

JOIN US: AAAS LUNCHEON DISCUSSION

VISUALIZATION METAPHORS FOR COMMUNICATING THE STRUCTURE AND DYNAMICS OF SCIENCE

JULIA LAURIN, THOMSON REUTERS AND KATY BÖRNER, INDIANA UNIVERSITY

Please join us and take part in our lunchtime discussion titled "Visualization Metaphors for Communicating the Structure and Dynamics of Science" hosted by Julia Laurin, Thomson Reuters and Katy Börner, Indiana University.

Date: Sunday, February 15, 2015

Time: 12 PM to 1 PM (PST)

Location: San Jose Convention Center
AAAS Conference Room: Glen Ellen
150 West San Carlos Street
San Jose, CA 95113

This luncheon will provide an opportunity for those who produce and work with maps of science to discuss the challenges of visualizing non-spatial scientific activity and investigate concrete ways for scholars and industry to advance understanding and engagement with maps of science. Brief talks by leading experts and brainstorming will be used to identify: What visual metaphors have been successful for representing trends, emerging research areas, or bursts of activity, etc.? Are there best practices for representing non-spatial information? How can the different teams producing maps of science collectively enhance the legibility and utility of science maps?

Agenda

Welcome by Julia and Katy

Setting the Stage:

Visual Languages: Industry Pull

by Julia Laurin, Thomson Reuters

Visualization Frameworks: Academic Push

by Katy Börner, Indiana University

Invited Talk:

Visualizing Knowledge Spaces: Cartographic Perspectives

by Dr. André Skupin, Geography, San Diego State University

Discussion

Visual Languages: Industry Pull

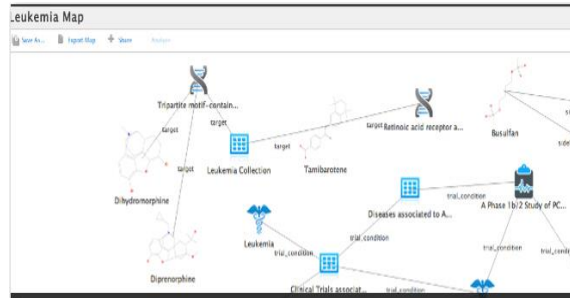
by Julia Laurin, Thomson Reuters

Visualizing Across Domains: Lessons Learned



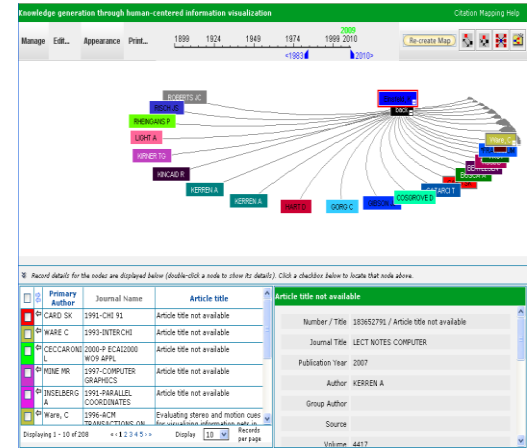
Intellectual Property

Thomson Data Analyzer



Life Sciences

Cortellis Data Fusion



Scholarly Research

Web of Science

- Support multiple approaches to data
- User-driven and use case driven
- Balancing transparency and usability

Graph Analytics: Answering the Big Questions

Mission: *Research and develop solutions which support graph data, analytics and machine learning at big data scales*

How do we provide research funders with **areas of research on the verge of developing** into new fields and worthy of deeper funding?

graph community detection and prediction

How do we provide scientific researchers with a **topic hierarchy for research discovery which remains current** w/rt recently published articles?

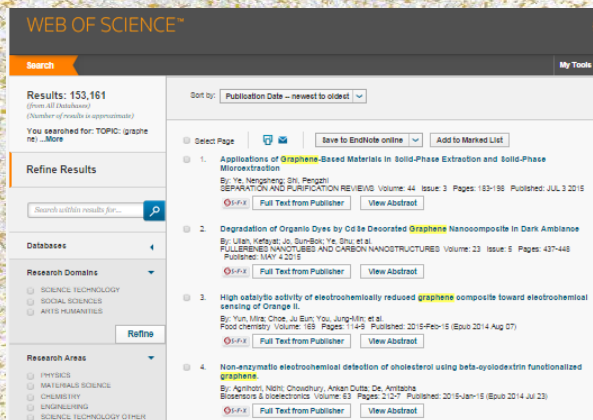
graph-based topic generation and clustering

How do we provide university administrators with **aggregation tools that effectively disambiguate entities** like people and organizations?

graph-based pattern matching

Getting from Table to Graph

37,225,696 publications
602,346,147 total citations



The screenshot shows the Web of Science search results for the topic 'graphene'. The interface includes a search bar, a results count of 153,161, and a list of search results. The results are sorted by 'Publication Date - newest to oldest'. The first four results are listed below:

