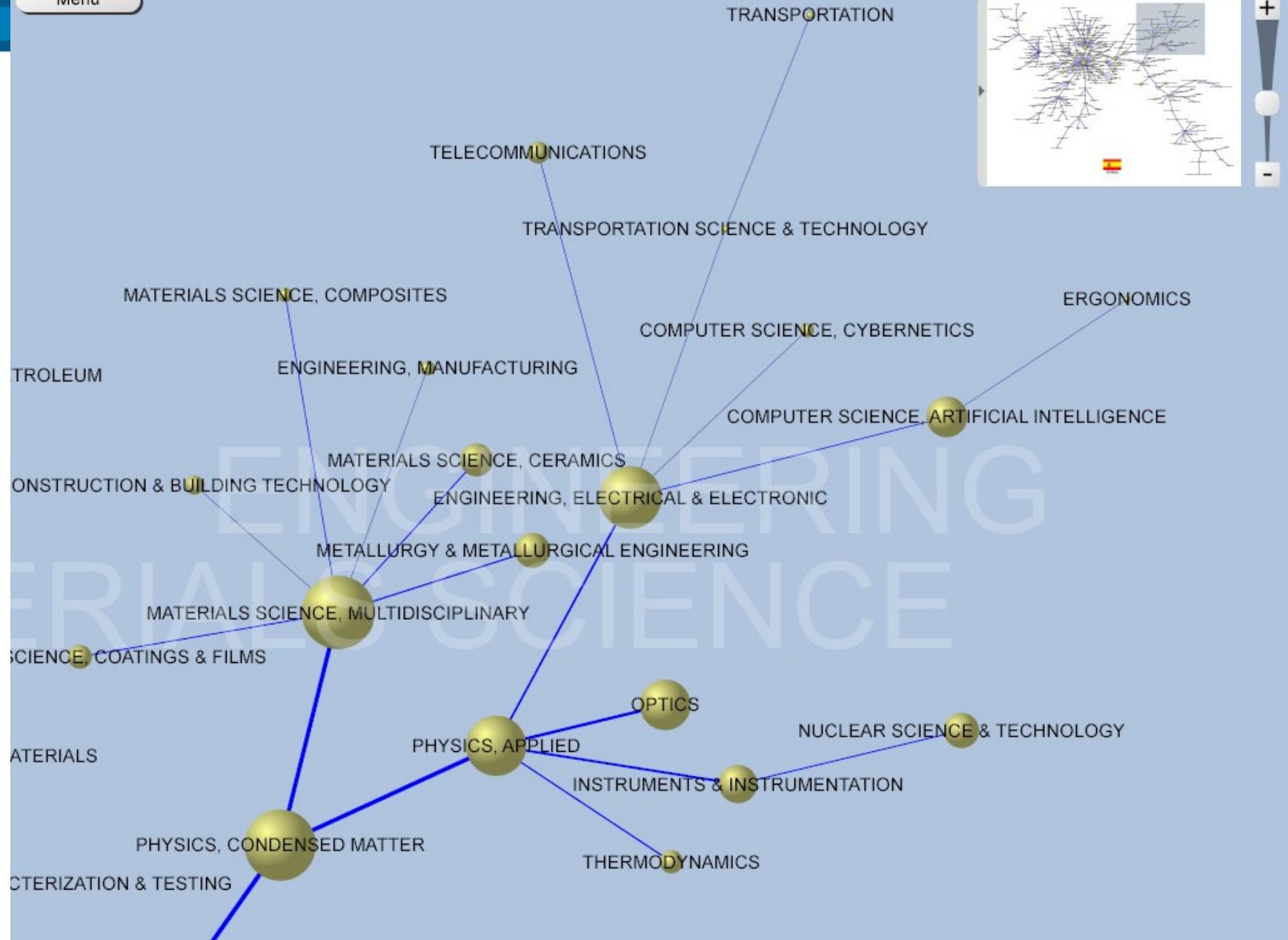
SJR

SCImago
Journal & Country
Rank



Cienciograma de Categorías (Zoom)

Menu



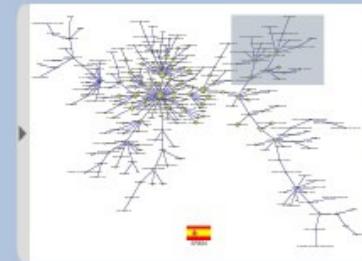
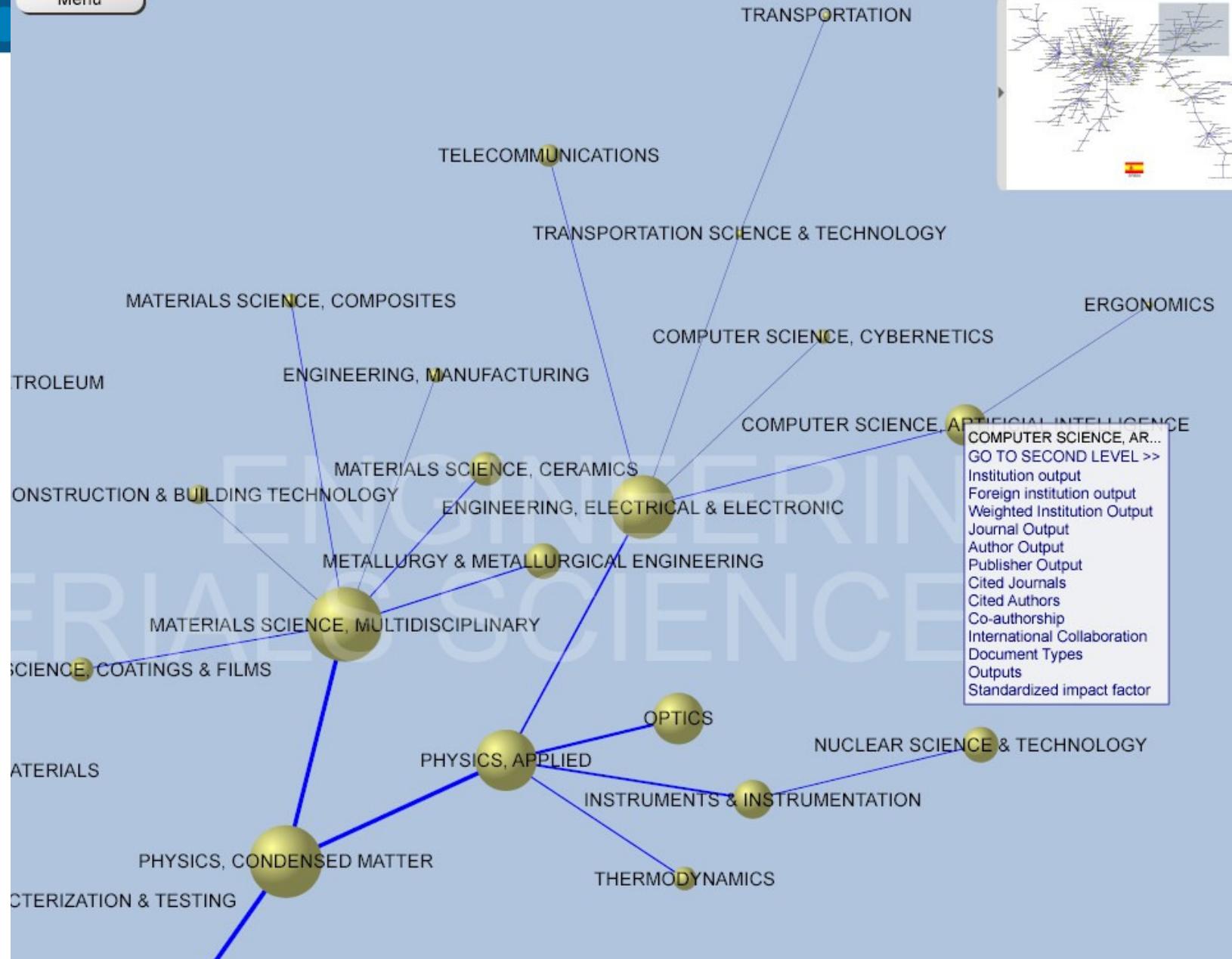
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-



Estructura Jerárquica

Menu



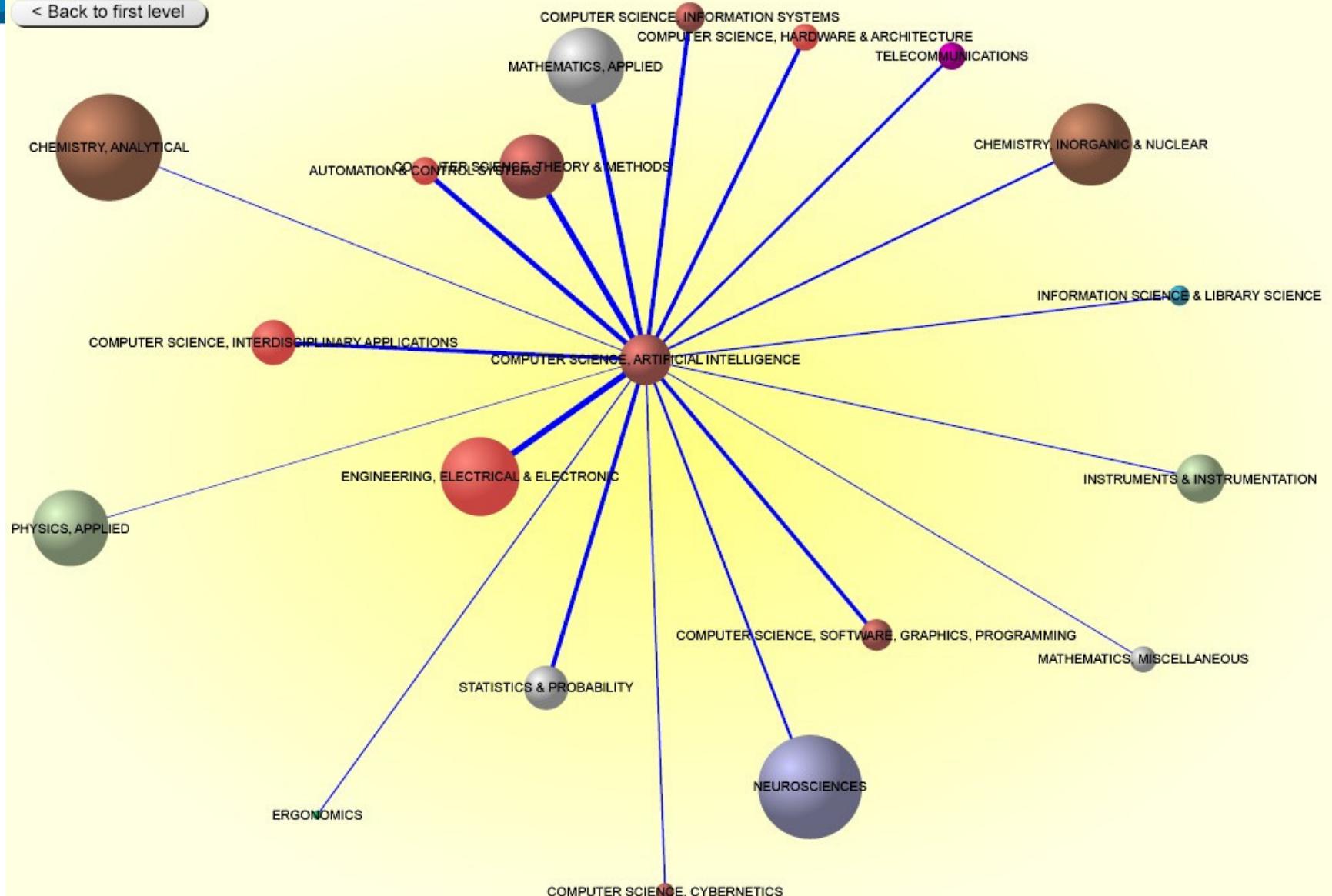
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Segundo Nivel: Mapa Heliocéntrico de Categorías

