Improving Data Visualization Literacy: Empowering Anyone to Read and Make Visualizations

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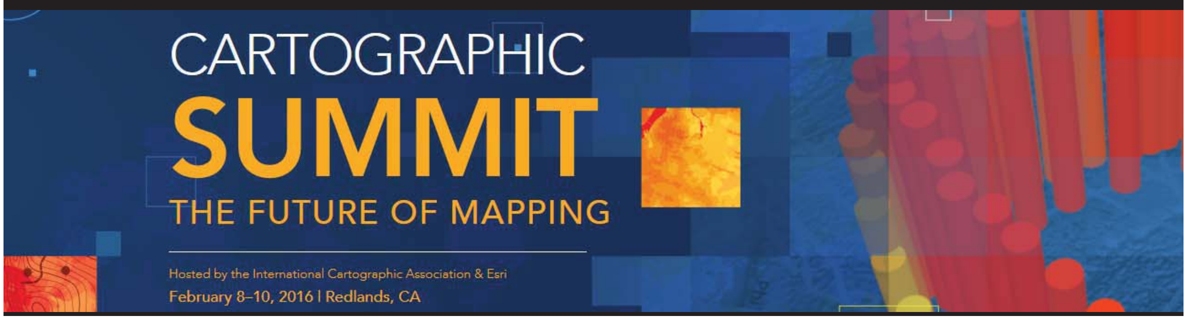
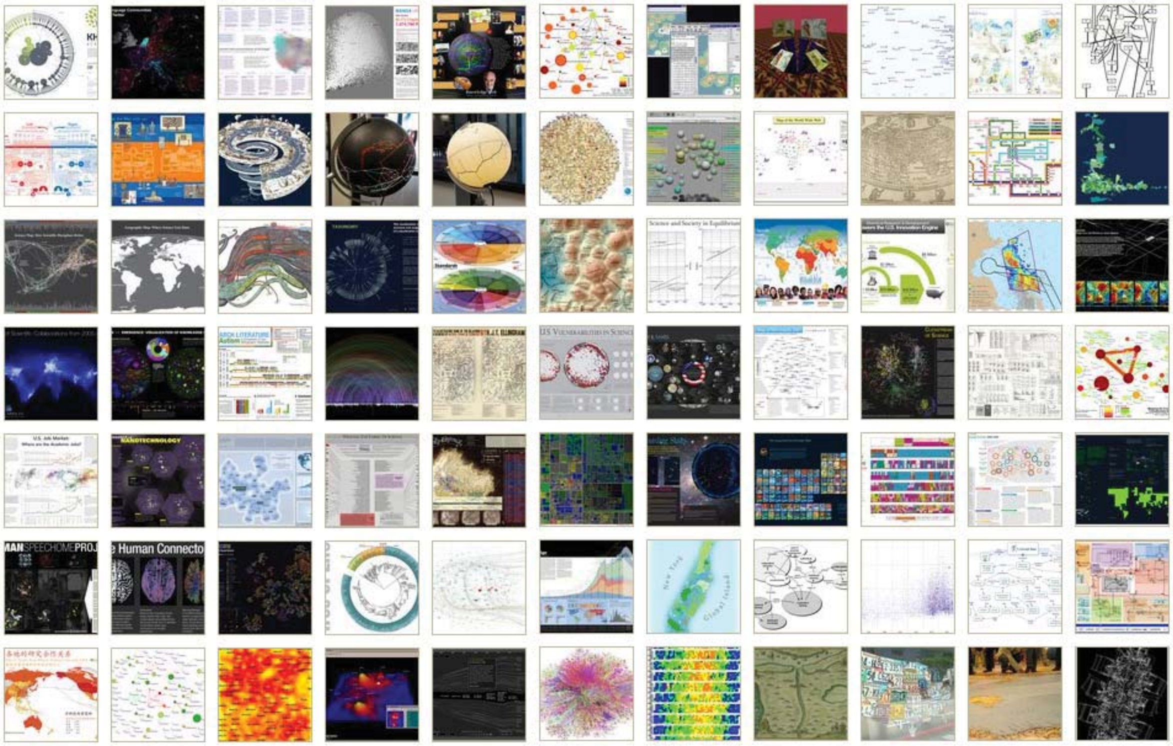
February 8, 2016



