

Human BioMolecular Atlas: Maps and Macroscopes

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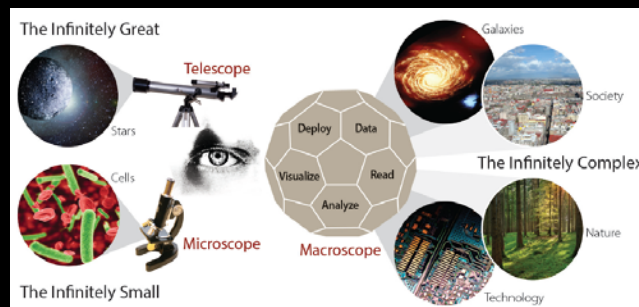
School of Informatics and Computing and Indiana University Network Science Institute

Indiana University, USA

Identifying Key Areas in a Human BioMolecular Atlas NIH Common Fund Planning WS

NIH Campus, Natcher Conference Center, Room D

June 15, 2016

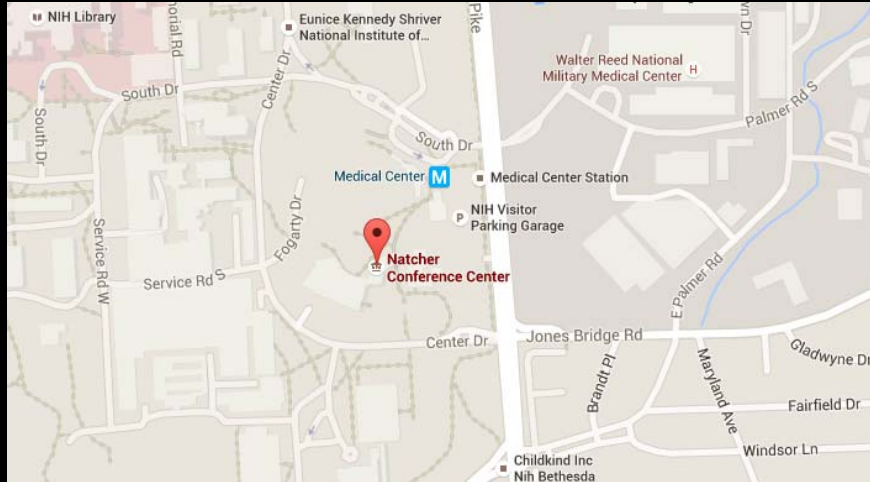


Basic Approach

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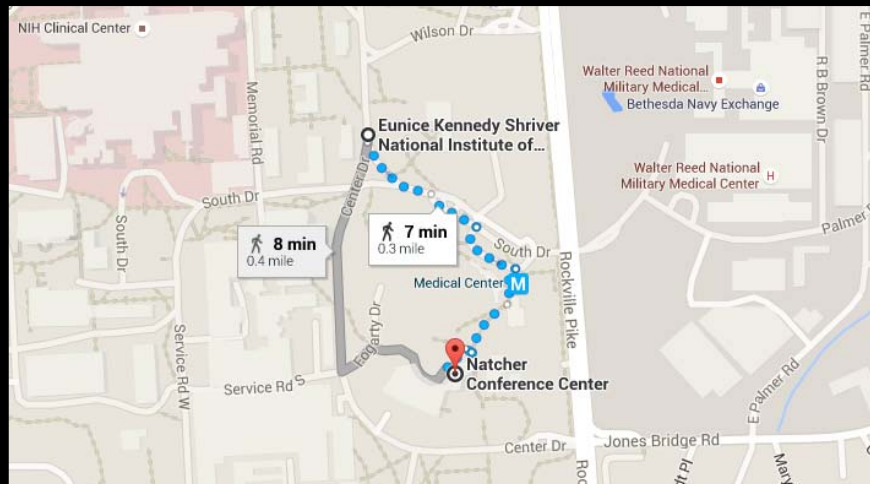
Basic Questions

Basemap vs. Data Overlay



Google map of current geolocation

Different Types of Data Overlays



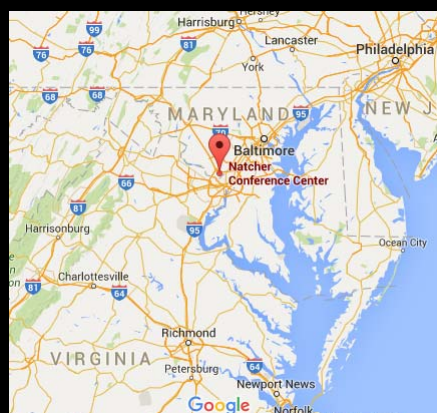
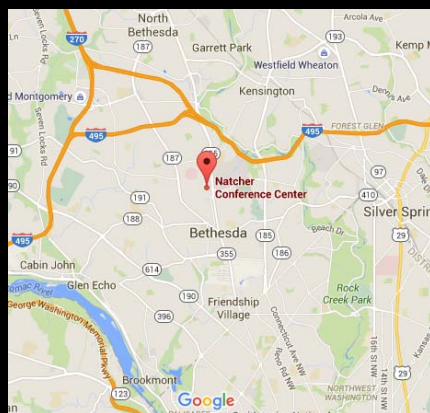
Path from current geolocation to Eunice Kennedy Shriver

Mapping Data

&

Interacting with Data

Multi-level: Micro to macro



Aim for constant information density.