[< Back to first level](#)



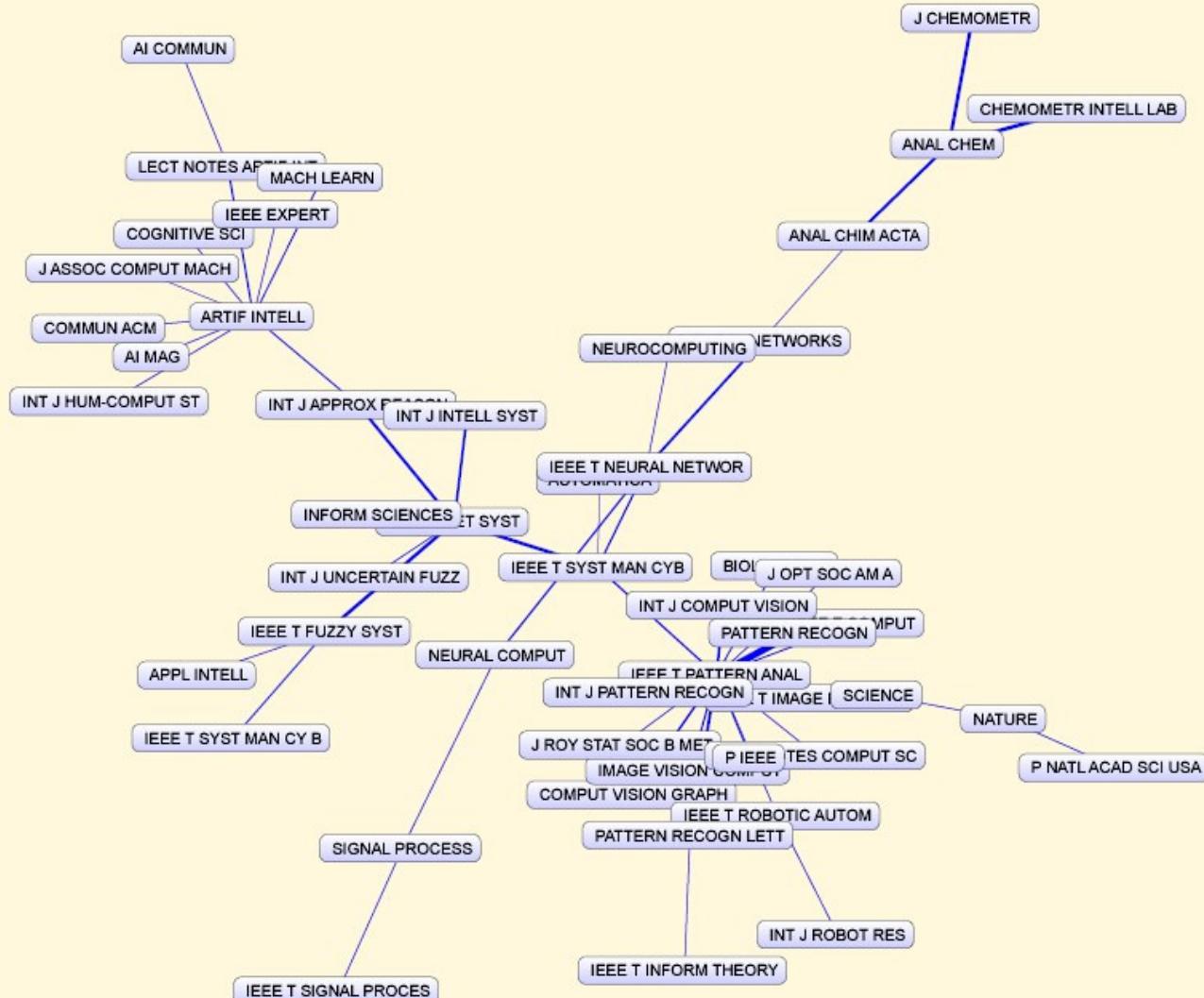


Tercer Nivel: Co-citación de Revistas (1)

[< Previous level](#)[view author net](#)

journal co-citation net:

COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE



Node selection: All | None

Modify Threshold (50)

A- A+

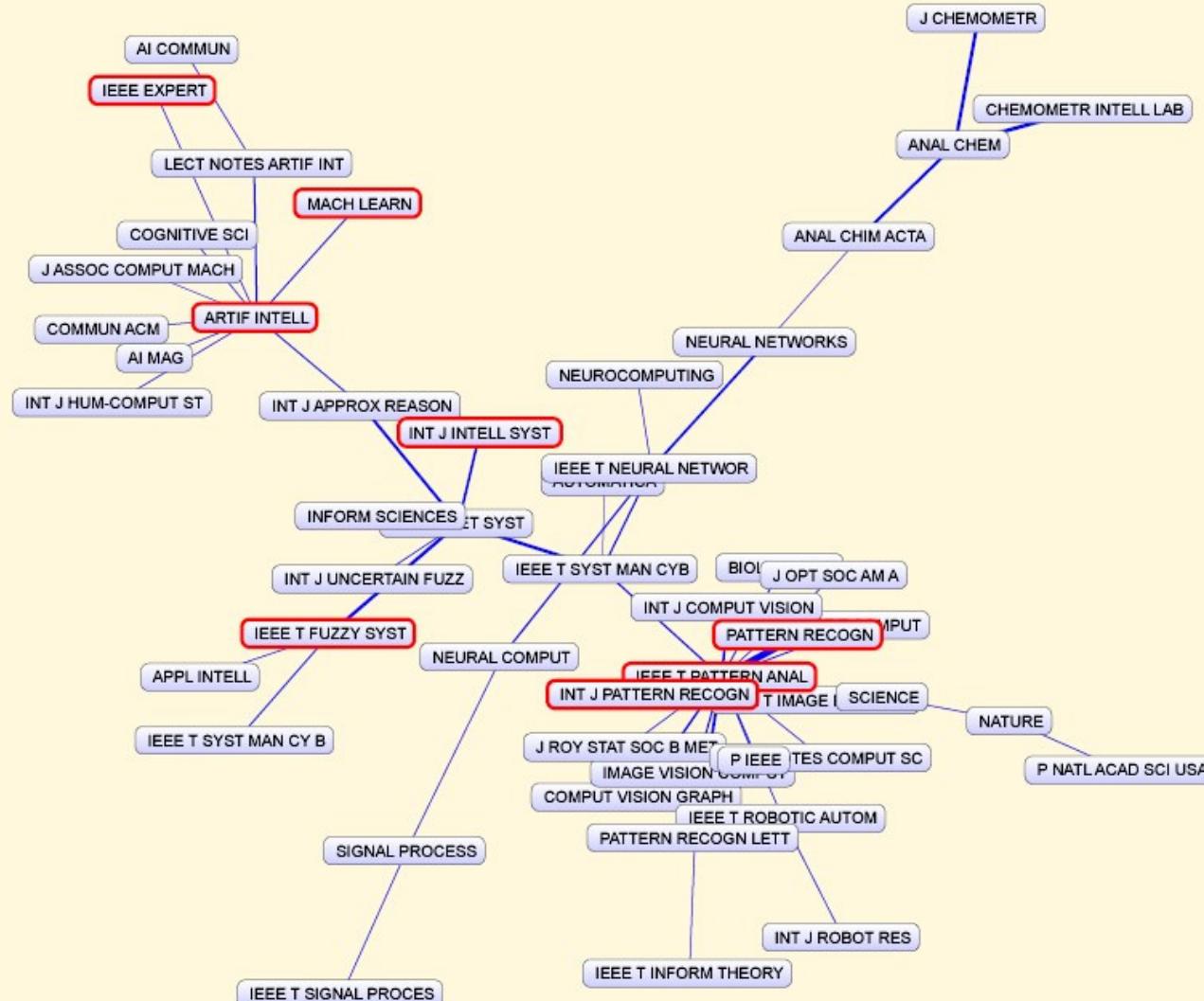


Tercer Nivel: Co-citación de Revistas (2)

[< Previous level](#)[view author net](#)

journal co-citation net:

COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE



Node selection: All | None

Modify Threshold (50)