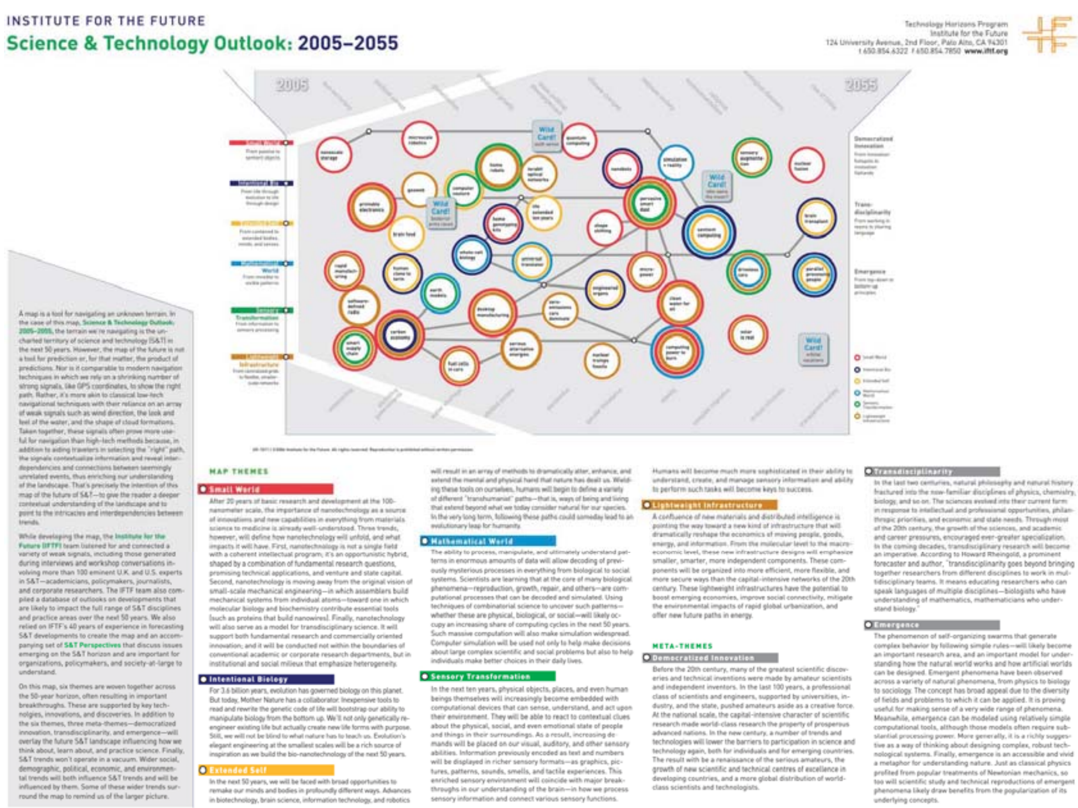
Part 1

PLACES & SPACES
MAPPING SCIENCE

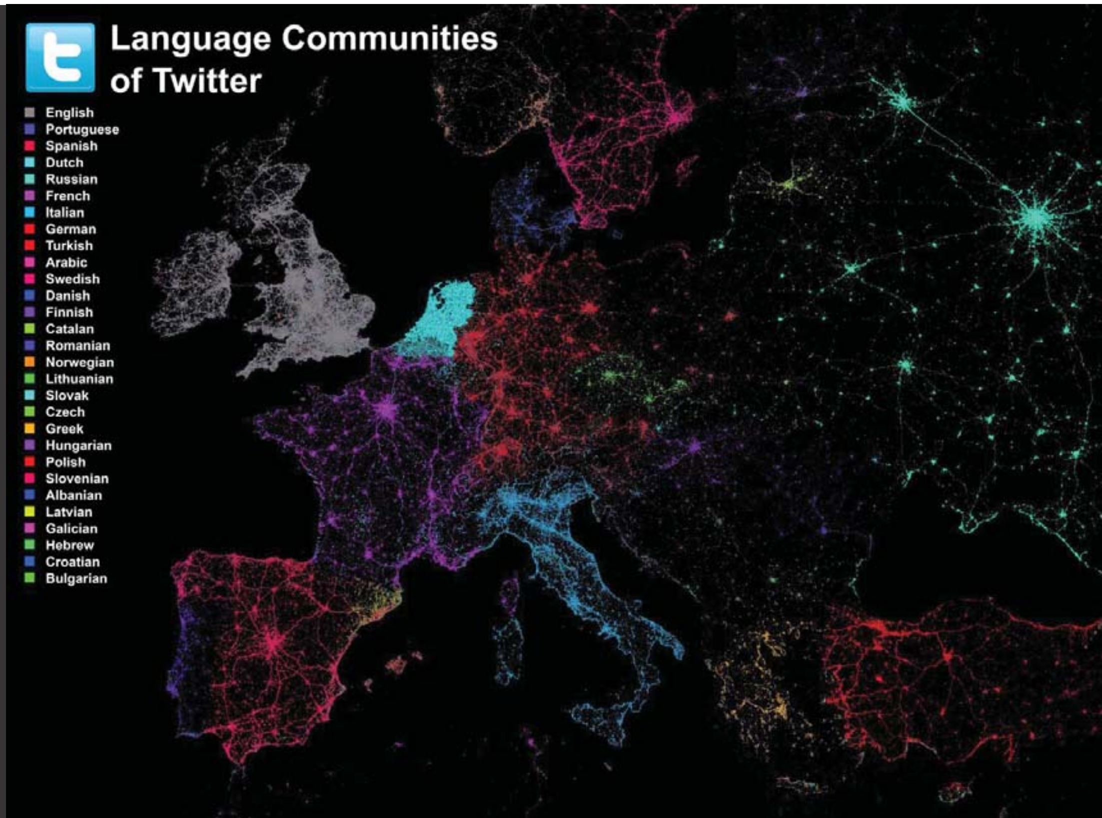
scimaps.org



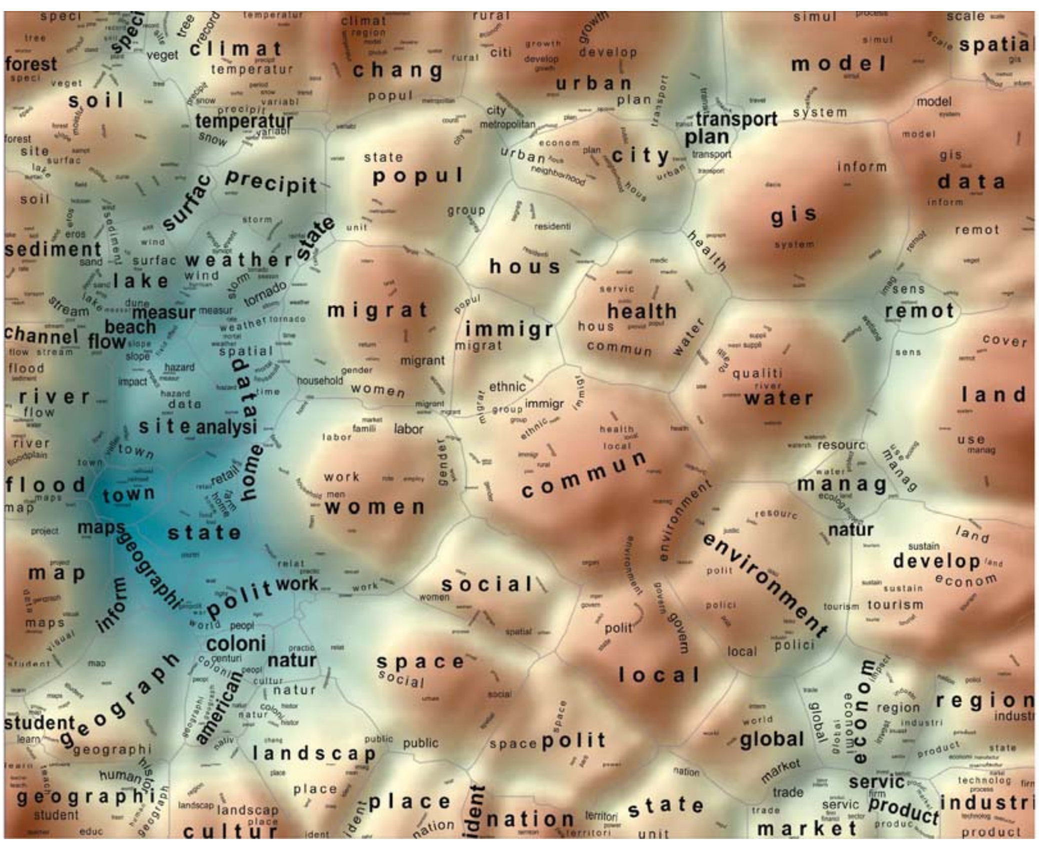
Places & Spaces: Mapping Science Exhibit, online at http://scimaps.org



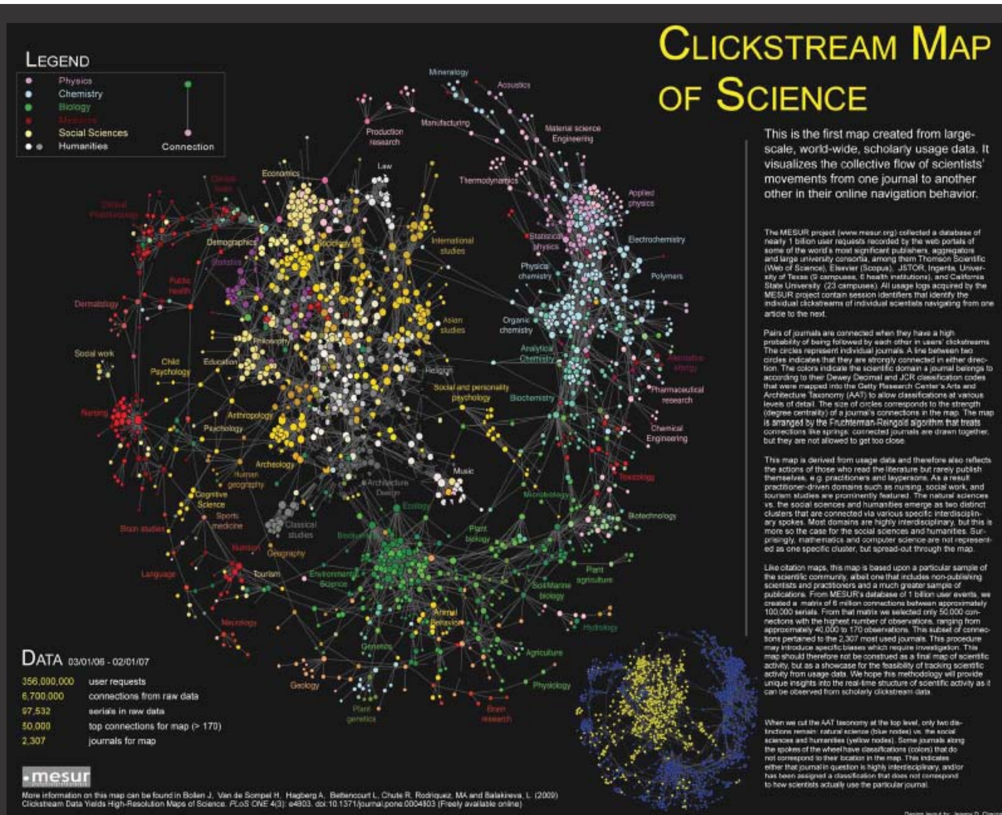
Science & Technology Outlook: 2005-2055 - Alex Soojung-Kim Pang, David Pescovitz, Marina Gorbis, Jean Hagan - 2006



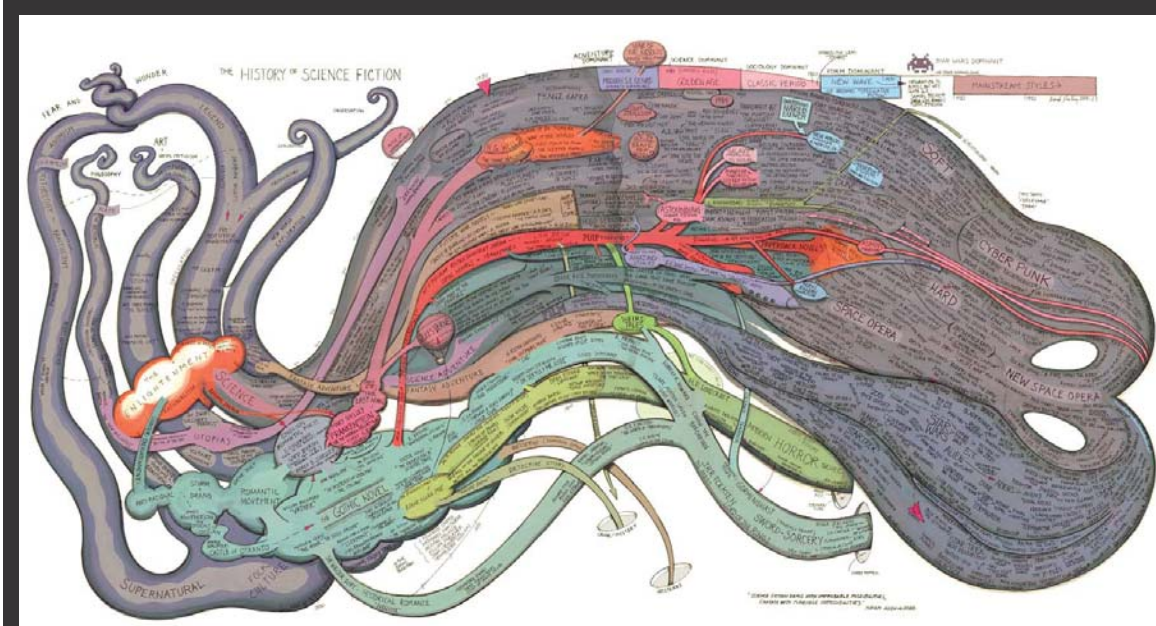
Language Communities of Twitter - Eric Fischer - 2012



In Terms of Geography - Andre Skupin - 2005



Bollen, Johan, Herbert Van de Sompel, Aric Hagberg, Luis M.A. Bettencourt, Ryan Chute, Marko A. Rodriquez, Lyudmila Balakireva. 2008. A Clickstream Map of Science.