- Applications of Graphene-Based Materials in Solid-Phase Extraction and Solid-Phase Microextraction**
By: Ye, Nengqiang; Shi, Pengxi
SEPARATION AND PURIFICATION REVIEWS Volume 44 Issue 3 Pages: 182-198 Published: JUL 3 2015
[View Abstract](#)
- Degradation of Organic Dyes by Cd Se Decorated Graphene Nanocomposite in Dark Ambiance**
By: Ullah, Khatun; Xu, Sun-Bok; Ye, Shu et al.
FULLERENE NANOTUBES AND CARBON NANOSTRUCTURES Volume 23 Issue 5 Pages: 437-448
Published: MAY 4 2015
[View Abstract](#)
- High catalytic activity of electrochemically reduced graphene composite toward electrochemical sensing of Orange II.**
By: You, Ming; Chen, Ji; Sun, You; Junghin et al.
FOOD CHEMISTRY Volume 168 Pages: 114-9 Published: 2015-Feb-15 (Epub 2014 Aug 27)
[View Abstract](#)
- Non-enzymatic electrochemical detection of cholesterol using beta-cyclodextrin functionalized graphene**
By: Agnihoti, Nishi; Choudhury, Arpan; Dutta, De. Arindam
Biosensors & Bioelectronics Volume 63 Pages: 212-7 Published: 2015-Jan-15 (Epub 2014 Jul 23)
[View Abstract](#)

Mapping Science Requires *a lot* of Choices

- Insight needed
- Types of analysis
- Levels of analysis
- Data scale types
- Visualization types
- Graphic symbol types
- Level of interactivity

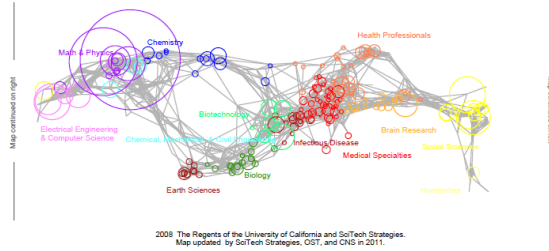
Visualization Frameworks: Academic Push

by Katy Börner, Indiana University

De-Facto Standardization of Science Basemaps

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



2008 The Regents of the University of California and SoTech Strategies.
 Map updated by SoTech Strategies, CGI, and CNS in 2011.

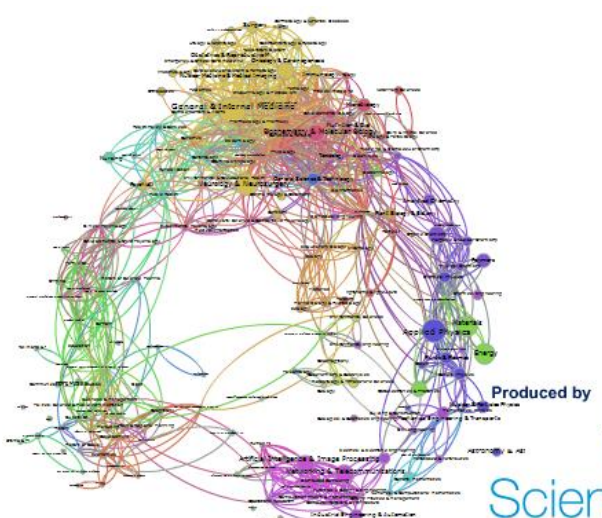
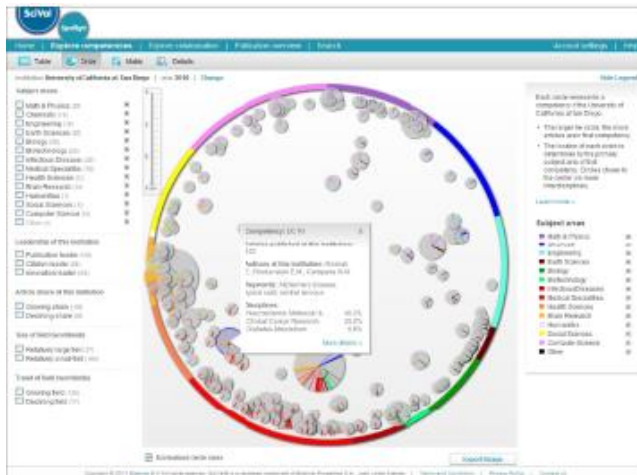
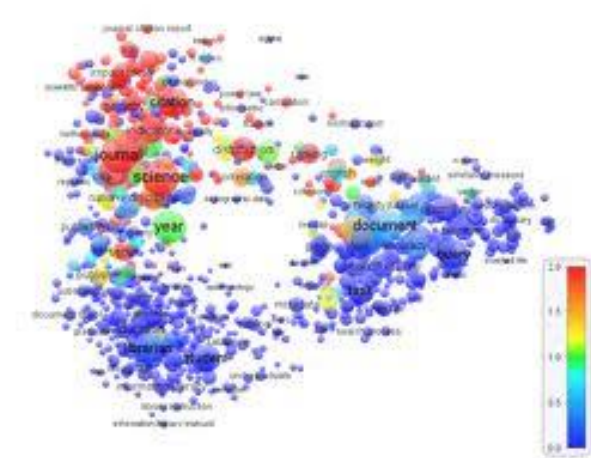
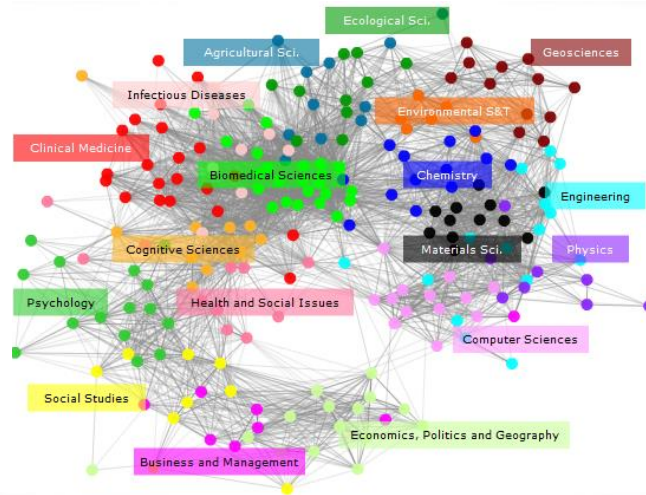
Legend