A- A+



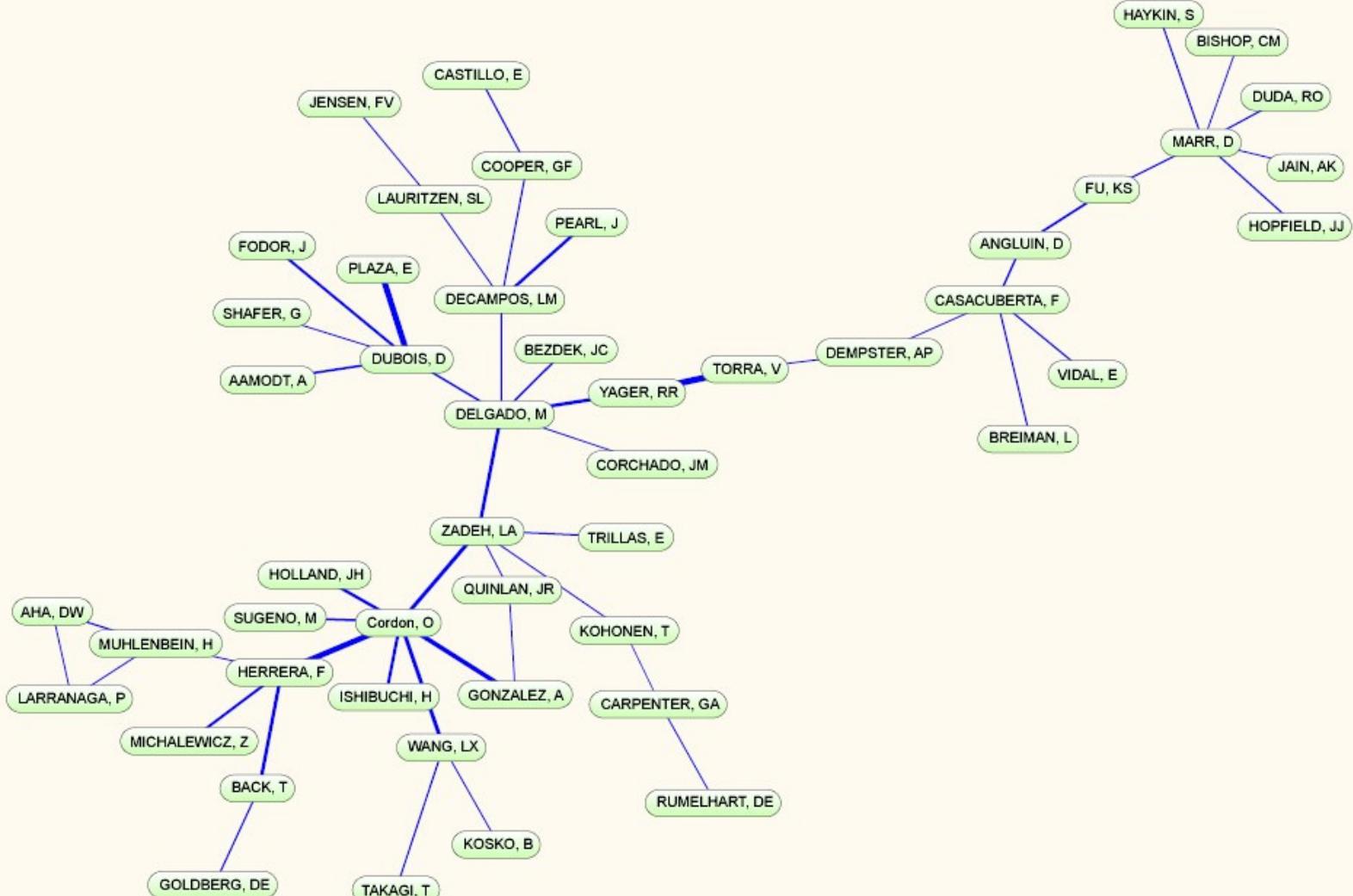
Cuarto Nivel: Co-citación de Autores

[< Previous level](#)[join author forms](#)

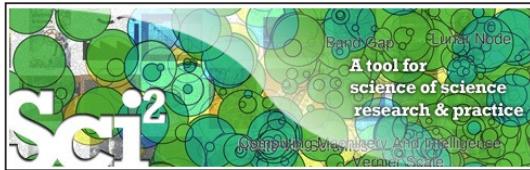
author co-citation net:

COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE

journals: ARTIF INTELL, IEEE EXPERT, IEEE T FUZZY SYST, IEEE T PATTERN ANAL, INT J INTELL SYST, INT J PATTERN RECOG...

[Modify Threshold \(60\)](#)[A-](#) [A+](#)

OTROS EJEMPLOS DE ANÁLISIS Y VISUALIZACIÓN DE REDES CIENTÍFICAS



Sci² Tool: Download, Install, and Run



Sci2 Tool v0.5.1 Alpha (May 4th, 2011)

Can be freely downloaded for all major operating systems from

<http://sci2.cns.iu.edu>

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

Unpack into a /sci2 directory.

Run /sci2/sci2.exe

Sci2 Manual is at

<http://sci2.wiki.cns.iu.edu>

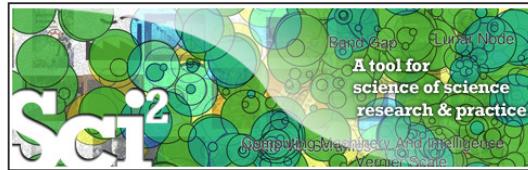
Cite as

Sci² Team. (2009). Science of Science (Sci²) Tool. Indiana University and SciTech Strategies,
<http://sci2.cns.iu.edu>

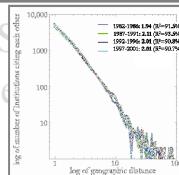
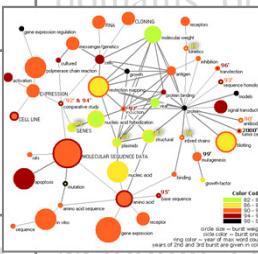
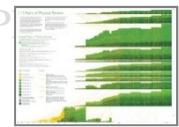
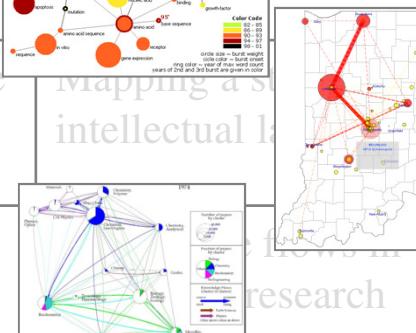
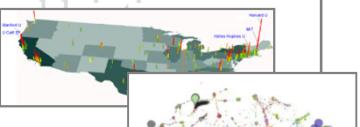
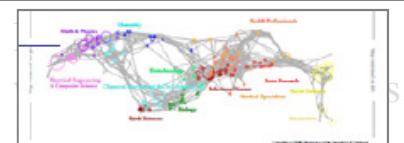
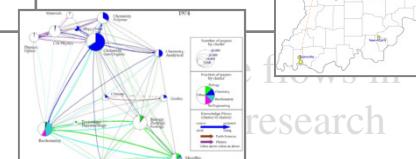
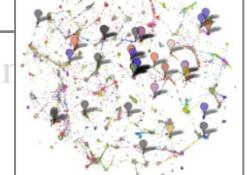
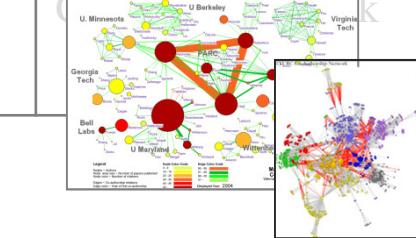
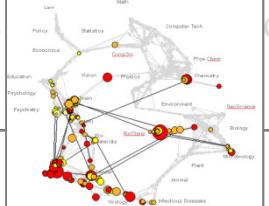


Dr. Katy Börner

Cyberinfrastructure for Network Science Center
Information Visualization Laboratory
School of Library and Information Science
Indiana University, Bloomington, IN
<http://cns.iu.edu>



Type of Analysis vs. Level of Analysis

	<i>Micro/Individual (1-100 records)</i>	<i>Meso/Local (101–10,000 records)</i>	<i>Macro/Global (10,000 < records)</i>
Statistical Analysis/Profiling	Individual person and their expertise profiles	Larger labs, centers, universities, research domains, or states	All of NSF, all of science, USA, 
Temporal Analysis (When)	Funding portfolio of one individual		113 Years of PNAS Research 
Geospatial Analysis (Where)	Career trajectory of one individual		PNAS 113 Years 
Topical Analysis (What)			VxOrd/Topic in NIH funding 
Network Analysis (With Whom?)	NSF network of one		NIH's Network of Science 



Sci² Tool

Welcome to the Science of Science Tool (Sci²). The development of this tool is supported in Network Science center and the School of Library and Information Science at Indiana University, the National Science Foundation IIS-0715303, and the James S. McDonnell Cyberinfrastructure portal (<http://sci.slis.indiana.edu>).

The primary investigators are Katy Börner, Indiana University, and SciTech Strategies Inc. The Sci² tool was developed by J. Duhon, Patrick A. Phillips, Chintan Tank, and the Cyberinfrastructure Shell (<http://cishell.org>) for Network Science Center (<http://cns.slis.indiana.edu>). Many algorithm plugins were derived from the Network Science Laboratory (<http://nwb.slis.indiana.edu>).

Please cite as follows:
Sci² Team. (2009). Science of Science Tool. Indiana University, and SciTech Strategies Inc., <http://sci.slis.indiana.edu>.

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Console

Scheduler

Remove From List Remove completed

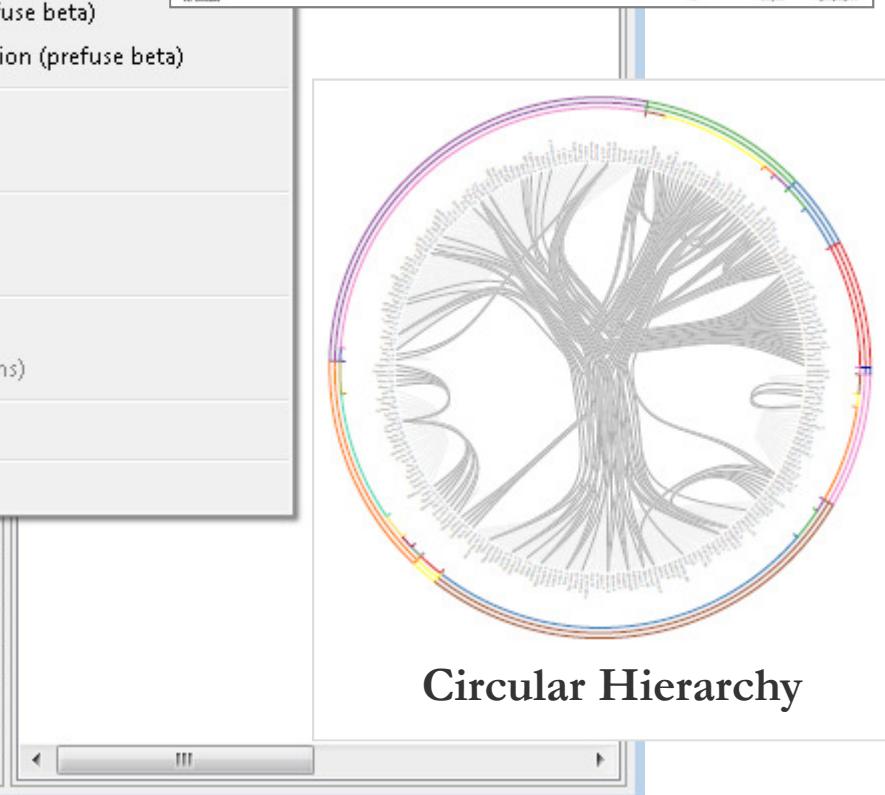
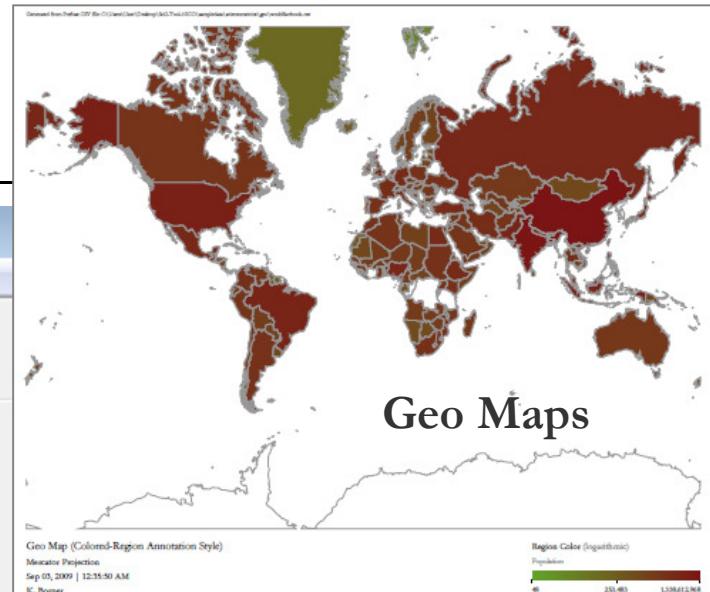
! Algorithm Name Date Time % Com