Ward Shelley . 2011. History of Science Fiction.

April, 2005: 101st Annual Meeting of the
Association of American Geographer, Denver, Colorado.

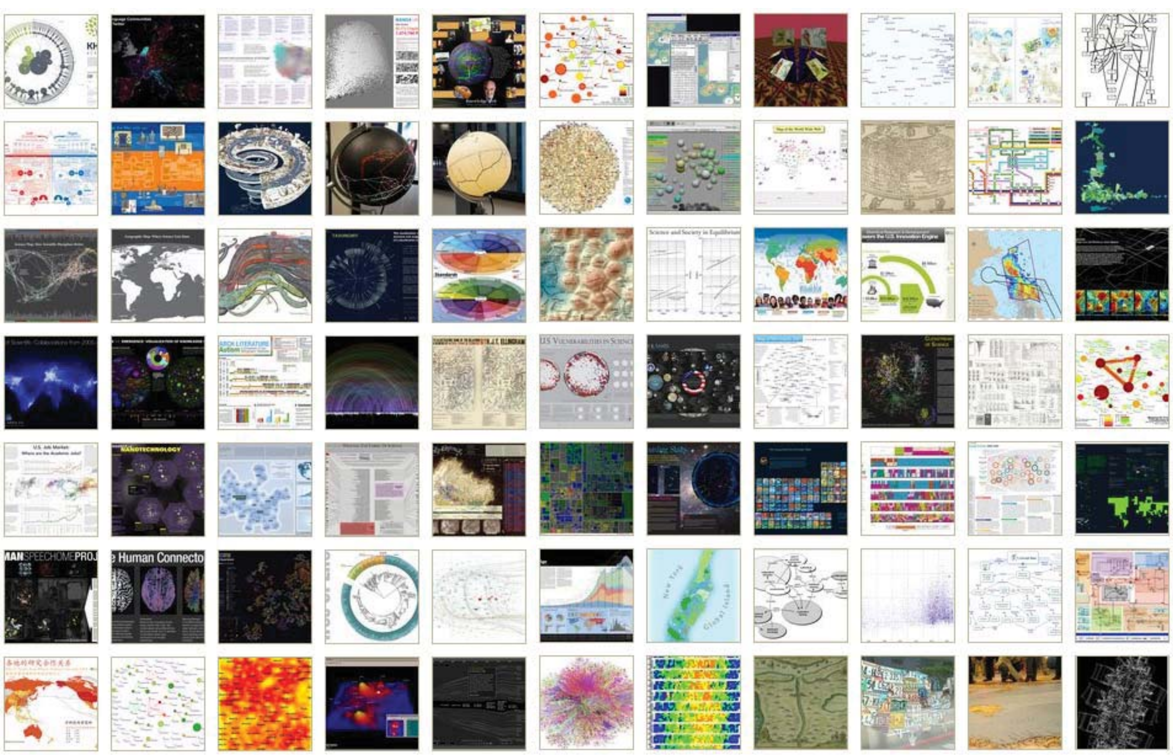
Science Maps in "Expedition Zukunft" science train visited 62 cities in 7 months.
Opening on April 23rd, 2009 by German Chancellor Merkel

Places & Spaces at Northwestern University
May 14 - September 23, 2015

Places & Spaces Exhibit at the David J. Sencer CDC Museum, Atlanta, GA
January 25-June 17, 2016

Seeing for Action - Using Maps and Graphs to Protect the Public's Health.

CDC Opening Event: Maps of Health
Tutorial and Symposium
February 4-5, 2016



How to Classify (Name & Make) Different Visualizations?

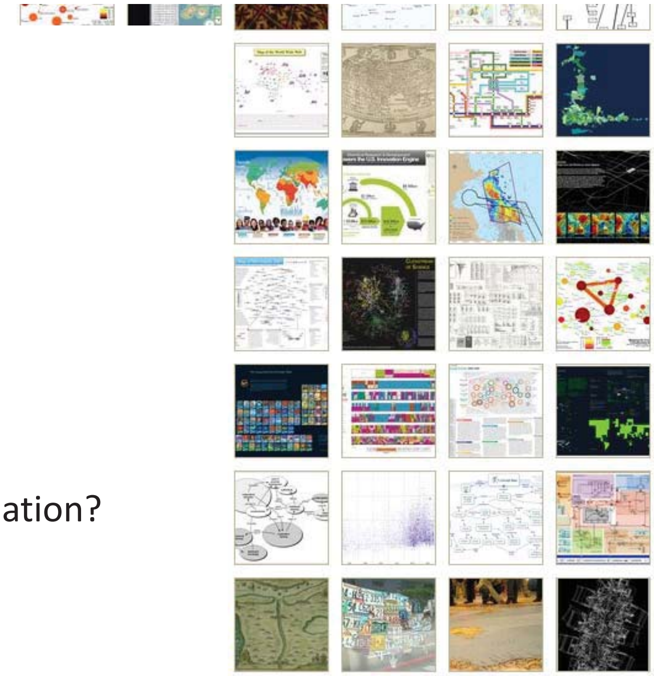
By

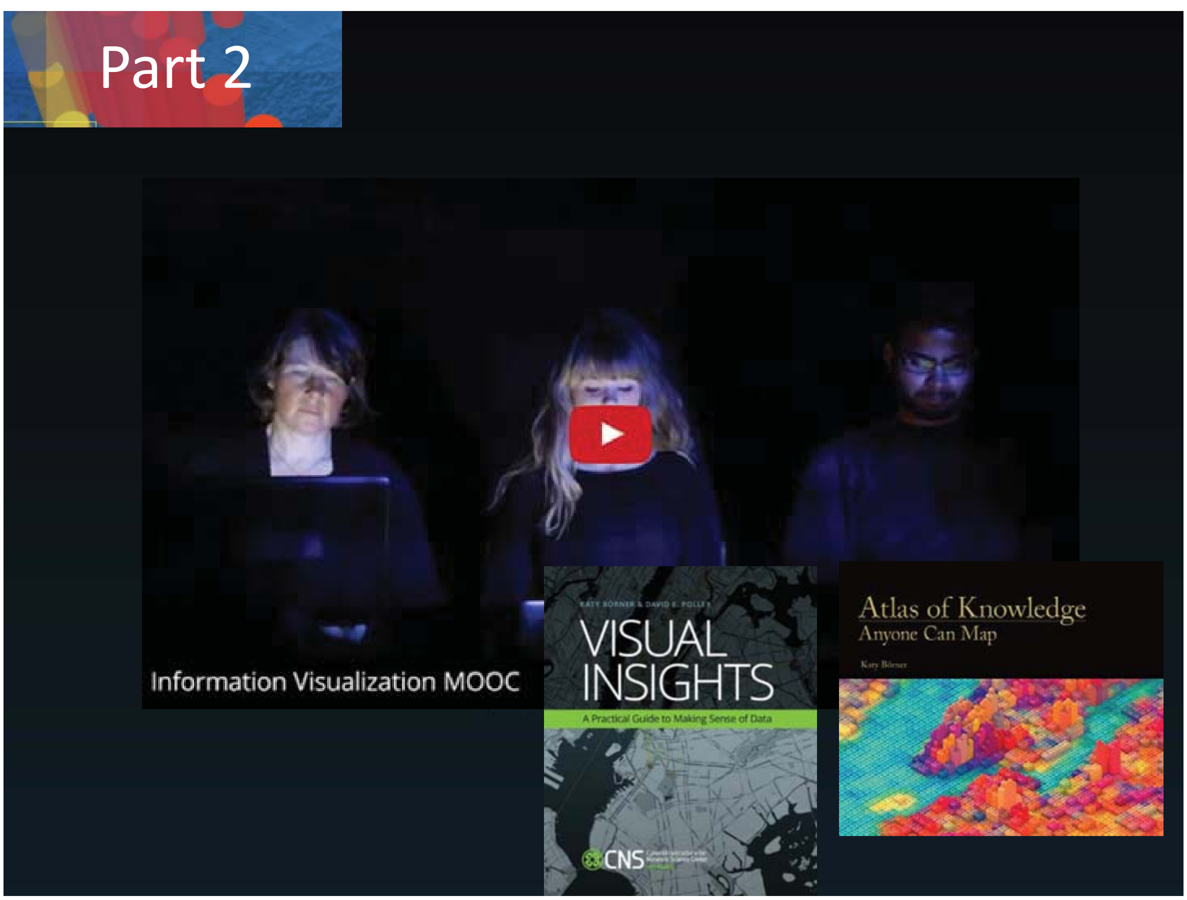
- User insight needs?
- User task types?

- Data to be visualized?
- Data transformation?

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

- Or ?