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

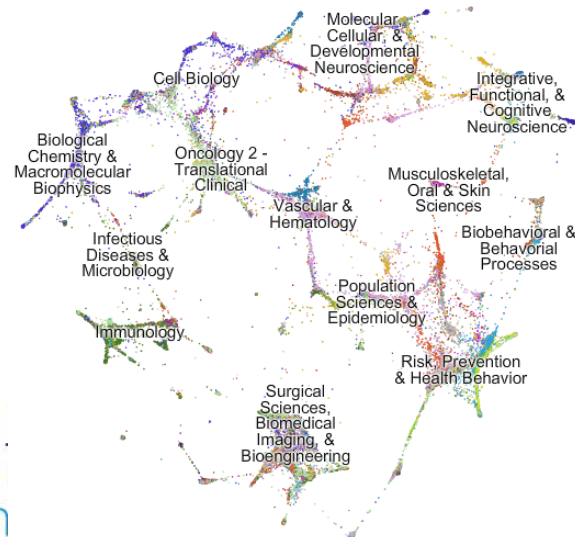


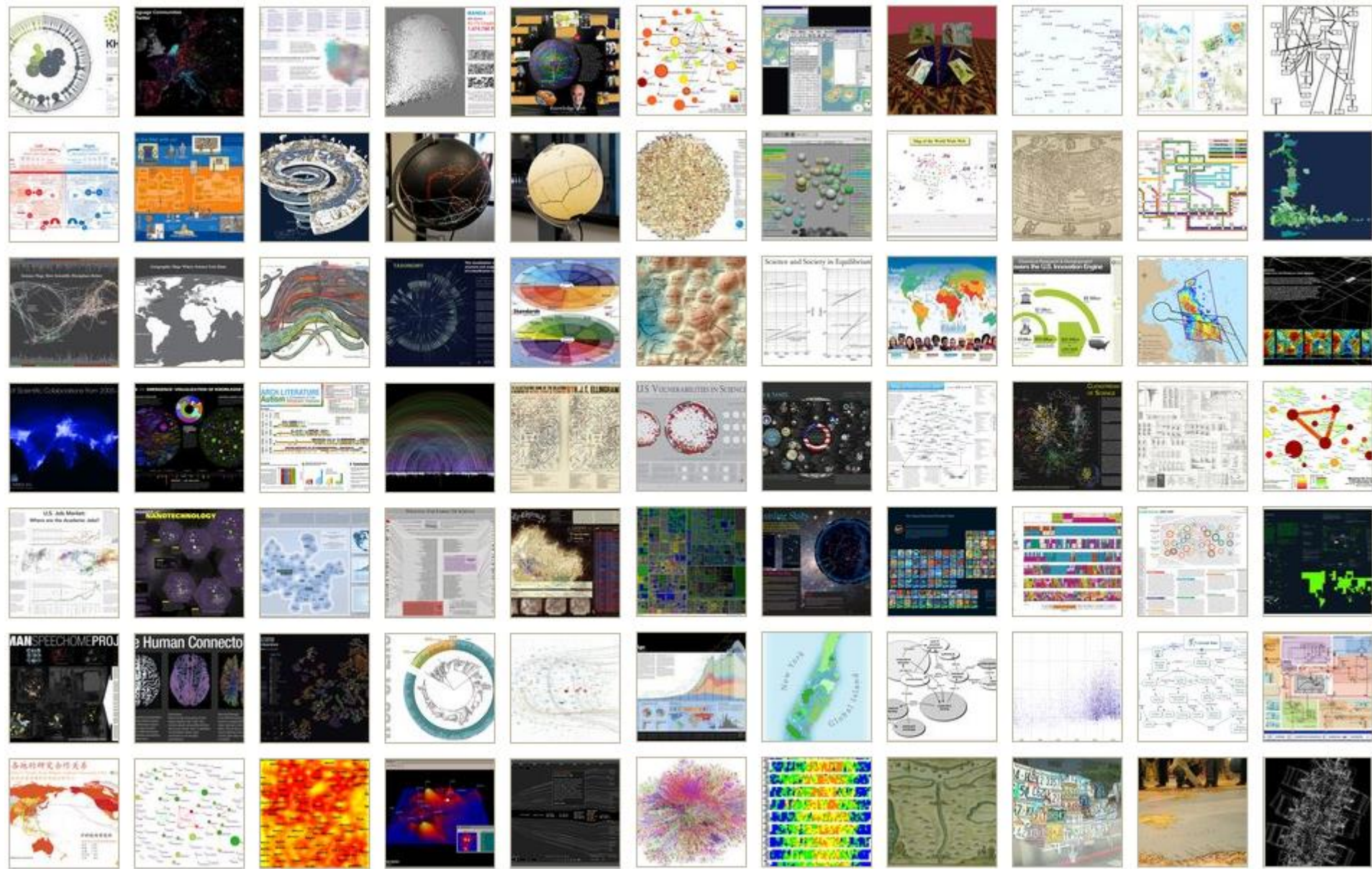
How To Read This Map

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.ucsd.edu)



Produced by
 Scien





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?