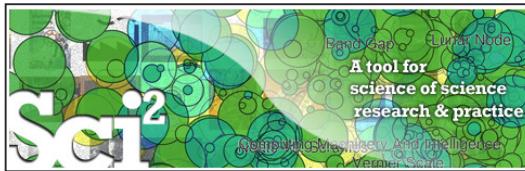
Extract Co-Author Network 09/03/2009 00:15:20 AM

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

Geo Map (Colored Mercator Projection Sep 03, 2009 | 12:35:50 K. Bonner)





Network Extraction: Examples

Author co-occurrence network

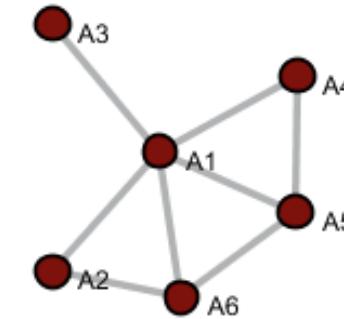
	A	B
1	Publication	Authors
2	Paper1	A1
3	Paper2	A1;A2;A6
4	Paper3	A1;A3
5	Paper4	A1;A4;A5
6	Paper5	A5;A6
7	Paper6	A1;A2

Extract Network from Table

Extracts a network from a delimited table

Column Name: Authors

Text Delimiter: ;



Extract Bipartite Network

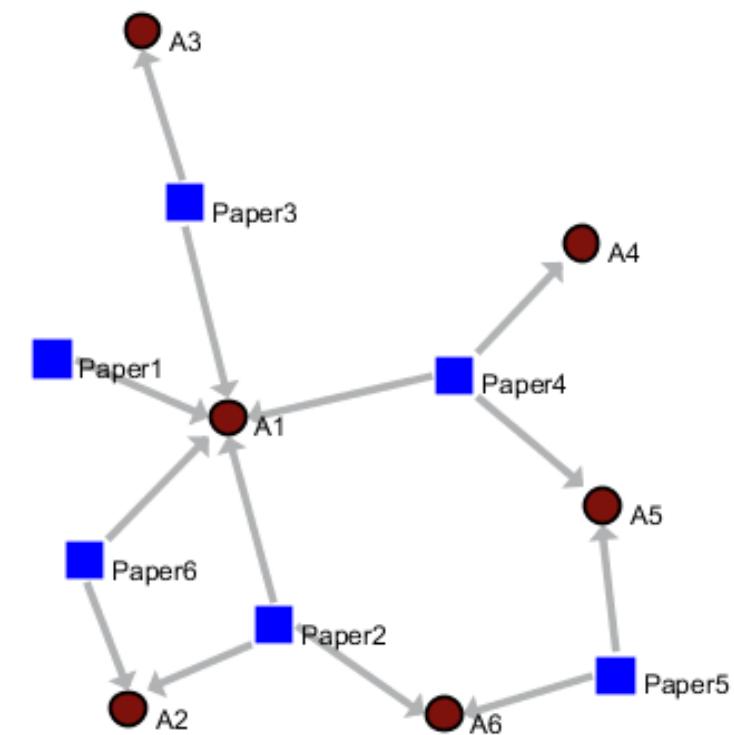
Extract a bipartite network from two columns in the table. If the column values may list multiple entries, enter the special text which delimits them.

First column: Publication

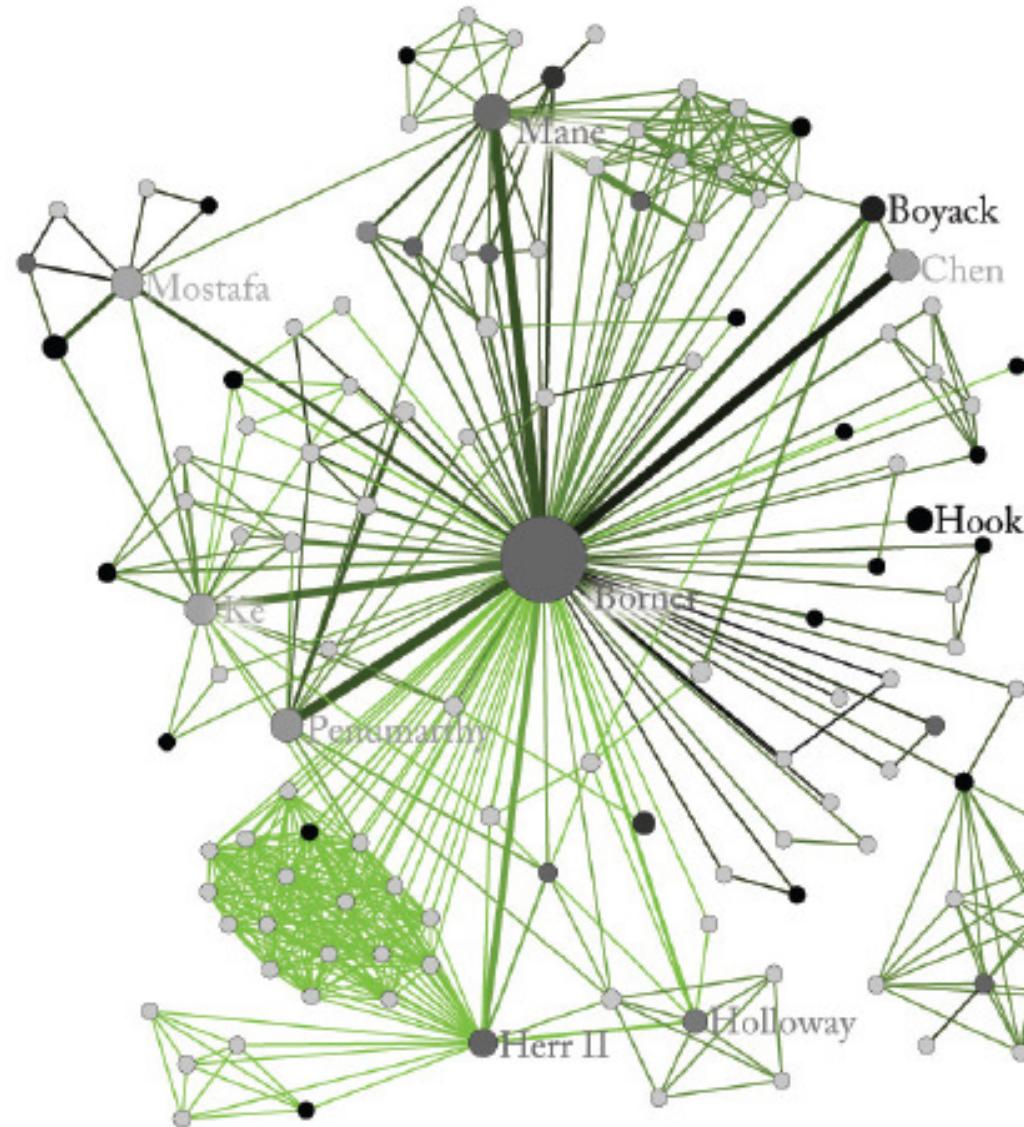
Second column: Authors

Text Delimiter: ;