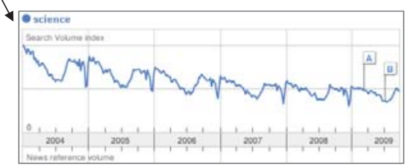
Different Question Types

Terabytes of data

Descriptive & Predictive Models

Find your way

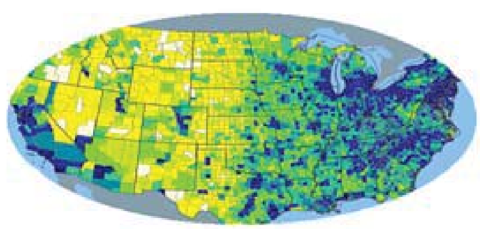
Find collaborators, friends



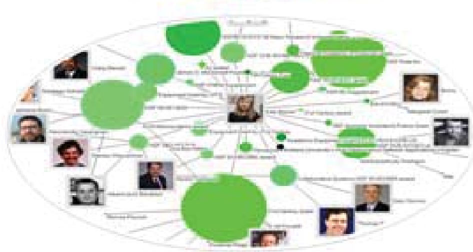
Identify trends

Different Levels of Abstraction/Analysis

Macro/Global
Population Level



Meso/Local
Group Level

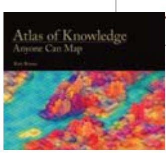


Micro
Individual Level

Tasks

LEVELS / TYPES

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



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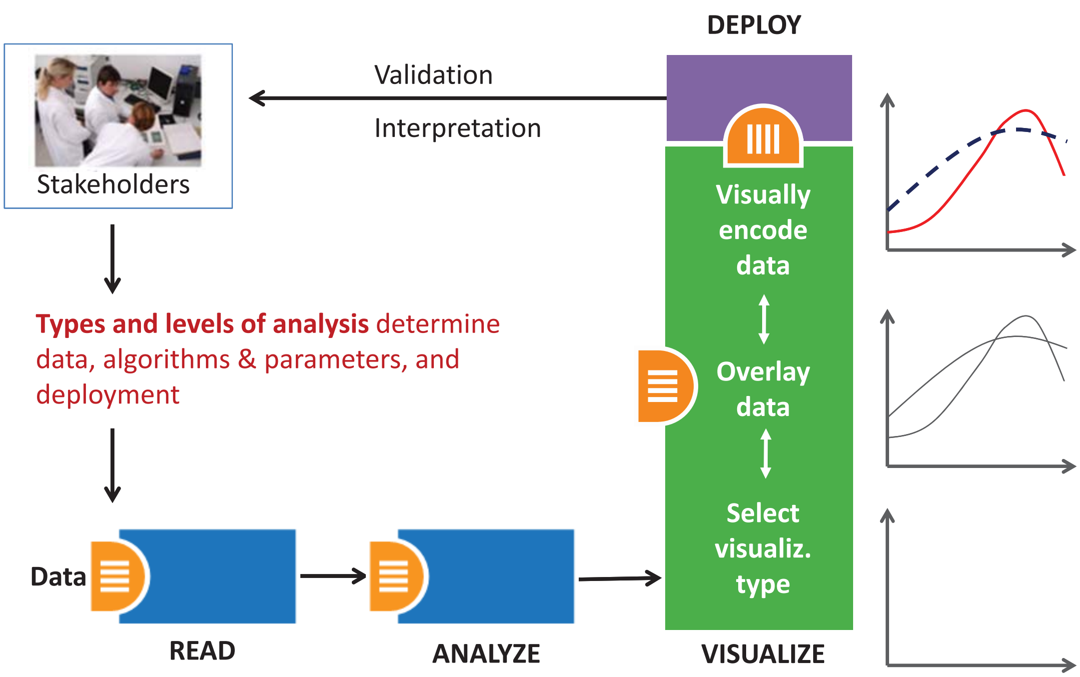
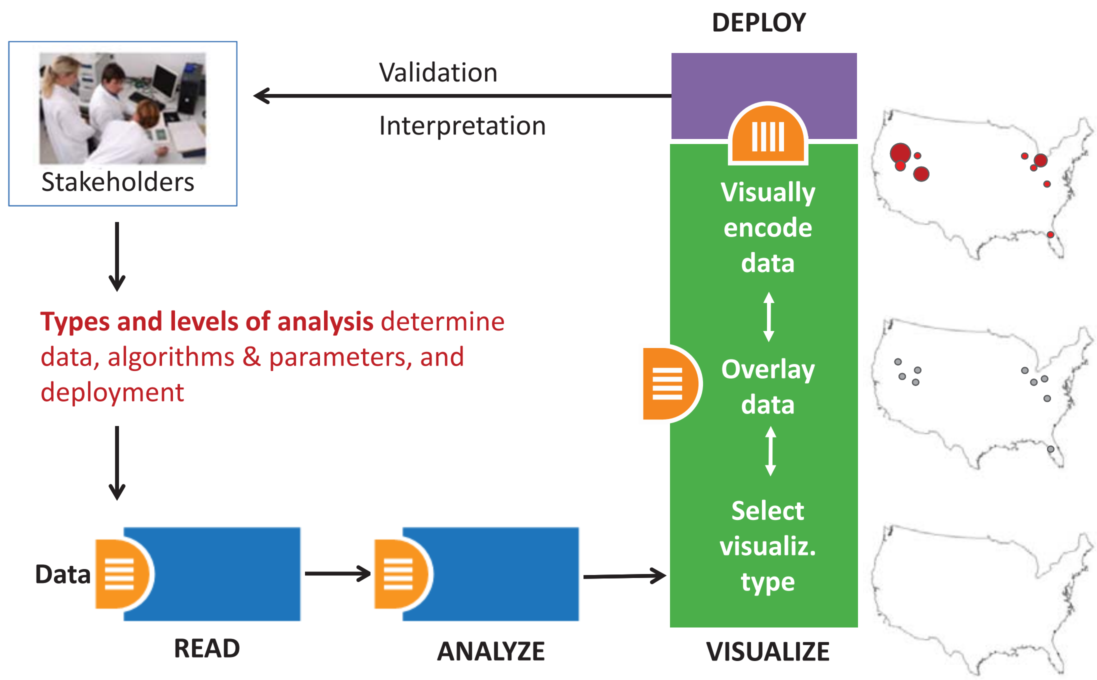
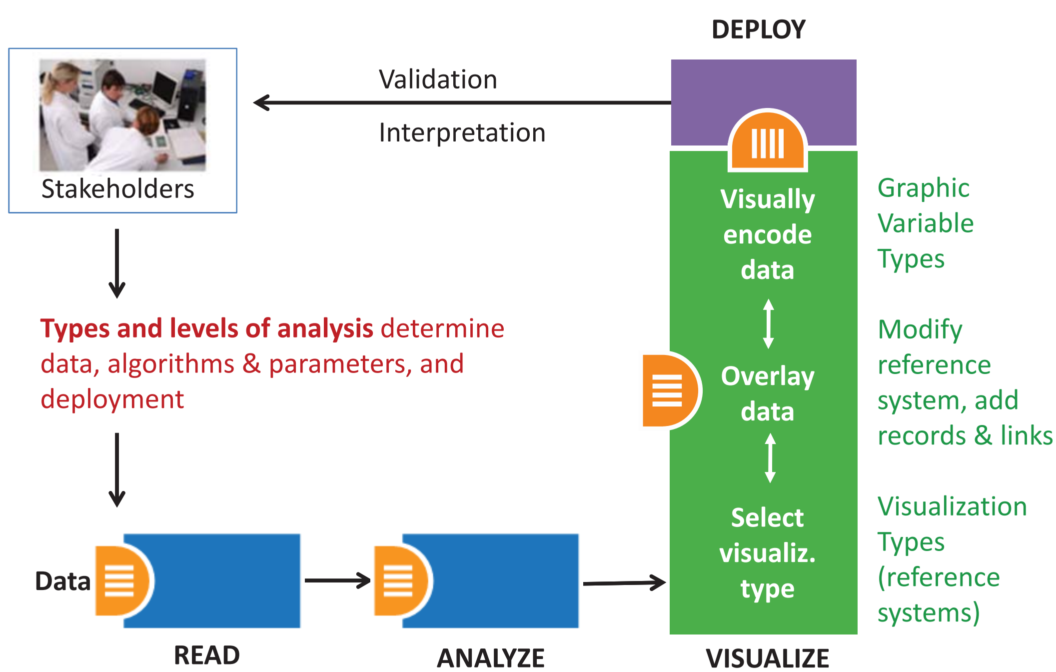
Needs-Driven Workflow Design



Needs-Driven Workflow Design



Needs-Driven Workflow Design

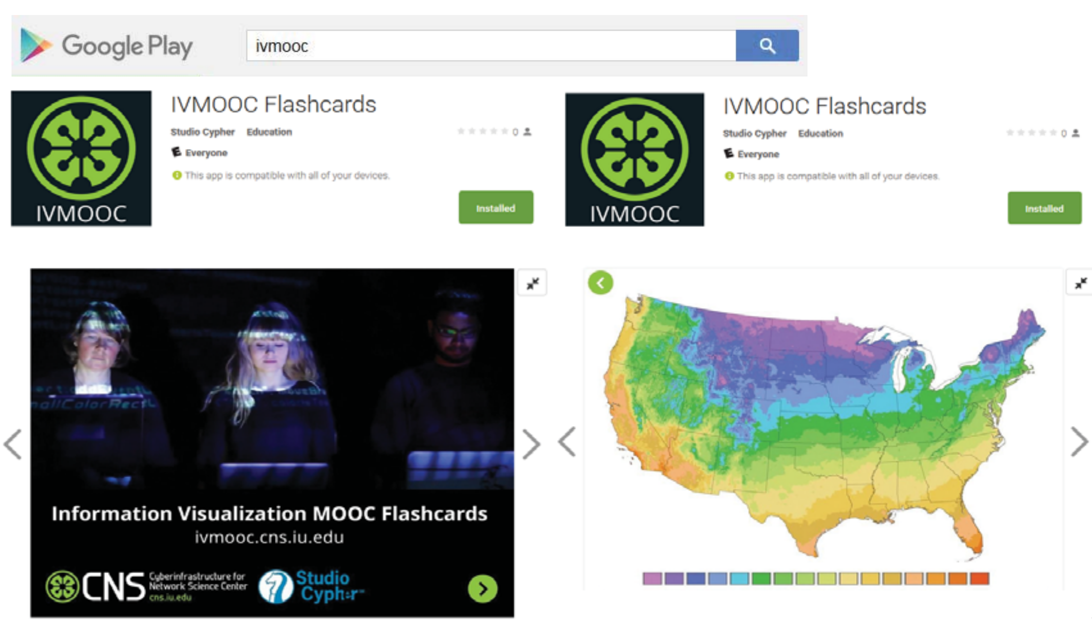


Visualization Types (Reference Systems)

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.