How to support the design of effective visualizations by experts and citizen scientists?

Study

LEVELS

MICRO: Individual Level
about 1–1,000 records
page 6



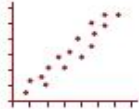


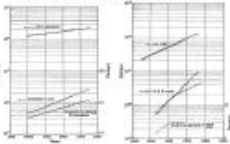
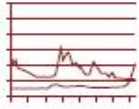


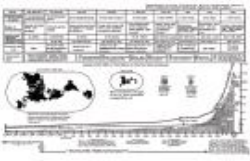

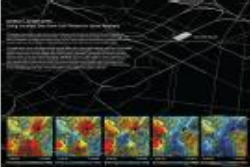










MESO: Local Level
about 1,001–100,000 records
page 8

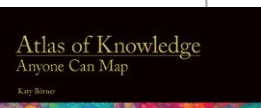


MACRO: Global Level
more than 100,000 records
page 10



TYPES

<p>Statistical Analysis page 44</p> 	 <p>Knowledge Cartography page 135</p>	 <p>Productivity of Russian life sciences research teams page 105</p>	<p>Science and Society in Equilibrium</p>  <p>Number of scientists versus population and R&D costs versus GNP. page 103</p>
<p>WHEN: Temporal Analysis page 48</p> 	 <p>Visualizing decision-making processes page 95</p>	 <p>Key events in the development of the video tape recorder page 85</p>	 <p>Increased travel and communication speeds page 83</p>
<p>WHERE: Geospatial Analysis page 52</p> 	 <p>Cell phone usage in Milan, Italy page 109</p>	 <p>Victorian poetry in Europe page 137</p>	 <p>Ecological footprint of countries page 99</p>
<p>WHAT: Topical Analysis page 56</p> 	 <p>Evolving patent holdings of Apple Computer, Inc. and Jerome Lemelson page 89</p>	 <p>Evolving journal networks in nanotechnology page 139</p>	 <p>Product space showing co-export patterns of countries page 93</p>
<p>WITH WHOM: Network Analysis page 60</p> 	 <p>World Finance Corporation network page 87</p>	 <p>Electronic and new media art networks page 133</p>	 <p>World-wide scholarly collaboration networks page 157</p>



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Workflow Design



Interpret

Validation and Interpretation, **page 72**



Acquire

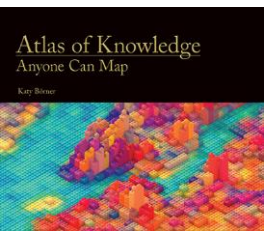
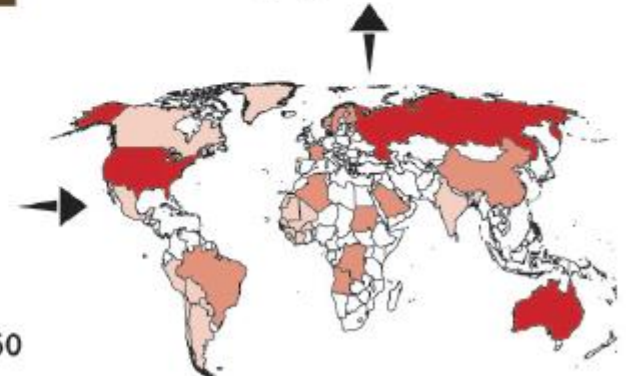
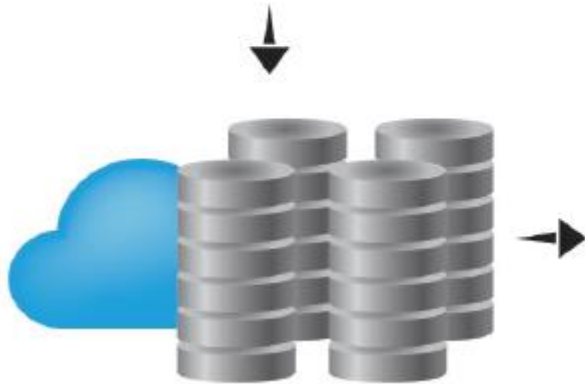
User Needs Acquisition, **page 40**
Data Acquisition, **page 42**

Deploy

Human-Computer Interface, **page 70**
Interaction, **page 68**
Combination, **page 66**

Analyze & Visualize

Statistical Studies, **page 44**
Statistical Visualization Types, **page 46**
Temporal Studies—"When", **page 48**
Temporal Visualization Types, **page 50**
Geospatial Studies—"Where", **page 52**
Geospatial Visualization Types, **page 54**
Topical Studies—"What", **page 56**
Topical Visualization Types, **page 58**
Network Studies—"With Whom", **page 60**
Network Visualization Types, **page 62**
Studying Dynamics, **page 64**