Paper-author 2-mode network



Coauthor Network



Node Size

Number of Works Authored



1 96

Node & Label Color

% Time First Author



0 100

Edge Width

Number of Times Coauthored



1

12

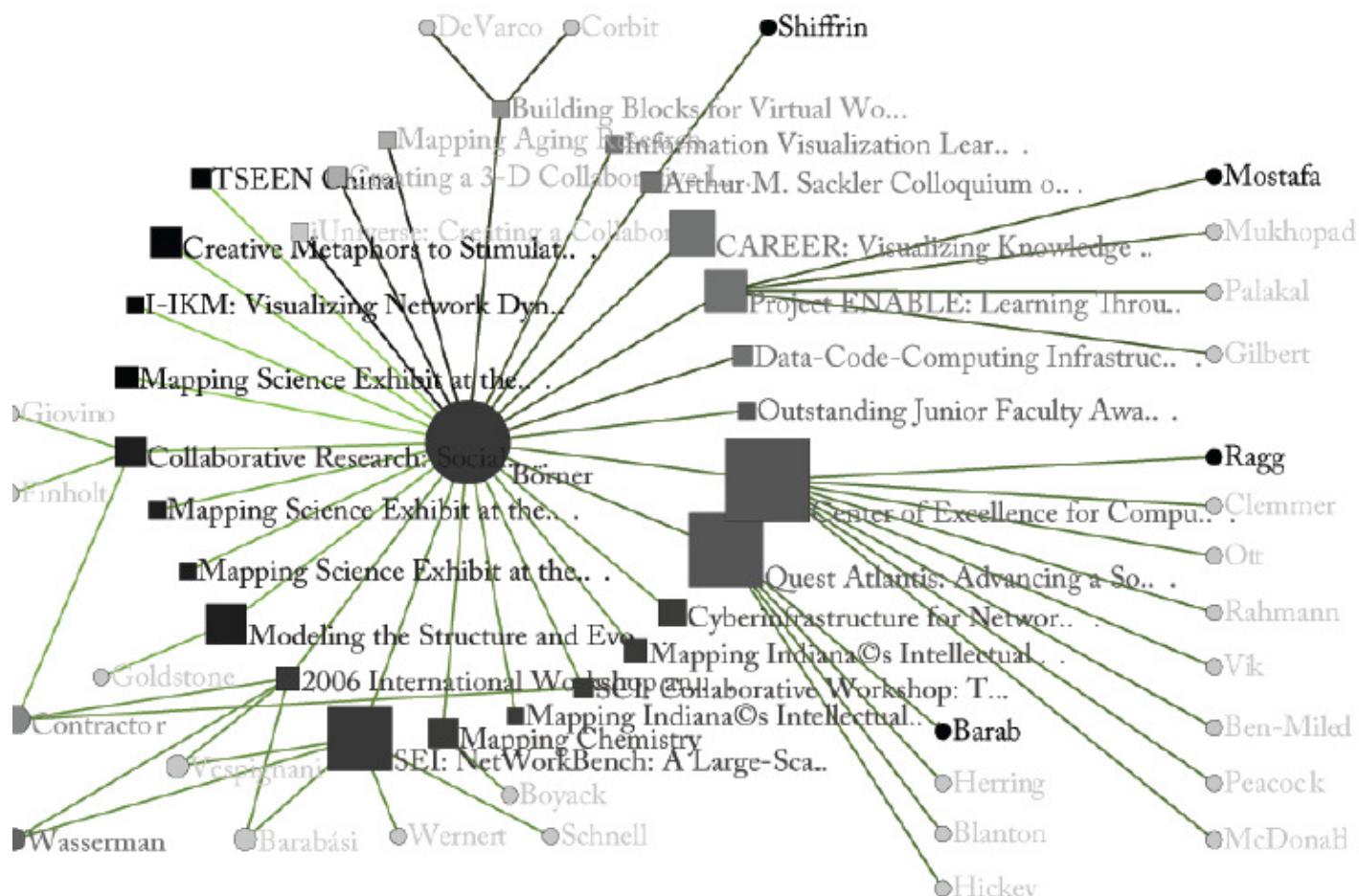
Edge Color

Date of Earliest Collaboration

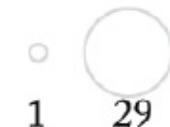


1.1.2000 11.6.2007

Investigator-Project Network



PI Node Size
Number of Grants



PI Node & Label Color
% Times Main PI



Project Node Size
Amount of Grant

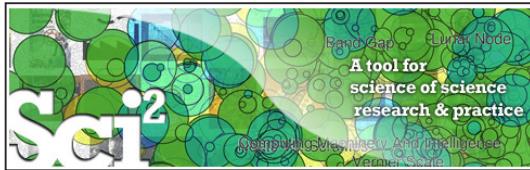


Project Node Color
Starting Date

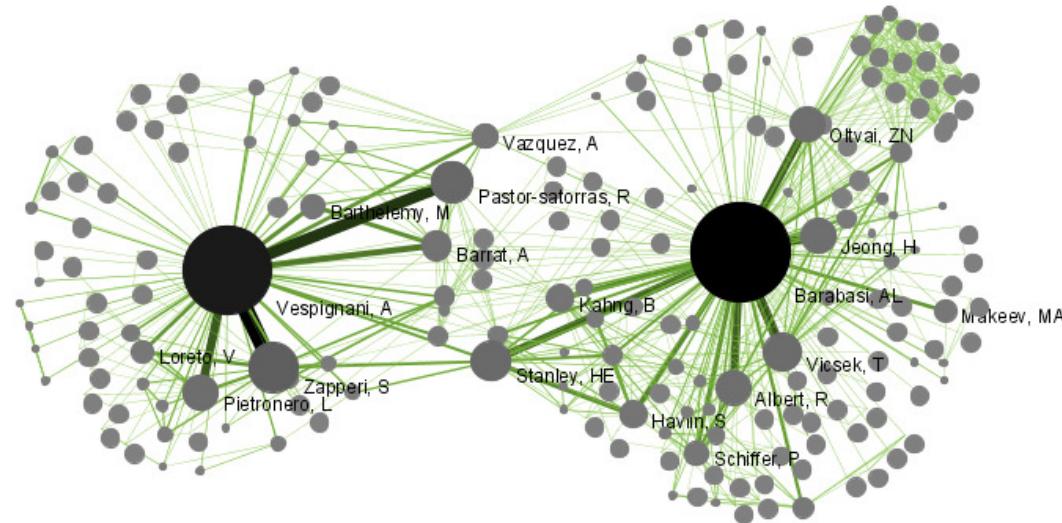


Edge Color
Starting Date





Network Visualization: Giant Component



.....
Weak Component Clustering was selected.

Implementer(s): Russell Duhon

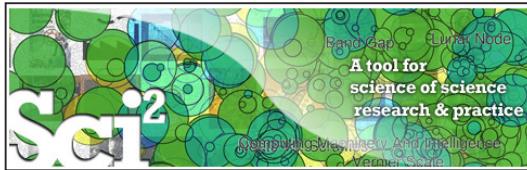
Integrator(s): Russell Duhon

Input Parameters:

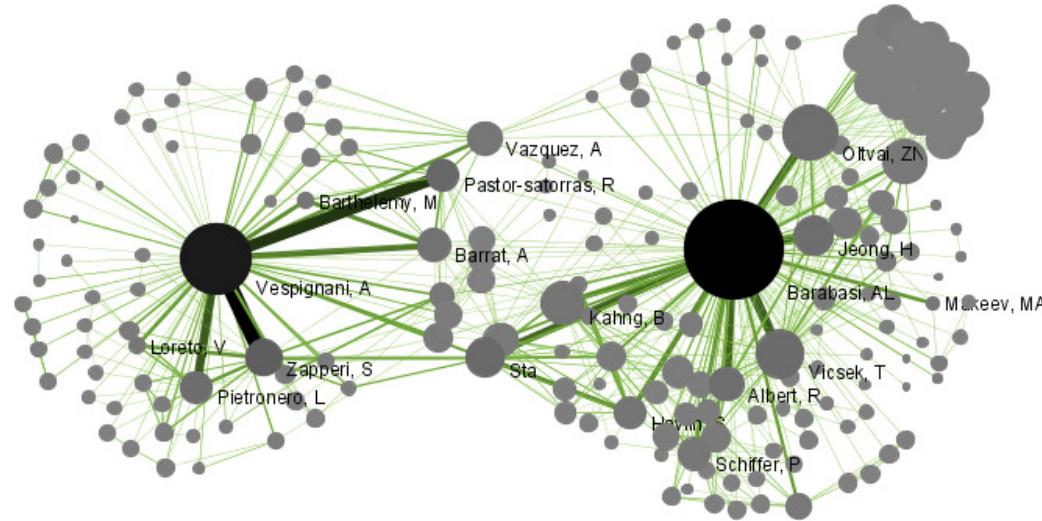
Number of top clusters: 10

3 clusters found, generating graphs for the top 3 clusters.

.....



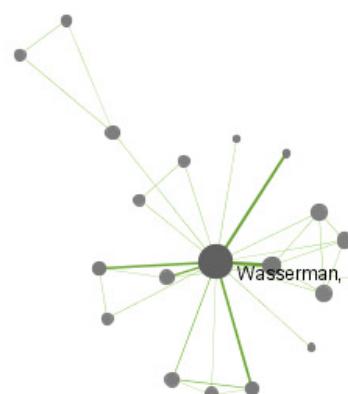
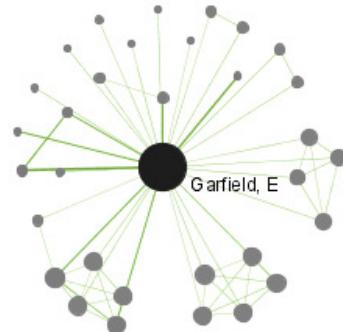
Network Visualization: Color/Size Coding by Degree



.....
Node Degree was selected.

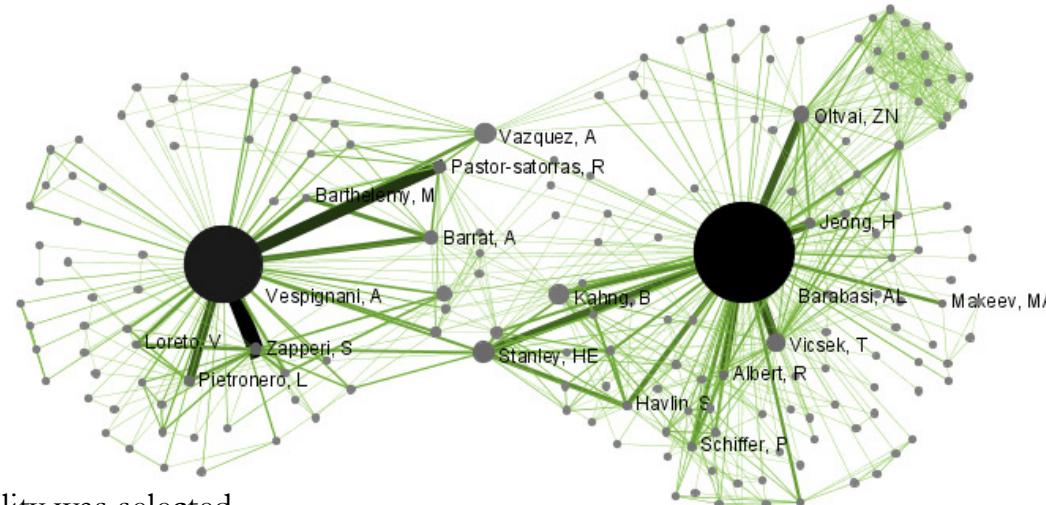
Documentation:

<https://nwb.slis.indiana.edu/community/?n=AnalyzeData.No>
deDegree





Network Visualization: Color/Size Coding by Betweenness Centrality



.....
Node Betweenness Centrality was selected.

Author(s): L. C. Freeman

Implementer(s): Santo Fortunato

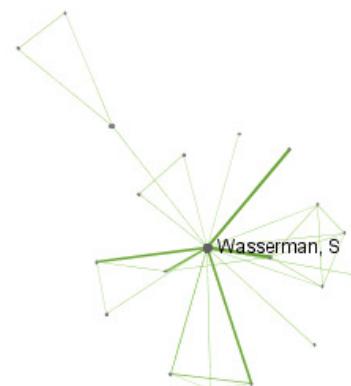
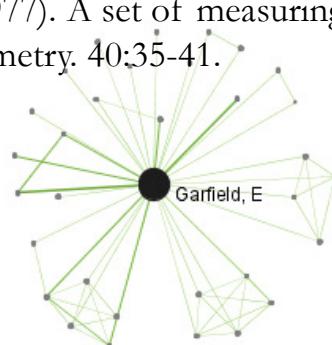
Integrator(s): Santo Fortunato, Weixia Huang

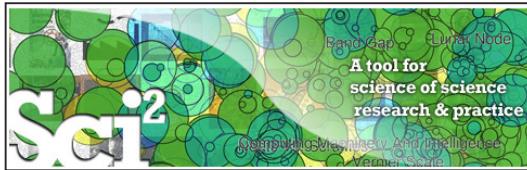
Reference: Freeman, L. C. (1977). A set of measuring centrality based on betweenness. *Sociometry*. 40:35-41.