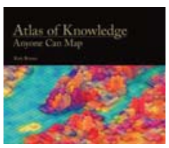
IVMOOC App – More than 60 visualizations

The “IVMOOC Flashcards” app can be downloaded from Google Play and Apple iOS stores.



Visualization Framework

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



See page 24

Visualization Framework

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

Visualization Framework

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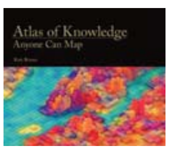

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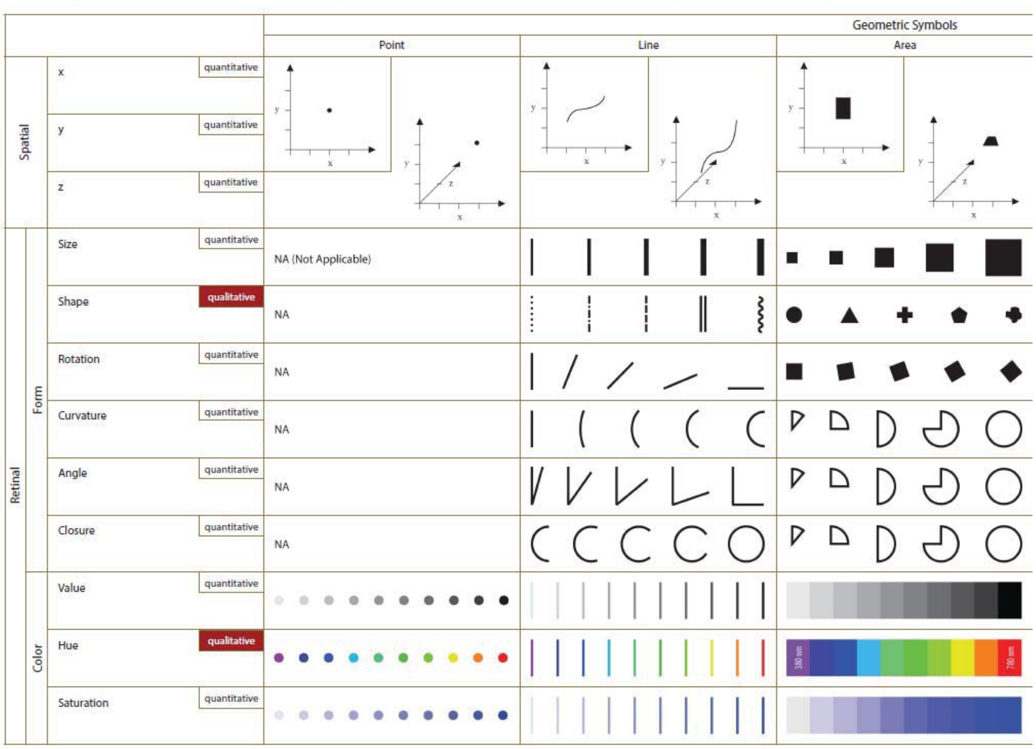
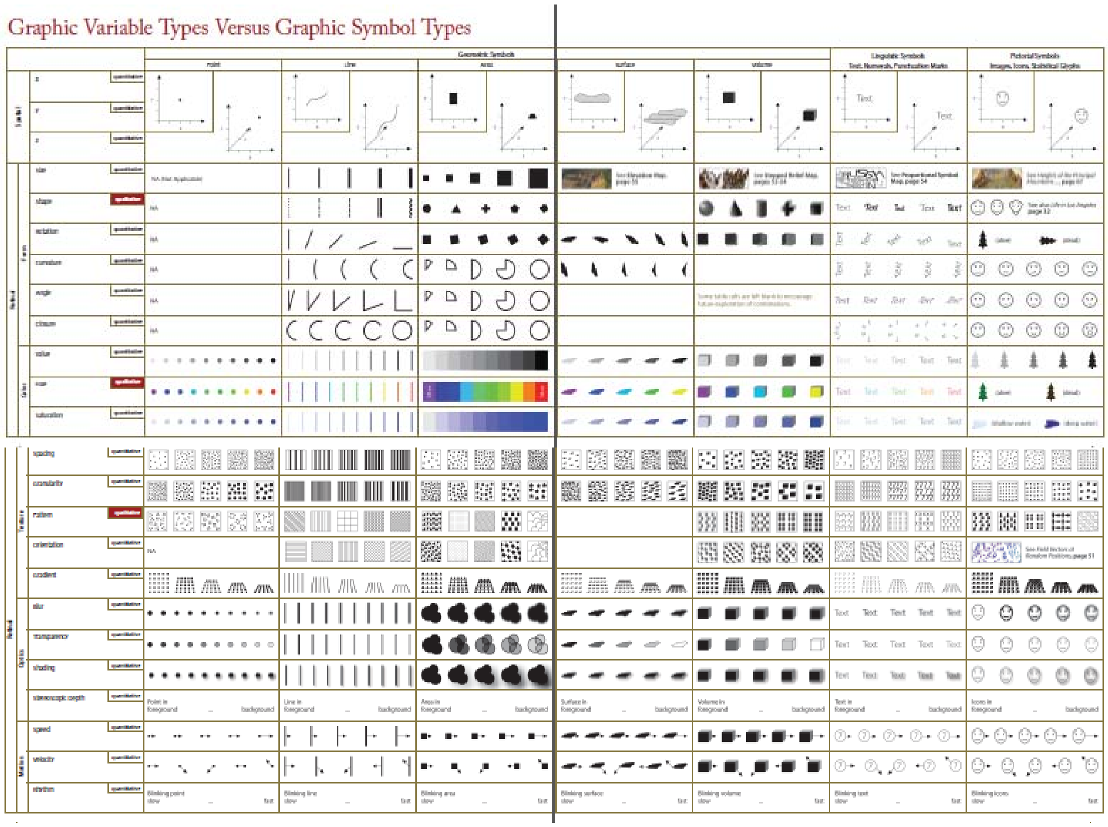
Graphic Variable Types Versus Graphic Symbol Types





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

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

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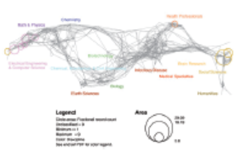
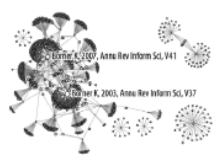
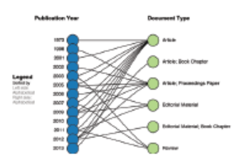
Topical Analysis—p. 56