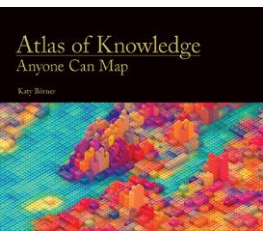


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Types

relevant for the design of effective visualizations

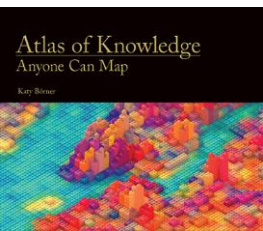
Insight Need Types page 26	Data Scale Types page 28	Visualization Types page 30	Graphic Symbol Types page 32	Graphic Variable Types page 34	Interaction Types page 26
<ul style="list-style-type: none">• categorize/cluster• order/rank/sort• distributions (also outliers, gaps)• comparisons• trends (process and time)• geospatial• compositions (also of text)• correlations/relationships	<ul style="list-style-type: none">• nominal• ordinal• interval• ratio	<ul style="list-style-type: none">• table• chart• graph• map• network layout	<ul style="list-style-type: none">• geometric symbols<ul style="list-style-type: none">pointlineareasurfacevolume• linguistic symbols<ul style="list-style-type: none">textnumeralspunctuation marks• pictorial symbols<ul style="list-style-type: none">imagesiconsstatistical glyphs	<ul style="list-style-type: none">• spatial<ul style="list-style-type: none">position• retinal<ul style="list-style-type: none">formcoloropticsmotion	<ul style="list-style-type: none">• overview• zoom• search and locate• filter• details-on-demand• history• extract• link and brush• projection• distortion



See page 24

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

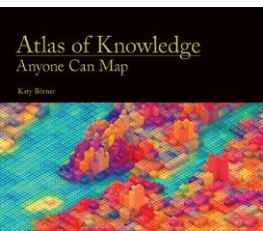


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Types

relevant for the design of effective visualizations

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See page 30

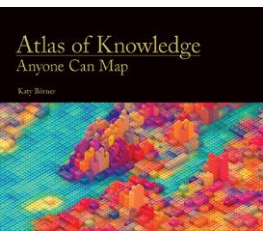
Visualization Types (Reference Systems)

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 graphs:** Node position might depends on node attributes or node similarity. **Tree graphs:** hierarchies, taxonomies, genealogies. **Networks:** social networks, migration flows.

Types

relevant for the design of effective visualizations

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See page 25

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					
	Color	Value	quantitative						
Hue		qualitative							
Saturation		quantitative							



Atlas of Knowledge: Anyone Can Map

by Katy Börner

To be published by MIT Press on March 13, 2015

[Pre-Order Now](#)

13 x 11, 250 pp.

580 illus.

978-0-262-02881-3

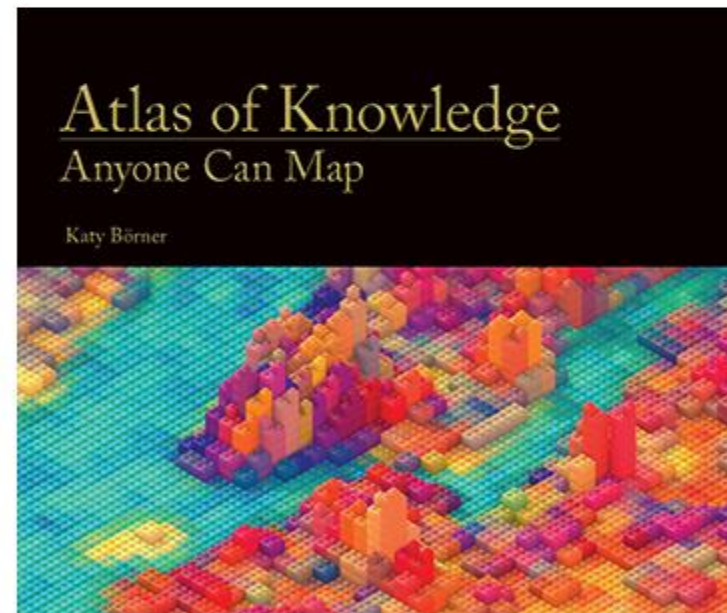
[Download informational flyer](#)

[Introduction](#) | [Author](#) | [Awards](#) | [History](#) | [Vendors](#) | [Images](#) | [References](#) | [Q&A](#) | [Press](#)

Introduction

In an age of information overload, the ability to make sense of vast amounts of data and to render insightful visualizations is as important as the ability to read and write. The *Atlas of Knowledge* explains and exemplifies the power of visualizations not only to help locate us in physical space but also to help us understand the extent and structure of our collective knowledge, to identify bursts of activity, pathways of ideas, and borders that beg to be crossed.