Input Parameters:

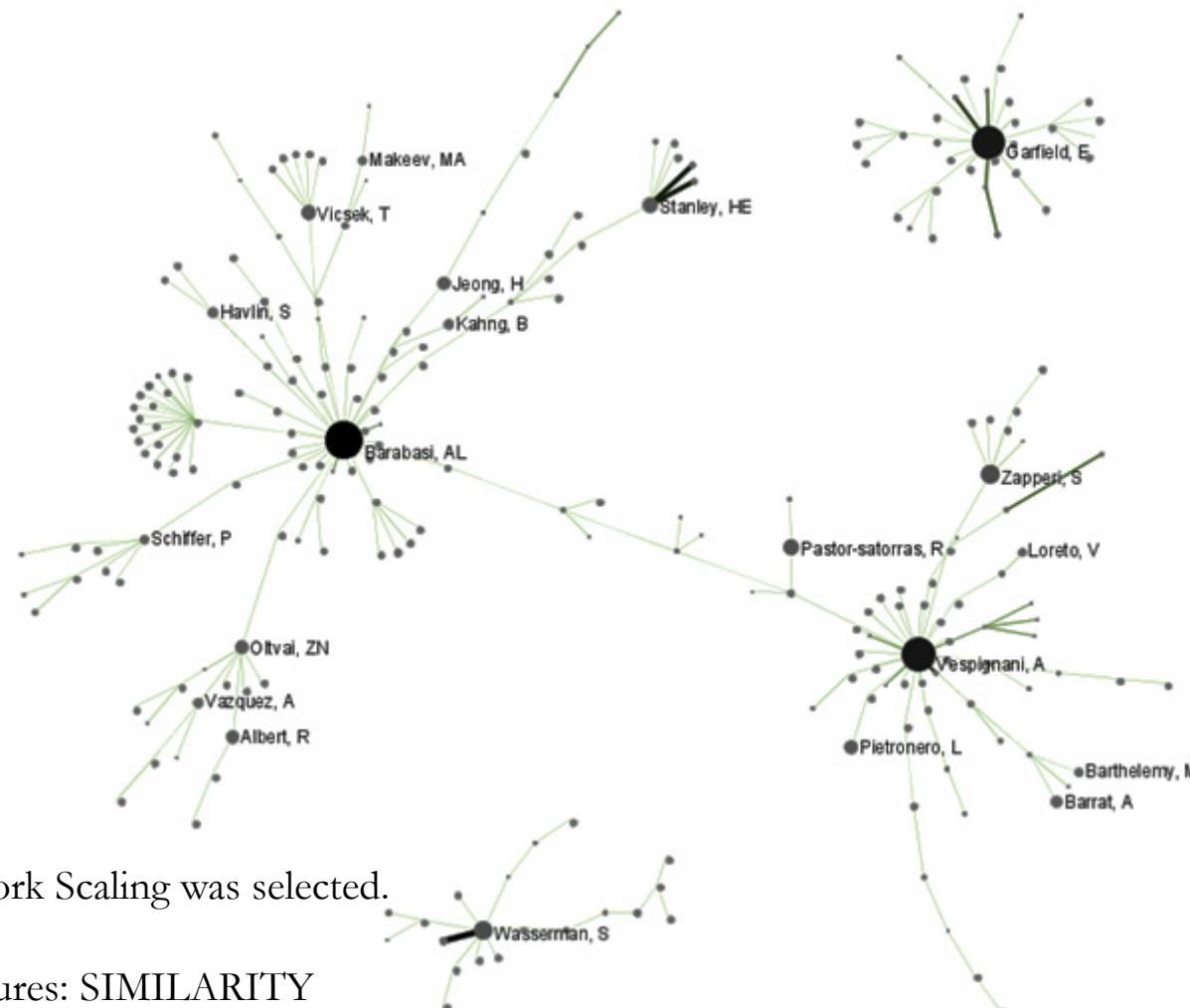
Number of bins: 10

.....
umber of bins: 10





Network Visualization: Reduced Network After Pathfinder Network Scaling



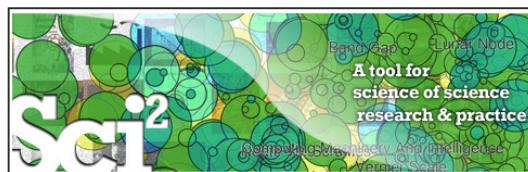
MST-Pathfinder Network Scaling was selected.

Input Parameters:

Weight Attribute measures: SIMILARITY

Edge Weight Attribute: weight

.....

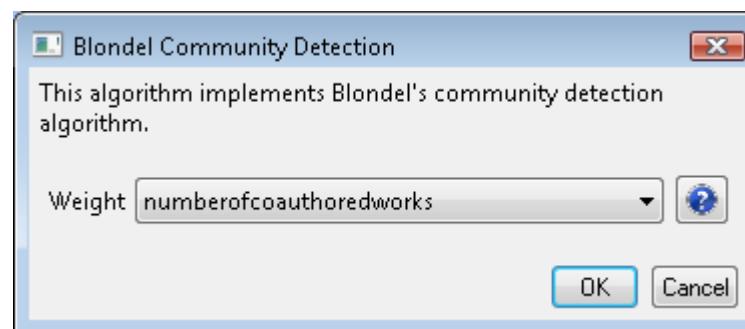


Network Visualization: Circular Hierarchy Visualization

Select Co-Author Network and run Blondel Community detection:

The screenshot shows the Sci2 software interface. The top menu bar includes File, Data Preparation, Preprocessing, Analysis, Modeling, Visualization, and Help. The Analysis menu is currently active, with its sub-menu items Temporal, Geospatial, Topical, and Networks visible. The Networks item is highlighted. A sub-menu for "Network Analysis Toolkit (NAT)" is displayed, listing several network analysis metrics and community detection algorithms. The "Blondel Community Detection" option is highlighted with a blue selection bar at the bottom of the list. On the left side of the interface, there is a "Console" window displaying log messages related to loading and cleaning ISI files, identifying authors, implementers, and integrators, and listing loaded records. The right side features a "Data Manager" window showing a hierarchical tree structure of data files.

With parameter values





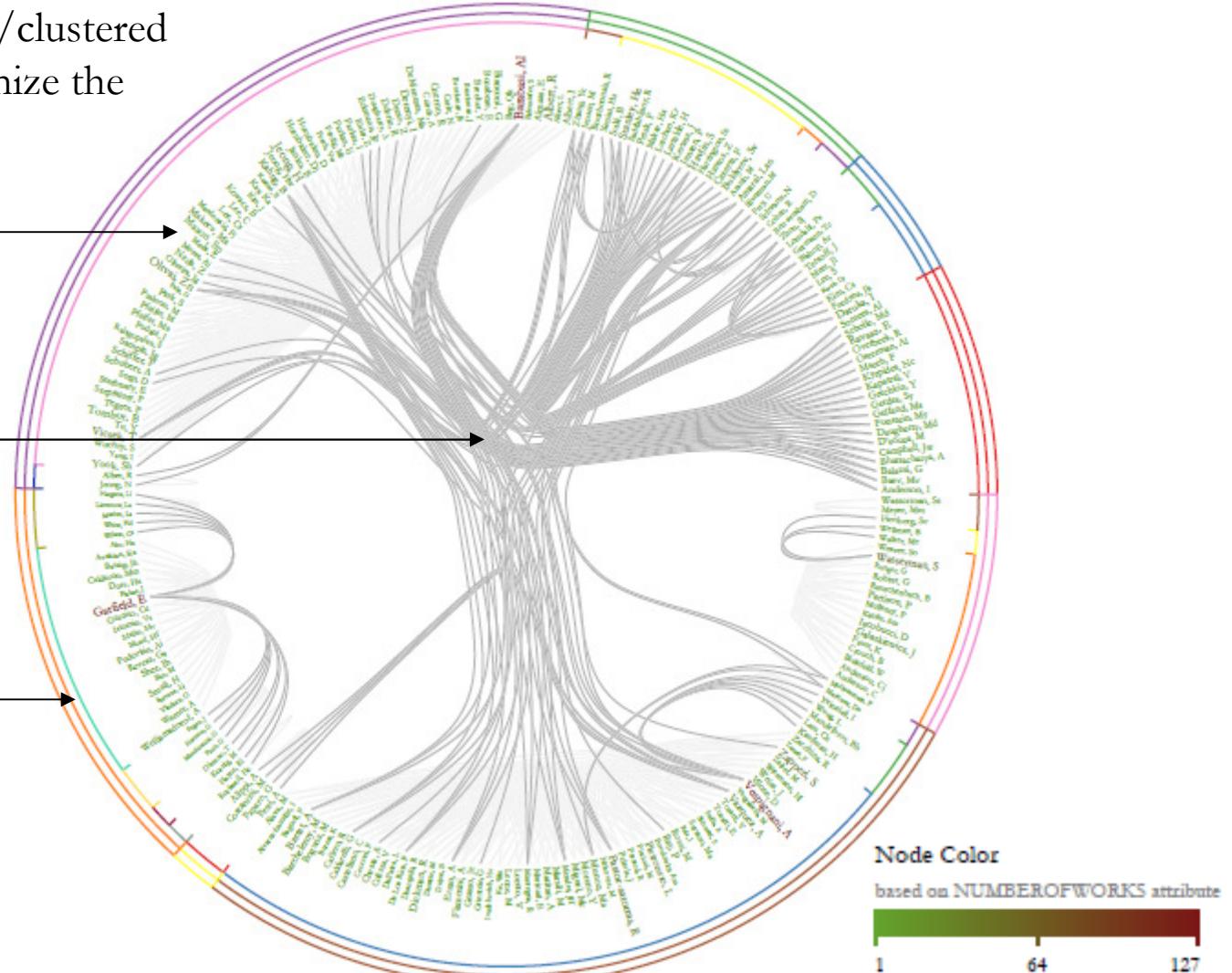
Network Visualization: Circular Hierarchy Visualization

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

Node labels, e.g.,
author names.

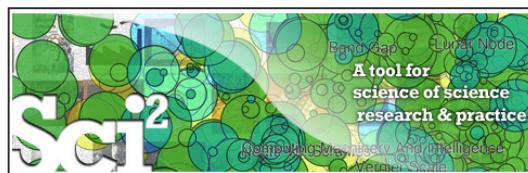
Network structure – using edge bundling

Color coded cluster hierarchy according to Blondel community detection algorithm.