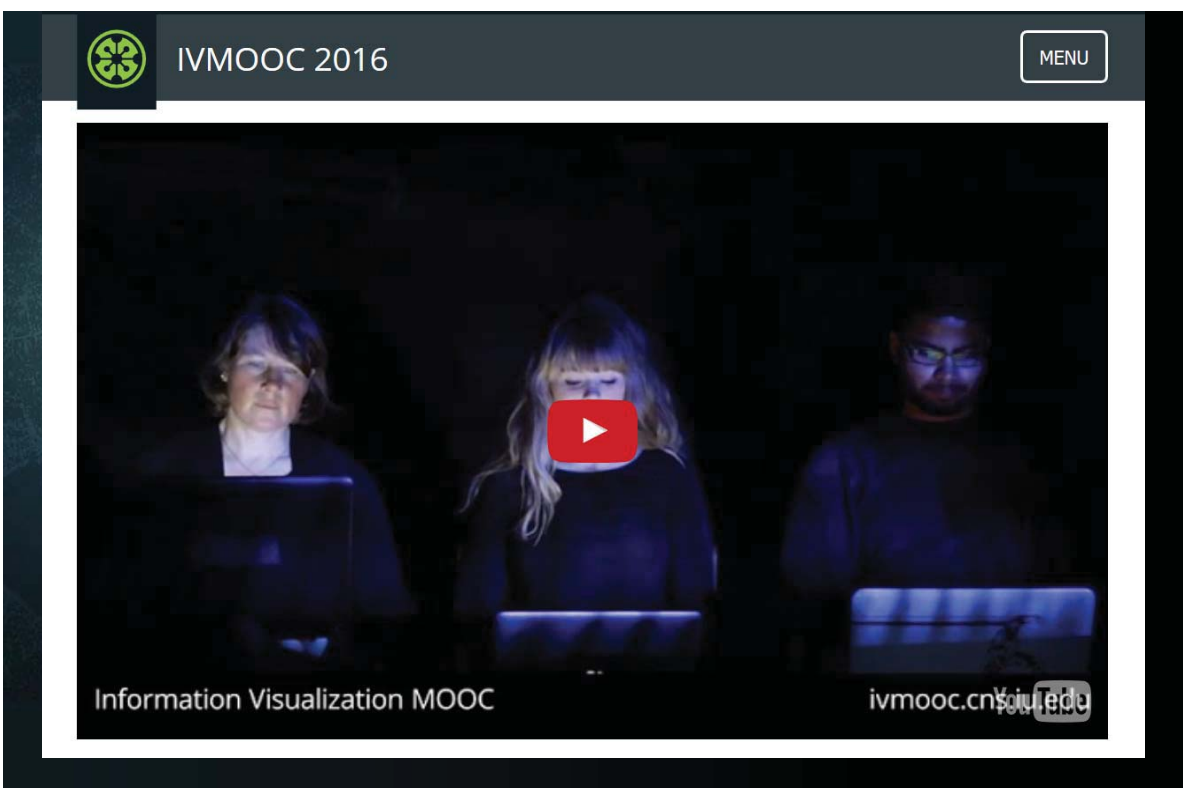
Paper Citation Network—p. 60



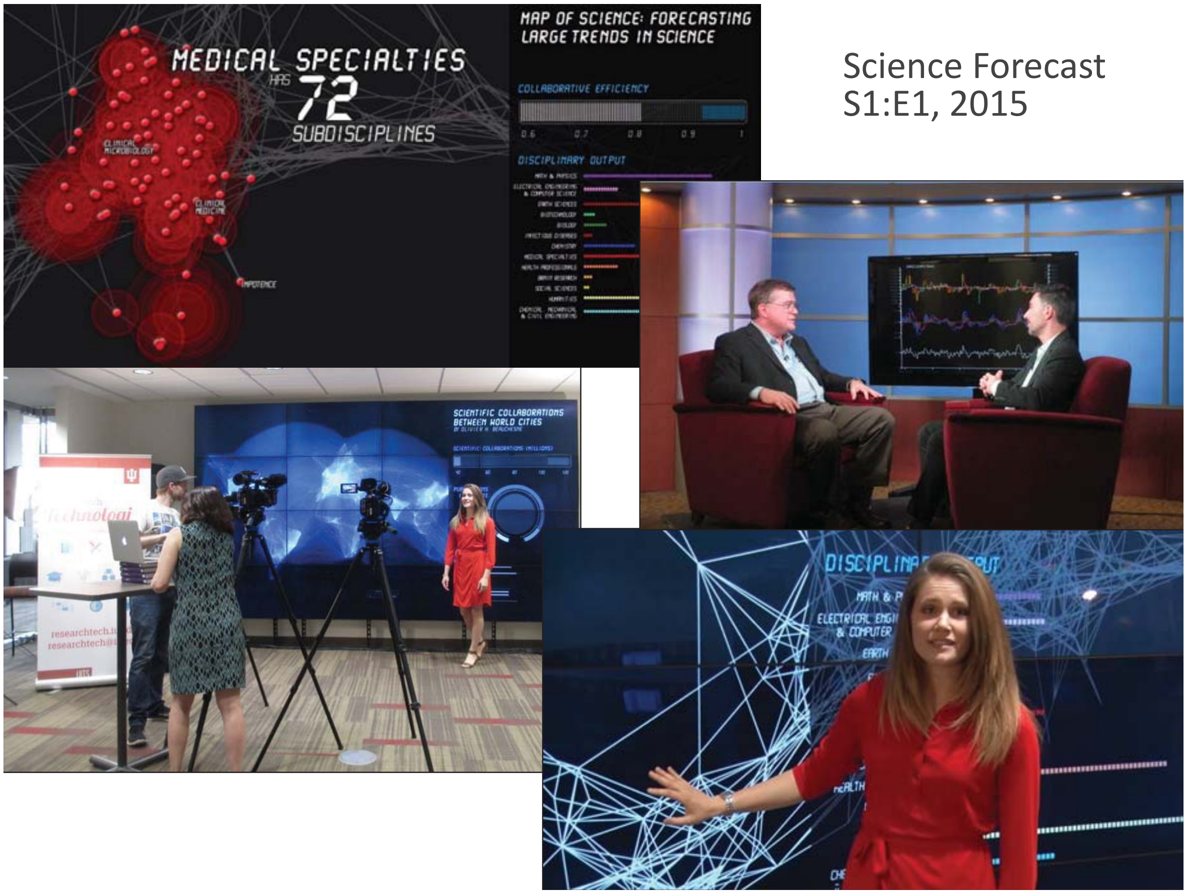
Bi-Modal Network—p. 60



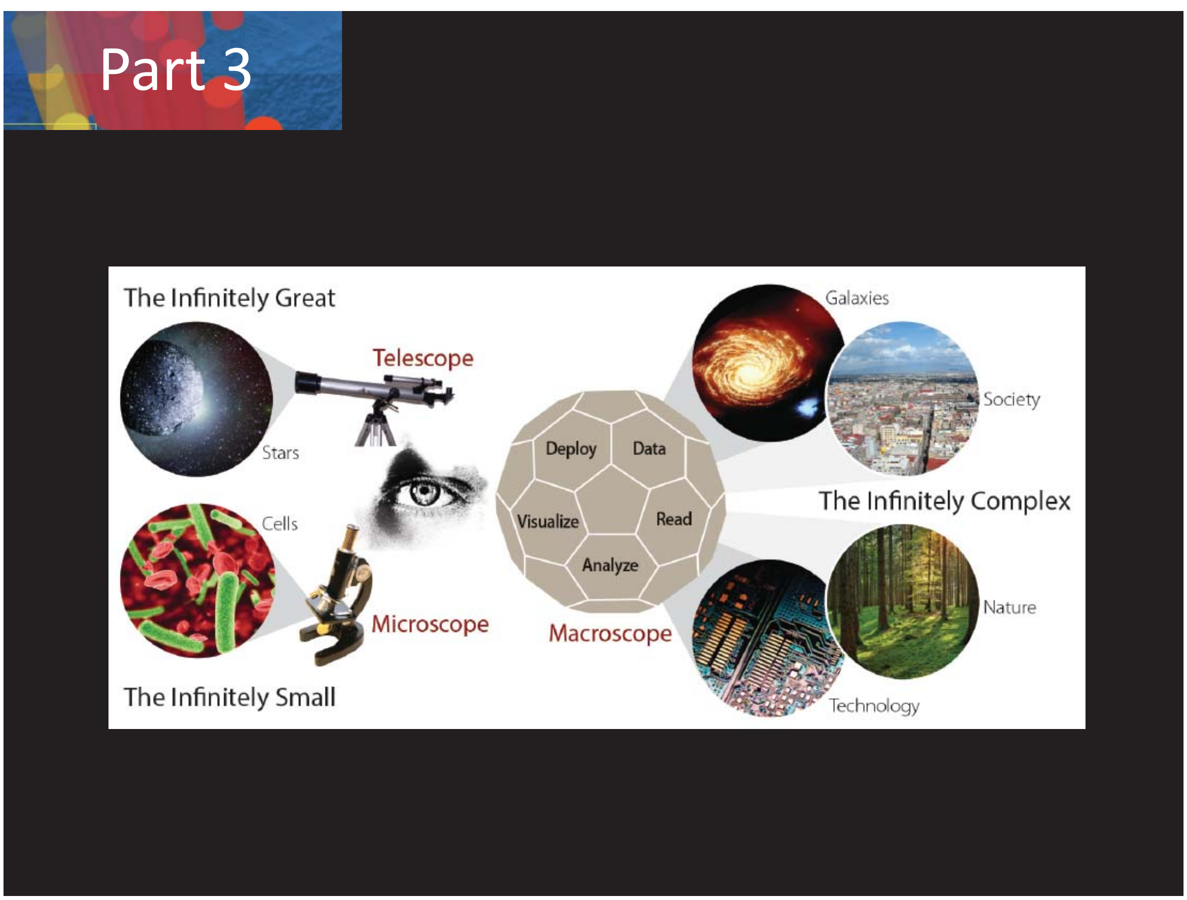
Co-author and many other bi-modal networks.



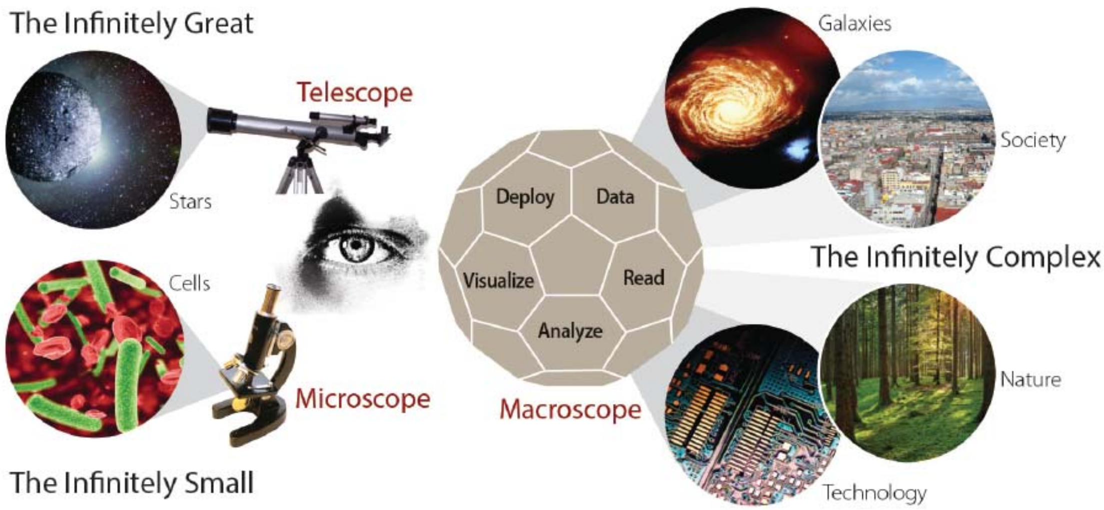
Register for free: http://ivmooc.cns.iu.edu. Class started Jan 12, 2016.