Drawing on 15 years of research and tool development, the *Atlas* introduces a theoretical visualization framework meant to empower anyone to systematically render data into insights. It aims to teach “timeless” knowledge that



[« back to the store](#)

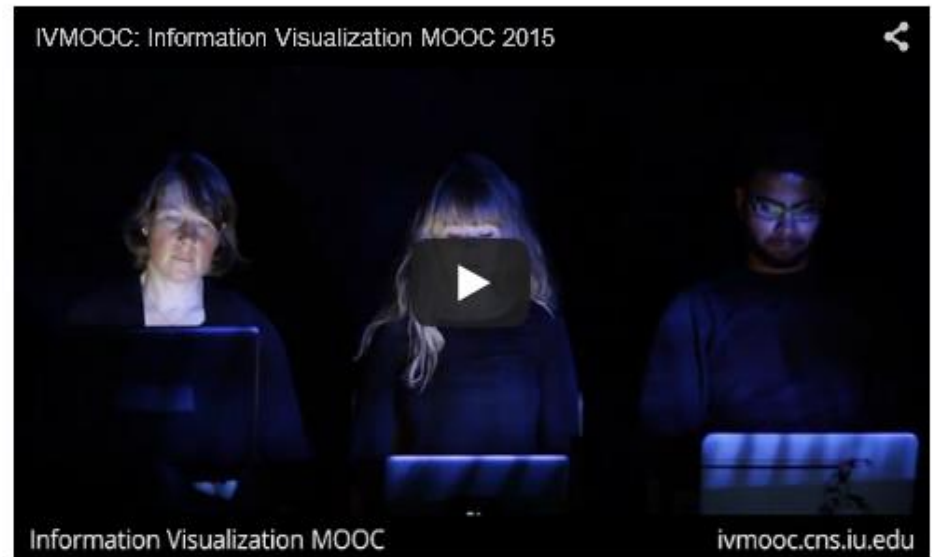
Overview

This course provides an overview about the state of the art in information visualization. It teaches the process of producing effective visualizations that take the needs of users into account.

The course can be taken for three Indiana University credits as part of the **Online Data Science Program**, as part of the **Information and Library Science M.S. program**, and as part of the online **Data Science M.S. Program** offered by the School of Informatics and Computing. Students seeking enrollment information should contact Rhonda Spencer at 812-855-2018, ilsmain@indiana.edu or datasci@indiana.edu.

Among other topics, the course covers:

- Data analysis algorithms that enable extraction of patterns and trends in data
- Major temporal, geospatial, topical, and network visualization techniques
- Discussions of systems that drive research and development.



[Register for Course](#)

Already registered? [Click here](#) to go to the course.

Forgot your password? [Click here](#) to reset it.

Invited Talk:

Visualizing Knowledge Spaces: Cartographic Perspectives

by Dr. André Skupin, Geography, San Diego State University

André Skupin

Professor of Geography
San Diego State University

Founder & Co-Director
Center for Information Convergence and Strategy
San Diego State University

Associate Director
Center for Entrepreneurship and Innovation
University of Dubai

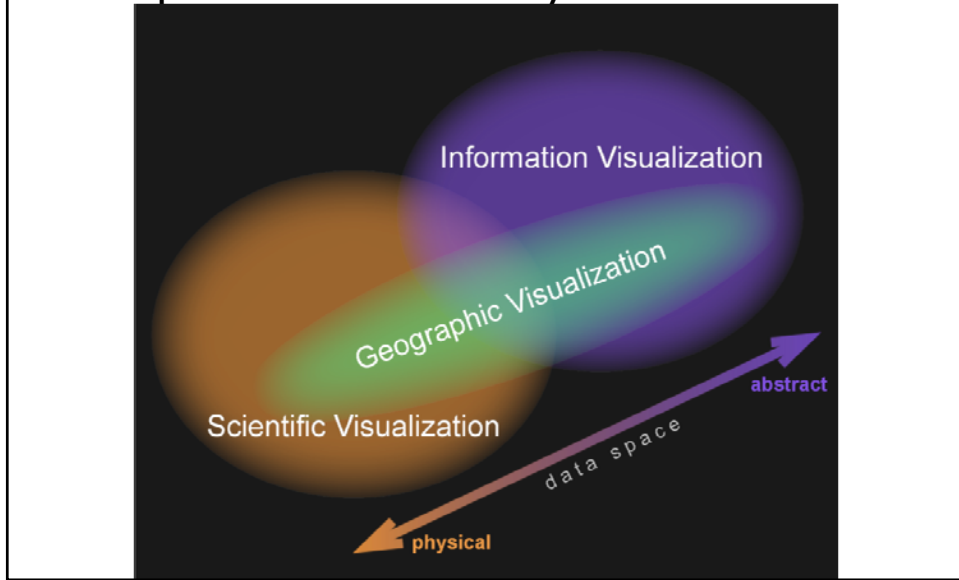
Co-Founder & Co-CEO
BigKnowledge LLC

Visualizing Knowledge Spaces
Cartographic Perspectives

Visualizing Knowledge Spaces
Cartographic Perspectives

- What is Visualization?
- Cartographic Lesson I: "Space – The Final Frontier"
- Cartographic Lesson II: "It's all been done before!"
- The Power of Spatial Concepts
- Gallery of Base Maps
- Visualization for Impact: Partners, Cultures, Values

“Visualization is a **data-driven representation** aimed at **amplifying cognition**, frequently supported by **computation and interactivity**.”