Note:

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

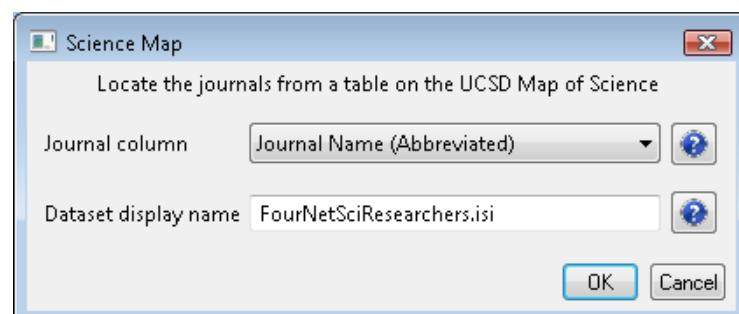
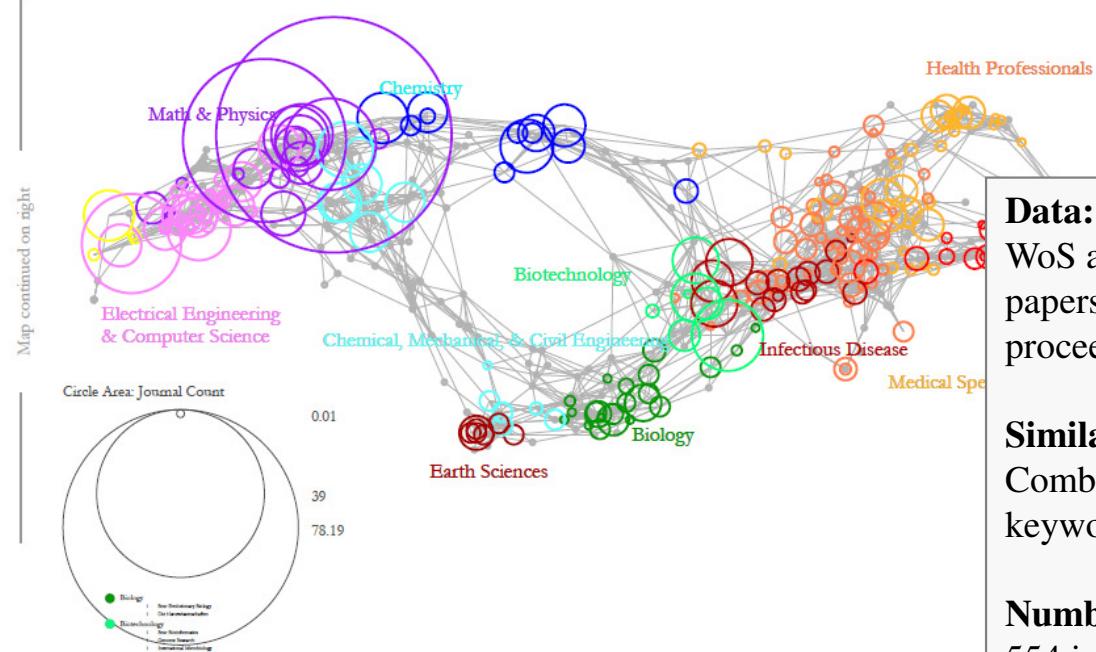


Topic Mapping: UCSD Science Map

Science Map via Journals for FourNetSciResearchers.isi

314 journal references matched out of 361 found.

These 314 references are associated with 13 of 13 disciplines of science and 255 of 554 research specialties in the UCSD Map of Science.



Data:

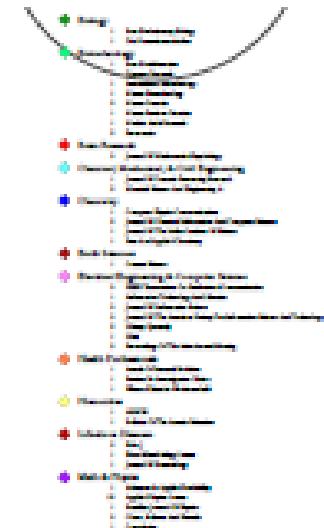
WoS and Scopus for 2001–2005, 7.2 million papers, more than 16,000 separate journals, proceedings, and series

Similarity Metric:

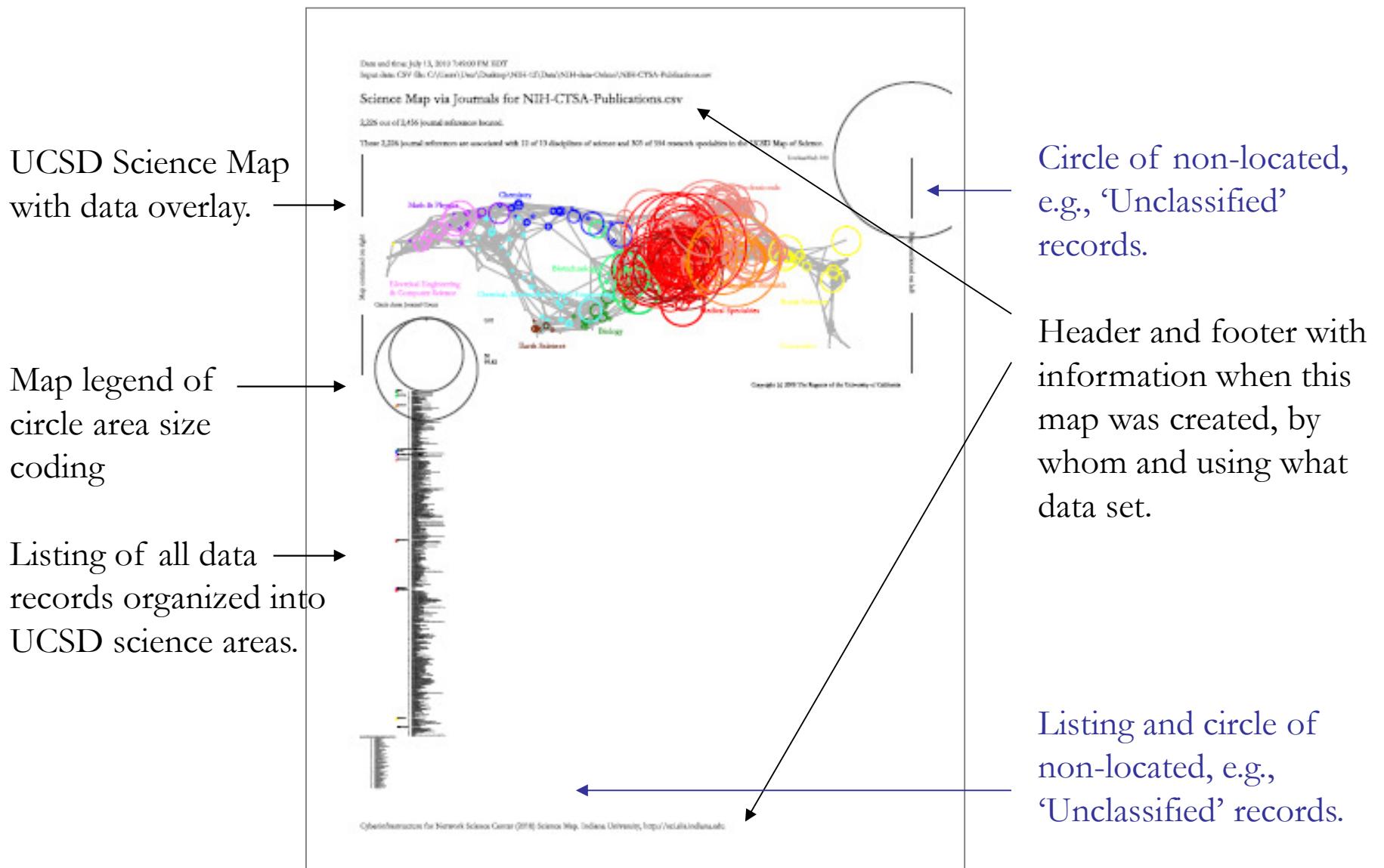
Combination of bibliographic coupling and keyword vectors

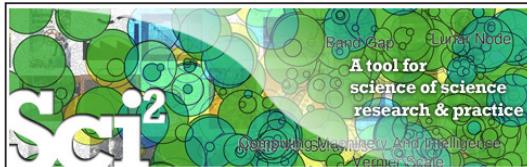
Number of Disciplines:

554 journal clusters further aggregated into 13 main scientific disciplines that are labeled and color coded in a metaphorical way, e.g., Medicine is blood red and Earth Sciences are brown as soil.



How to Read the UCSD Map





Geospatial maps with congressional districts

	A
1	Zip code
2	90095
3	4672
4	232980568
5	10032
6	10039242
7	46091500
8	191112434
9	27705
10	981959472
11	10065
12	10065



Identify Congressional District, Latitude, Longitude

	A	B	C	D
1	Zip code	Congressional District	Latitude	Longitude
2	90095	CA-30	34.0735035	-118.6645815
3	4672	ME-02	45.818717	-69.0290345
4	232980568	VA-03	37.270472	-77.0699835



Aggregate/Count identical Congressional Districts

	A	B	C	D
1	Congressional District	Latitude	Longitude	Count
2	CA-30	34.0735035	-118.6645815	4
3	ME-02	45.818717	-69.0290345	2
4	VA-03	37.270472	-77.0699835	1
5	NY-15	40.8341475	-73.9342095	4



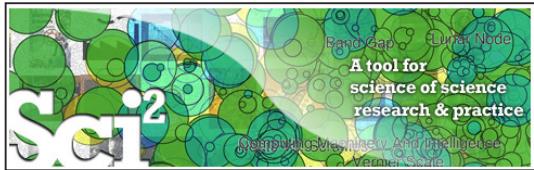
How to Read the Geo Map

U.S. Map with data overlay.