Science Forecast
S1:E1, 2015



Microscopes, Telescopes, Macroscopes Plug-and-Play Macroscopes



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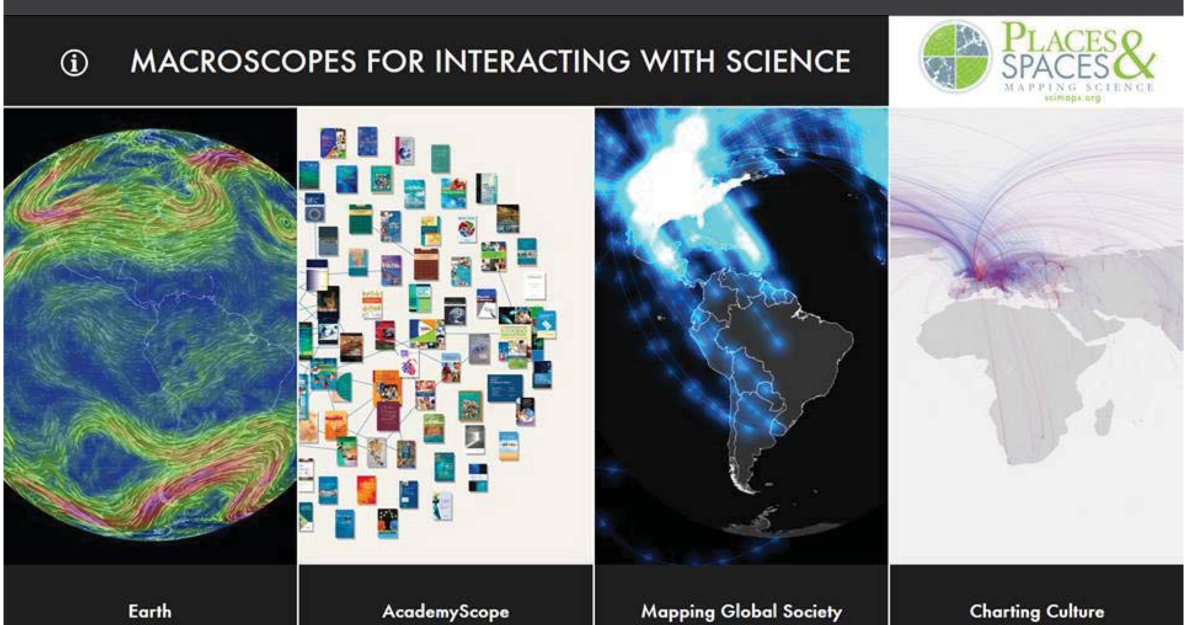
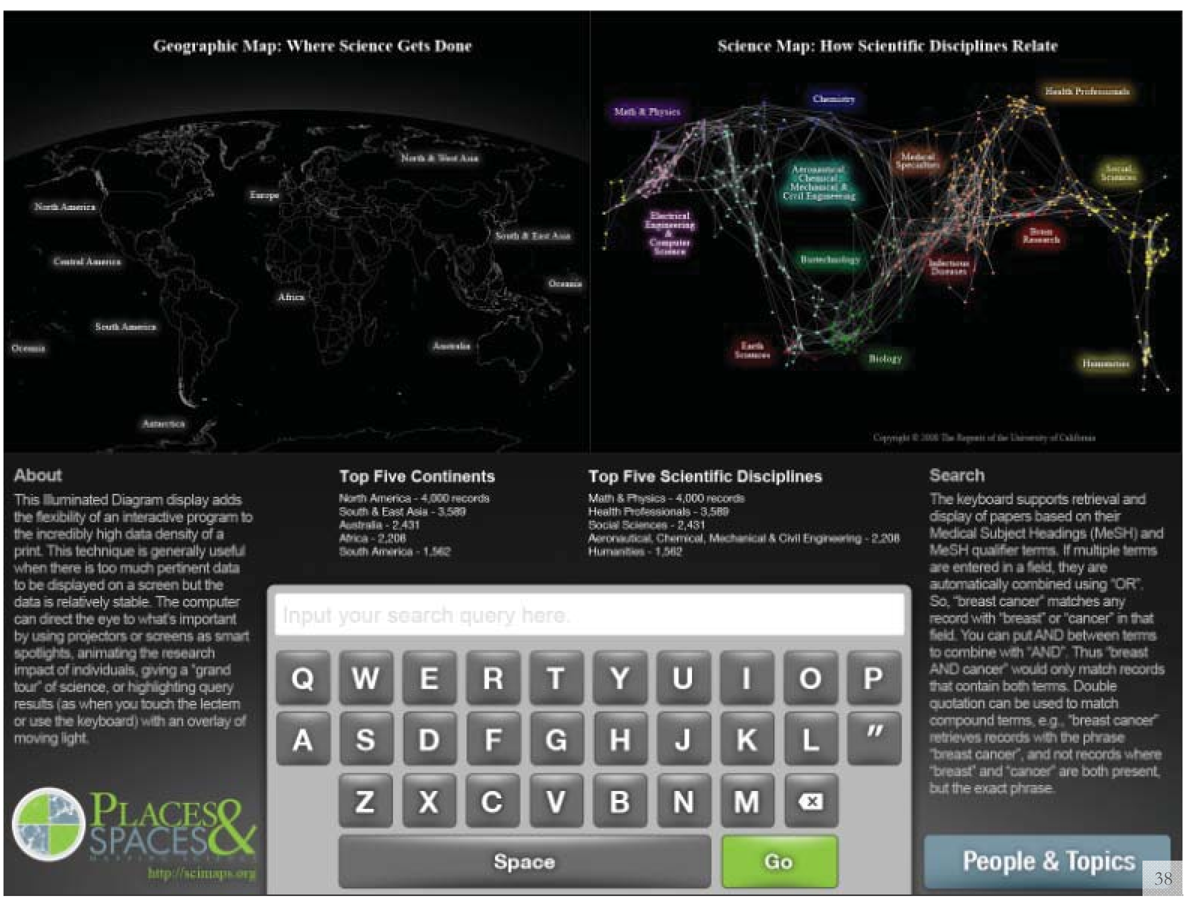
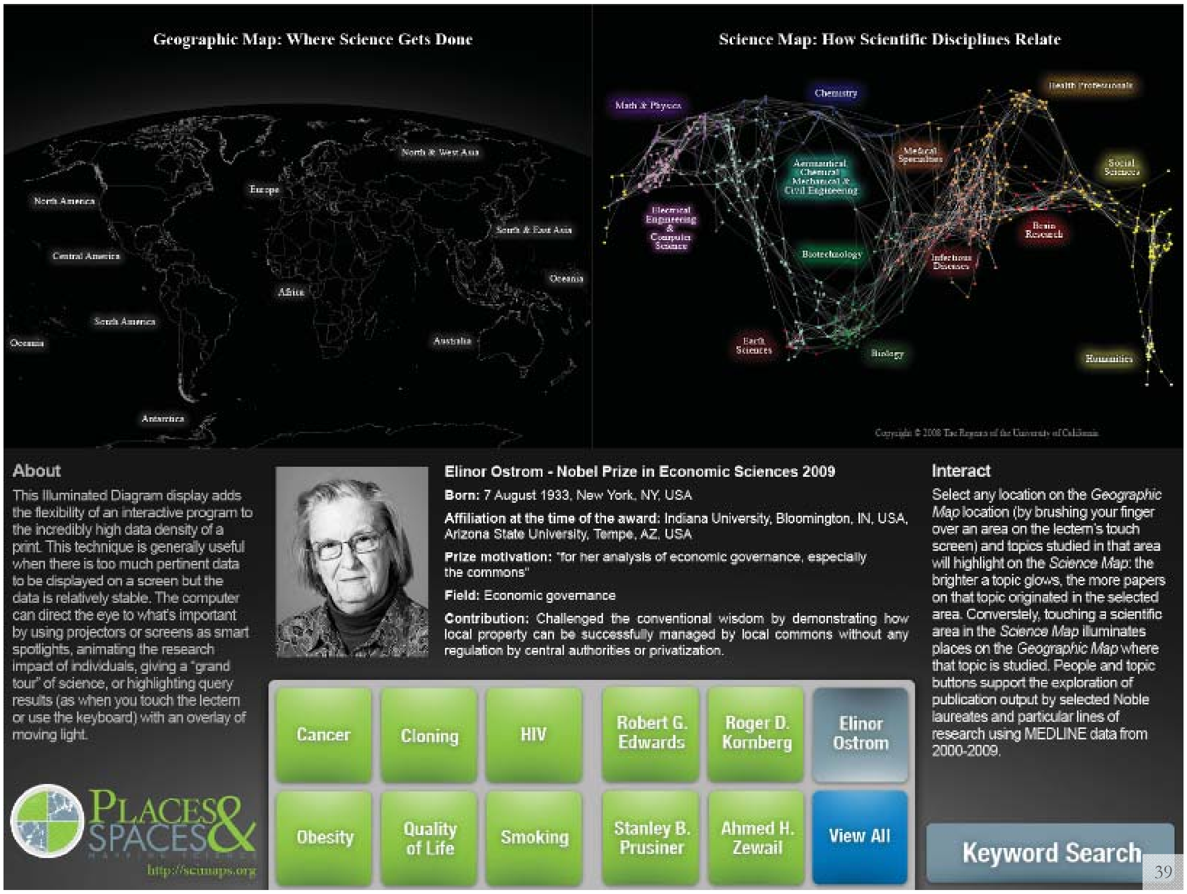


http://scimaps.org/iteration/11

Illuminated Diagram Display
on display at the Smithsonian in DC.
http://scimaps.org/exhibit_info/#ID