Knowledge Visualization

This block contains several examples of knowledge visualization:

- Network Graphs:** A large network graph on the left with nodes and edges, and a smaller network graph on the right showing relationships between 'Diabetes Mellitus', 'Cardiovascular Diseases', and 'Metabolic Syn'. Nodes include 'Fatty Acids', 'Hypoglycemic Agents', 'Blood Glucose', 'Insulin', 'Glucose Tolerance Test', 'Fasting', 'Lipids', 'Lipid Hillobs', 'Antidiabetic Agents', 'Hydroxymethylglutaryl-CoA', 'Reductase Inhibitors', and 'Cholesterol'.
- Word Clouds:** A central word cloud with terms like 'reconstruction', 'shape', 'surface', 'temperature', 'depth', 'mechanisms', 'acoustic', 'mechanism', 'signals', 'activity', 'detected', 'novelly', 'detection', 'intrusion', 'anomaly', 'detecting', 'computational', 'behavior', 'hidden', 'markov', 'movement', 'continuous', 'gis', 'health', 'remot', 'water', 'land', 'manag', 'natur', 'develop', 'environment', 'commun', 'synthop', 'electronic', 'synthop', 'darkwave', 'gothic', 'rock', 'ethereal', 'indus', 'wave', 'synthop', 'darkwave', 'gothic', 'rock', 'ethereal', 'indus', 'wave', 'synthop', 'darkwave', 'gothic', 'rock', 'ethereal', 'indus', 'wave', 'synthop'.
- Hierarchical Diagrams:** A grid-like structure on the right containing various sub-topics such as 'Academic and analytical', 'Basic analytical', 'History and trends', 'Graphical techniques', 'Map production', 'Data considerations', 'Principles of map design', 'Spatial statistics', 'Geostatistics', 'Spatial regression and location-allocation', 'The scope of GIS and T system design', 'Database design', 'Data mining', 'Network analysis', 'Optimization', 'Project definition', 'Resource planning', 'Analysis design', 'Philosophical foundation', 'Cognitive and social foundation', 'Domains of geographical information science', 'Basic storage', and 'Tessellation'.

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Knowledge Visualization



Spaces of Visualization

- **Geographic Space**
 - Discrete objects
 - Continuous fields
- **Vector Space**
 - Entities
 - Properties
- **Network Space**
 - Nodes
 - Links
- **Knowledge Space**
 - Domains
 - Actors
 - Concepts
 - Artifacts

It's all been done before

- Data → Symbols → Understanding
- Scale & Abstraction
- Semantic Zooming
- Base Map Creation
- Base Map Use
- Thematic Overlays
- Truth in Mapping

Data → Symbols → Understanding

visual | graphic | semiotic variables

- for static maps
 - Bertin (1967/1983)
 - seven variables
 - *Position*
 - Size
 - Value
 - Texture
 - Hue
 - Orientation
 - Shape

Data → Symbols → Understanding

visual | graphic | semiotic variables

- for static maps
 - Bertin+
 - eight variables
 - size
 - value
 - saturation
 - pattern texture
 - pattern arrangement
 - hue
 - orientation
 - shape

Data → Symbols → Understanding

visual | graphic | semiotic variables

- for static maps
 - Bertin+
 - quantitative data
 - size
 - value
 - saturation
 - pattern texture
 - qualitative data
 - pattern arrangement
 - hue
 - orientation
 - shape

Data → Symbols → Understanding

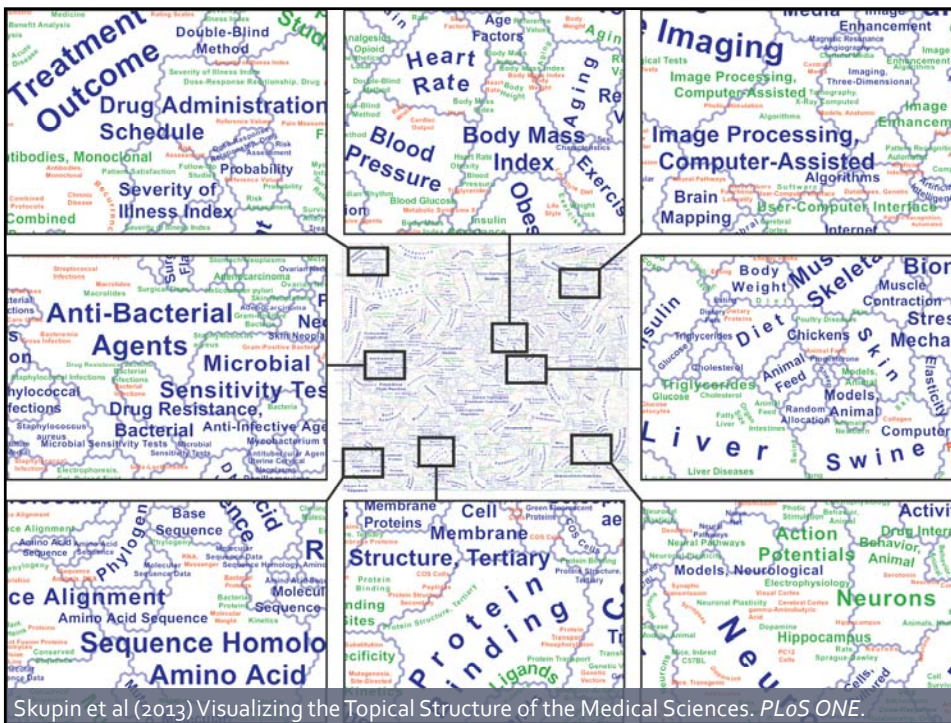
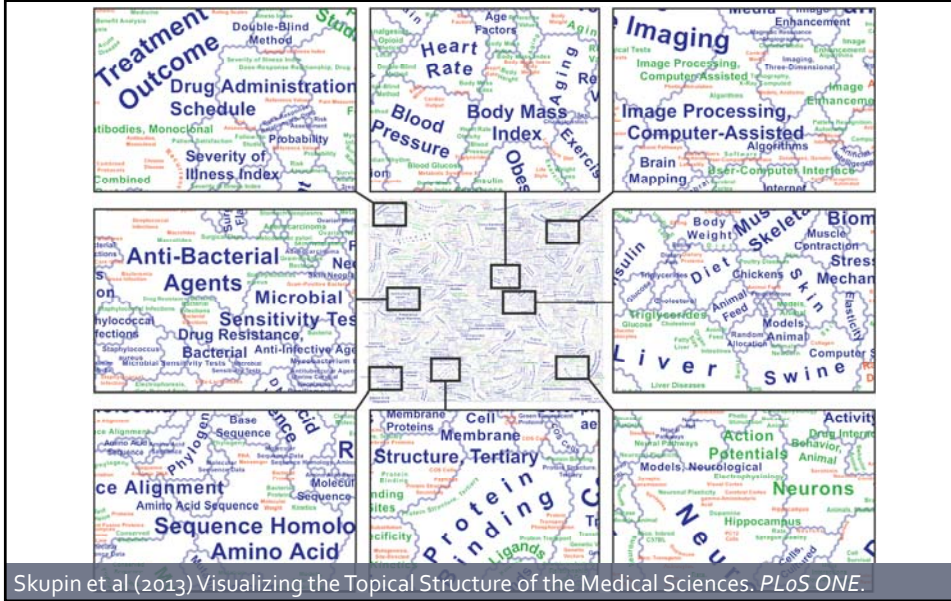
visual | graphic | semiotic variables