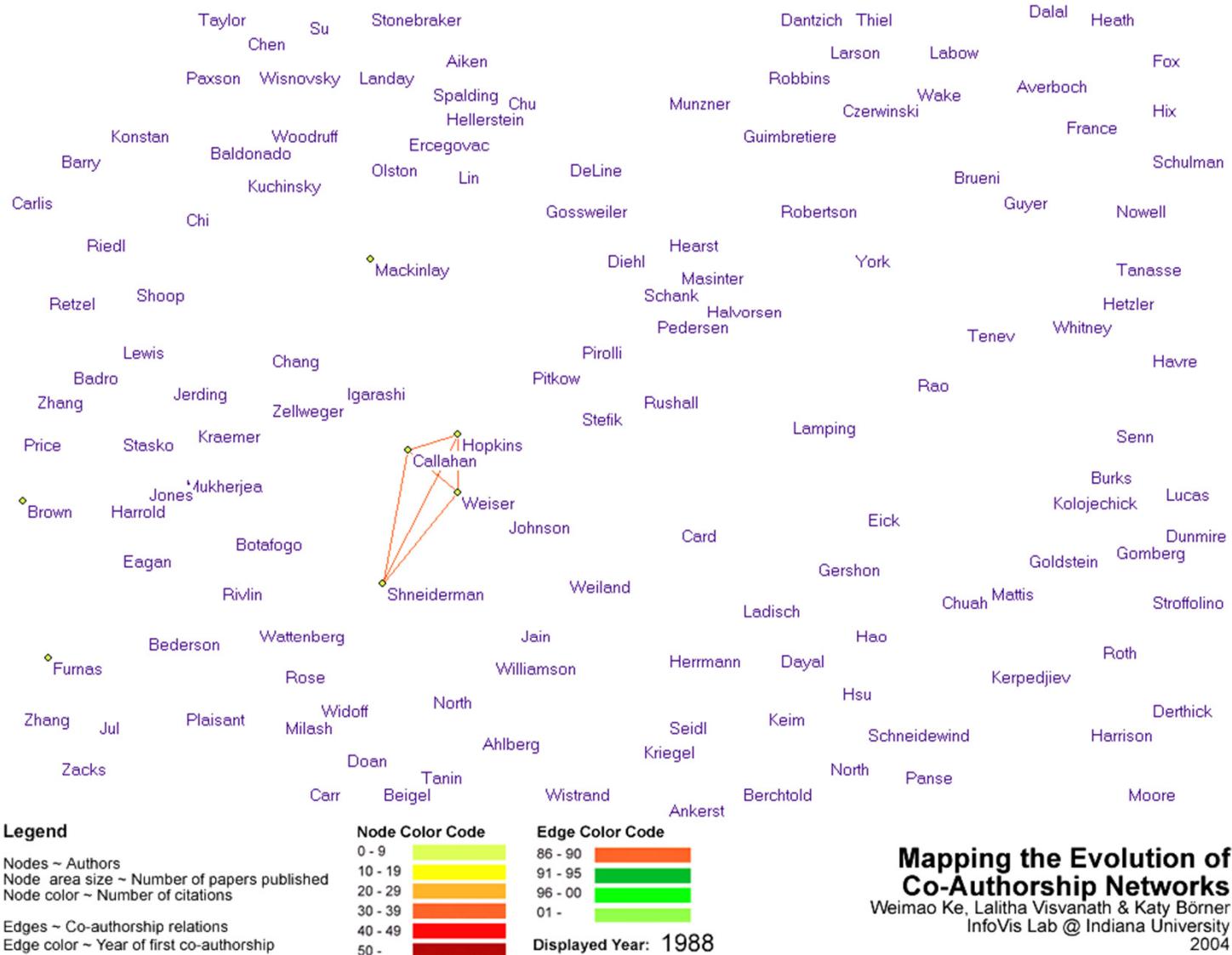


Header and footer with information when this map was created, by whom and using what data set.

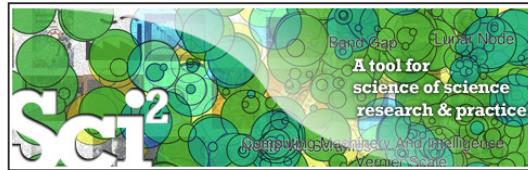
Map legend with color coding.



Evolving collaboration networks



**Mapping the Evolution of
Co-Authorship Networks**
Weimao Ke, Lalitha Visvanath & Katy Börner
InfoVis Lab @ Indiana University
2004



Evolving collaboration networks

Load isi formatted file

sci2-v0.5-alpha > sampledata > scientometrics > isi

New Folder

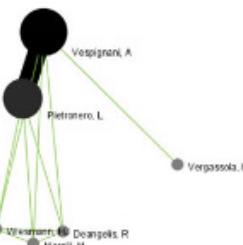
Name	Date modified	Type	Size
AlessandroVespignani.isi			
FourNetSciResearchers.isi			
StanleyWasserman.isi			



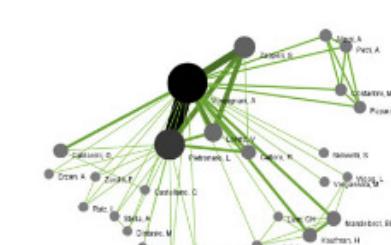
As csv, file looks like:

	A	B	C	D	E	F	G
1	Abstract	Authors	Authors (Full Names)	Beginning	Book Series	Book Series	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

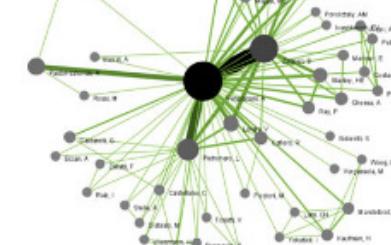
Visualize each time slide separately:



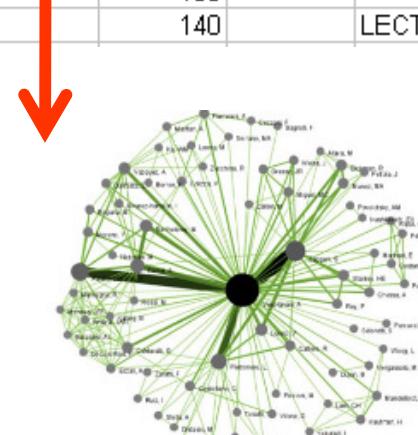
1990-1991



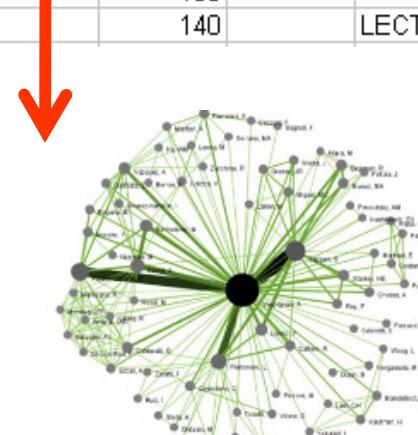
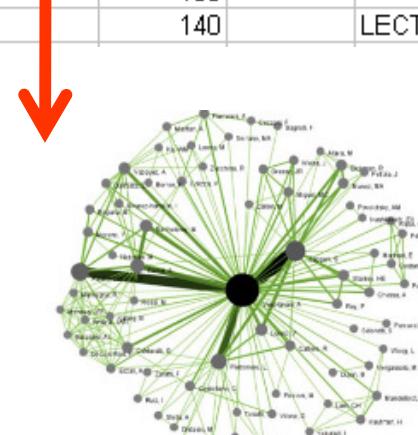
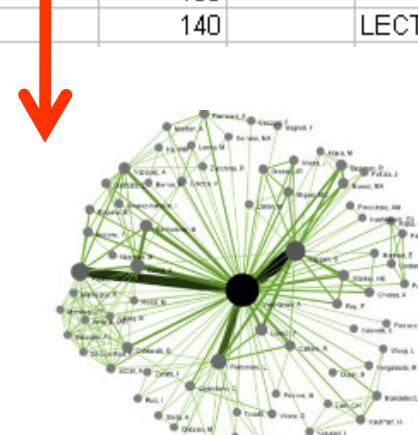
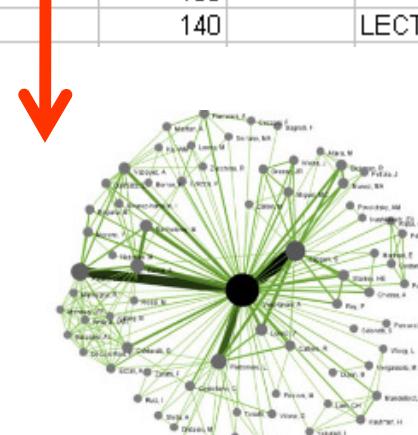
1990-1996

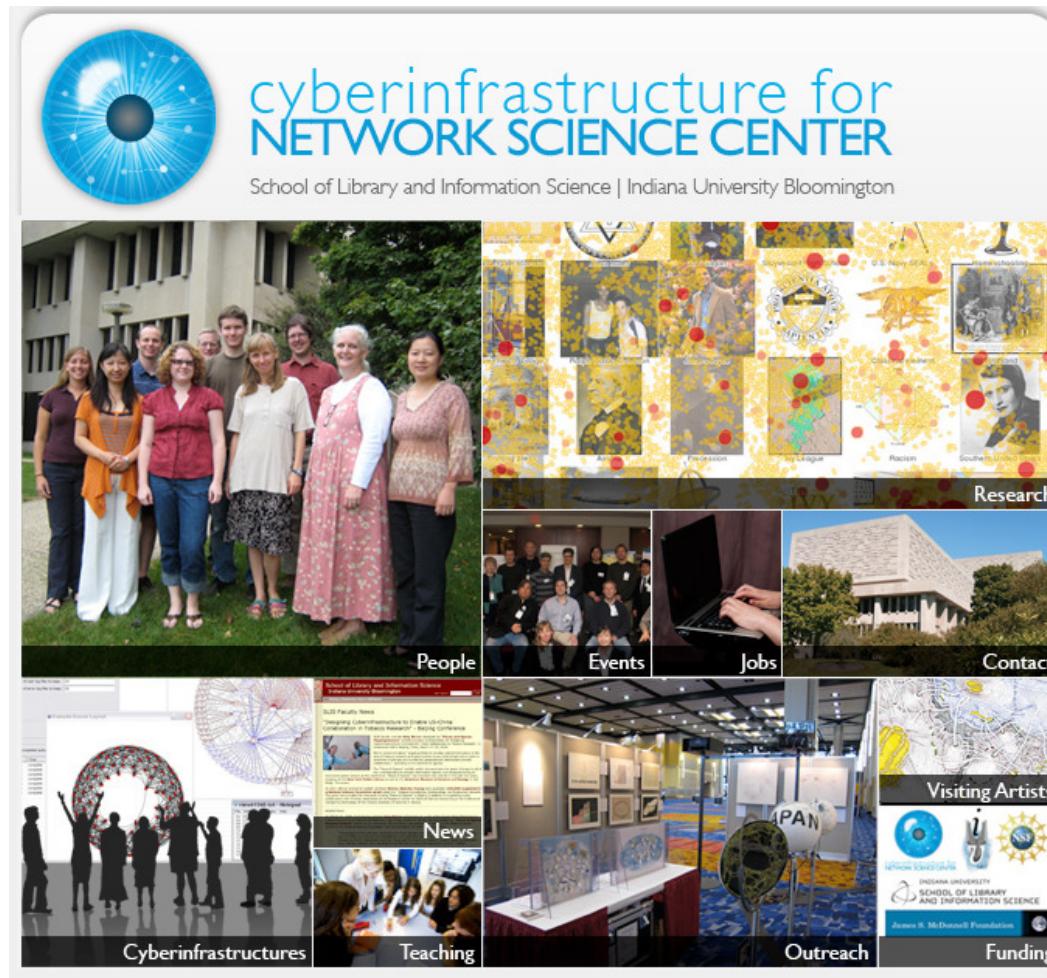


1990-2001



1990-2006





All papers, maps, tools, talks, press are linked from <http://cns.iu.edu>

CNS Facebook: <http://www.facebook.com/cnscenter>

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