Geographic Map: Where Science Gets Done
Science Map: How Scientific Disciplines Relate
North America
Europe
North & West Asia
Central America
South & East Asia
Africa
Oceania
South America
Australia
Antarctica
Math & Physics
Chemistry
Health Professionals
Electrical Engineering & Computer Science
Biotechnology
Social Sciences
Brain Research
Infectious Diseases
Earth Sciences
Biology
Humanities
About
This Illuminated Diagram display adds the flexibility of an interactive program to the incredibly high data density of a print. This technique is generally useful when there is too much pertinent data to be displayed on a screen but the data is relatively stable. The computer can direct the eye to what's important by using projectors or screens as smart spotlights, animating the research impact of individuals, giving a "grand tour" of science, or highlighting query results (as when you touch the lectern or use the keyboard) with an overlay of moving light.
Elinor Ostrom - Nobel Prize in Economic Sciences 2009
Born: 7 August 1933, New York, NY, USA
Affiliation at the time of the award: Indiana University, Bloomington, IN, USA, Arizona State University, Tempe, AZ, USA
Prize motivation: "for her analysis of economic governance, especially the commons"
Field: Economic governance
Contribution: Challenged the conventional wisdom by demonstrating how local property can be successfully managed by local commons without any regulation by central authorities or privatization.
Interact
Select any location on the Geographic Map location (by brushing your finger over an area on the lectern's touch screen) and topics studied in that area will highlight on the Science Map: the brighter a topic glows, the more papers on that topic originated in the selected area. Conversely, touching a scientific area in the Science Map illuminates places on the Geographic Map where that topic is studied. People and topic buttons support the exploration of publication output by selected Noble laureates and particular lines of research using MEDLINE data from 2000-2009.
Cancer
Cloning
HIV
Robert G. Edwards
Roger D. Kornberg
Elinor Ostrom
Obesity
Quality of Life
Smoking
Stanley B. Prusiner
Ahmed H. Zewail
View All
Keyword Search
PLACES & SPACES
http://scimaps.org
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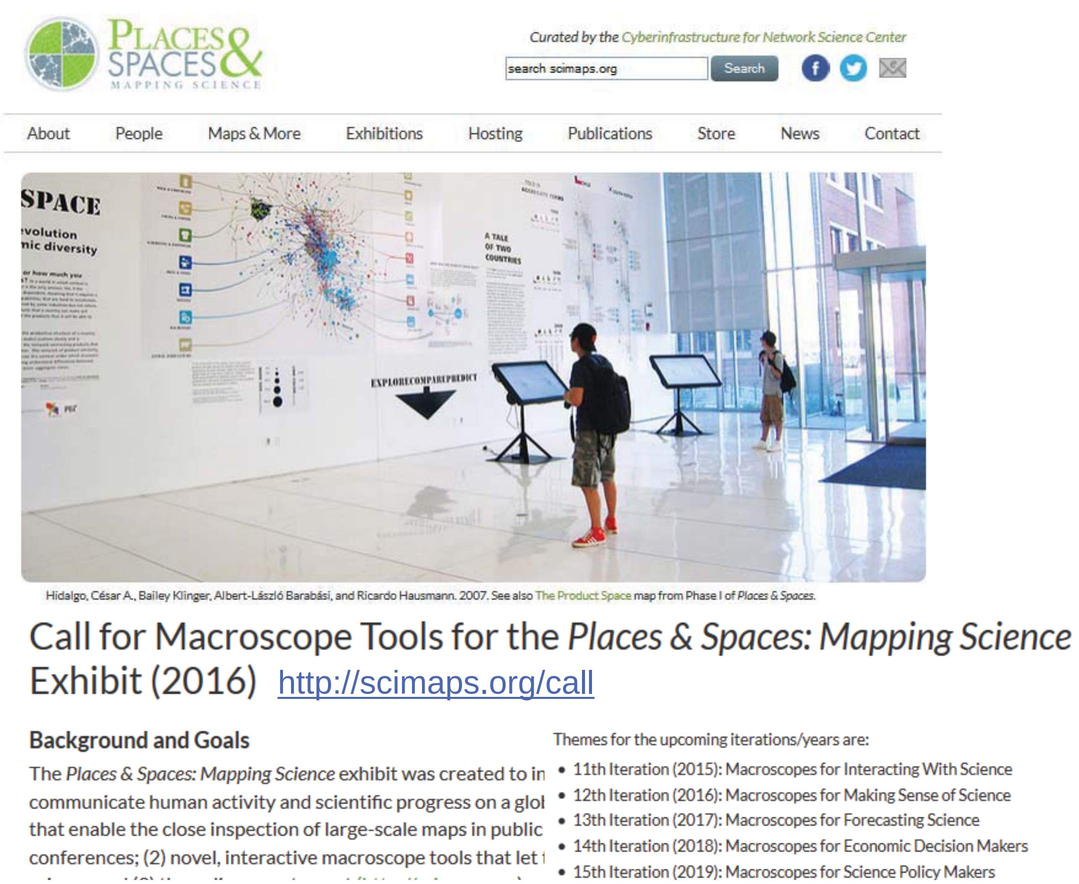
PLACES & SPACES
MAPPING SCIENCE
Curated by the Cyberinfrastructure for Network Science Center
search scimaps.org
Search
About
People
Maps & More
Exhibitions
Hosting
Publications
Store
News
Contact
Hidalgo, César A., Bailey Klinger, Albert-László Barabási, and Ricardo Hausmann. 2007. See also The Product Space map from Phase I of Places & Spaces.
Call for Macroscope Tools for the Places & Spaces: Mapping Science Exhibit (2016) http://scimaps.org/call
Background and Goals
The Places & Spaces: Mapping Science exhibit was created to in
communicate human activity and scientific progress on a glol
that enable the close inspection of large-scale maps in public
conferences; (2) novel, interactive macroscope tools that let t
Themes for the upcoming iterations/years are:
11th Iteration (2015): Macroscopes for Interacting With Science
12th Iteration (2016): Macroscopes for Making Sense of Science
13th Iteration (2017): Macroscopes for Forecasting Science
14th Iteration (2018): Macroscopes for Economic Decision Makers
15th Iteration (2019): Macroscopes for Science Policy Makers

References

Börner, Katy, Chen, Chaomei, and Boyack, Kevin. (2003). **Visualizing Knowledge Domains.** In Blaise Cronin (Ed.), *ARIST*, Medford, NJ: Information Today, Volume 37, Chapter 5, pp. 179-255. http://ivl.slis.indiana.edu/km/pub/2003-borner-arist.pdf

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/

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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.

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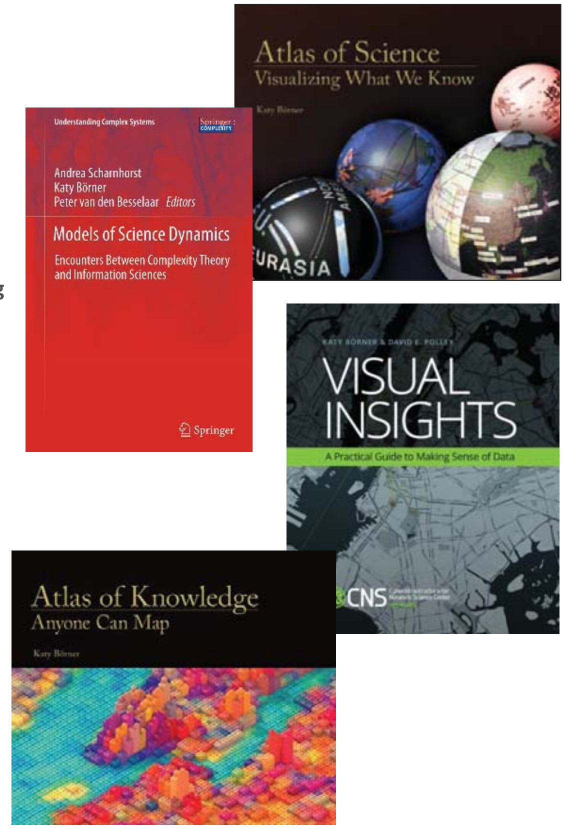

All papers, maps, tools, talks, press are linked from http://cns.iu.edu
These slides are at http://cns.iu.edu/docs/presentations

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