- for static maps
 - Bertin+
 - quantitative data
 - size
 - value
 - saturation
 - pattern texture
 - qualitative data
 - pattern arrangement
 - hue
 - orientation
 - shape
- for animated maps
 - duration
 - rate of change
 - order
 - display date
 - frequency
 - synchronization

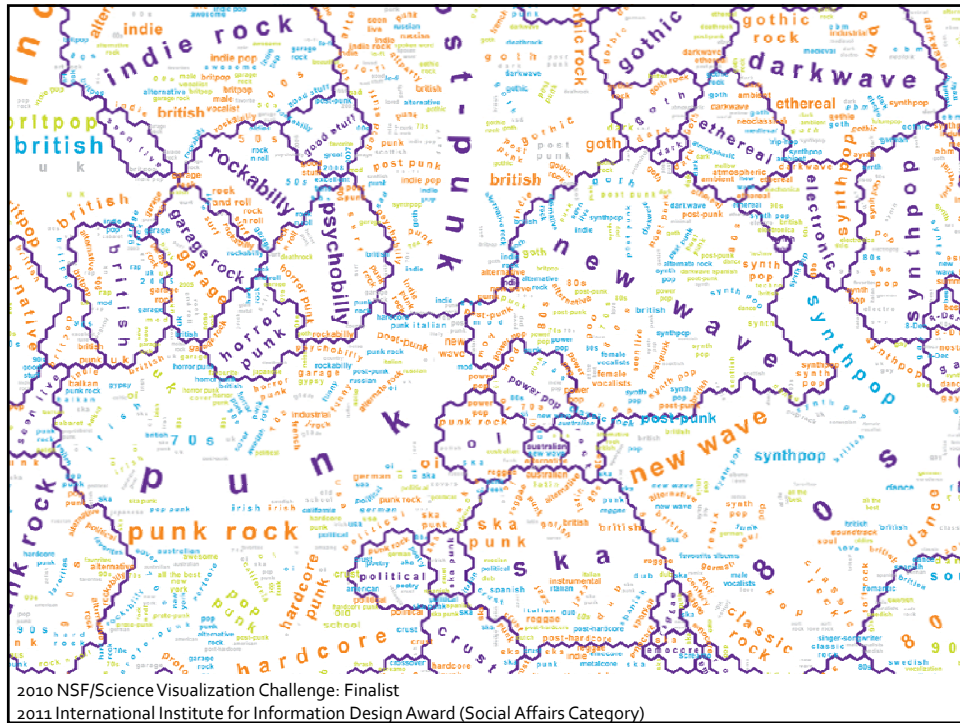
Scale & Abstraction



Base map: Two million biomedical papers



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Visualization for Impact: Partners, Cultures, Values

- Impactful Visualization
 - Inspire [domain experts]
 - Connect [across disciplines]
 - Understand [domain patterns]
- Power of Diversity
 - Partners
 - Institutions
 - Disciplines
 - Cultures
 - Technologies
 - Values



KNOWI FDGF FNGIFFRING
Space The Knowledge Frontier

RigKnowledge focuses on domain specific knowledge management and analytics solutions. We enable domain communities to discover, manage, and operationalize the knowledge hidden among very diverse data, ranging from formal ontologies to large collections of text content, goodata, and multivariate databases. The domains in which we operate include higher education, healthcare, biomedicine, law, and finance.

- Knowledge Management**
Set your organization's knowledge free, with ontology-driven solutions for capturing, organizing, and operationalizing domain knowledge. [more...](#)
- Knowledge Analytics**
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