Multi-resolution: Focus and context



By Fernando Vicente



Level of abstraction



By Fernando Vicente



Bodyworlds by Gunther von Hagens

Projections



Dymaxion Map by B. Fuller

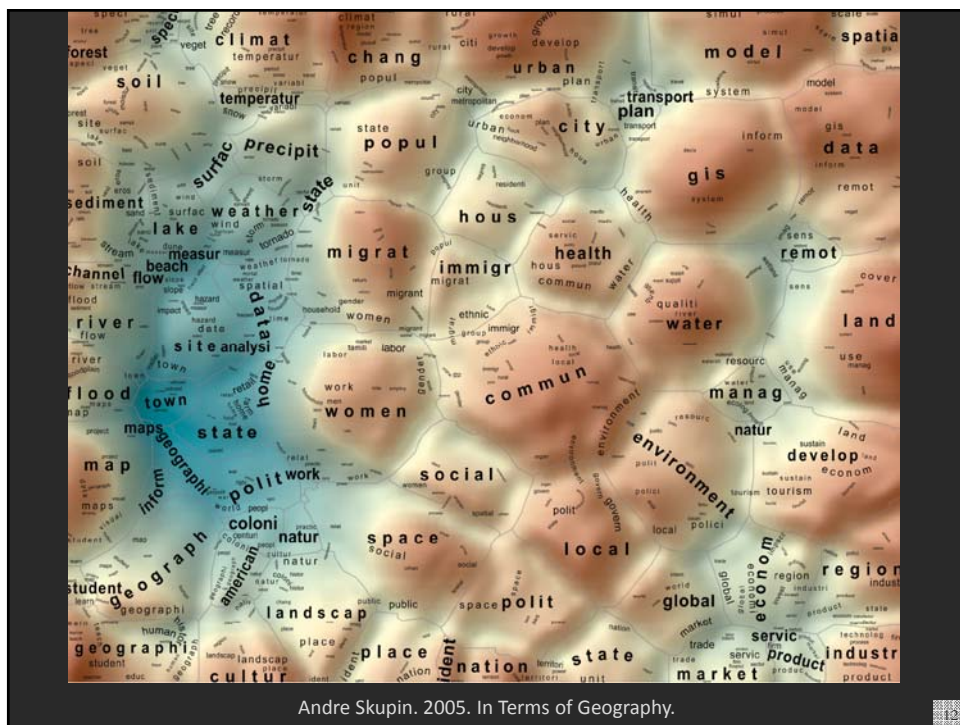
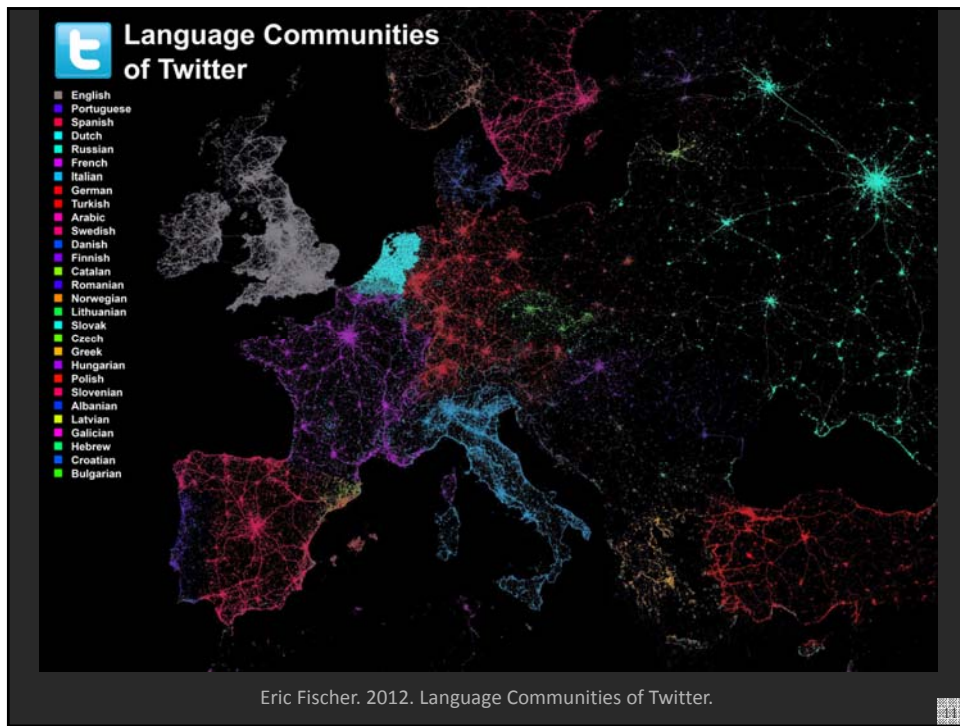


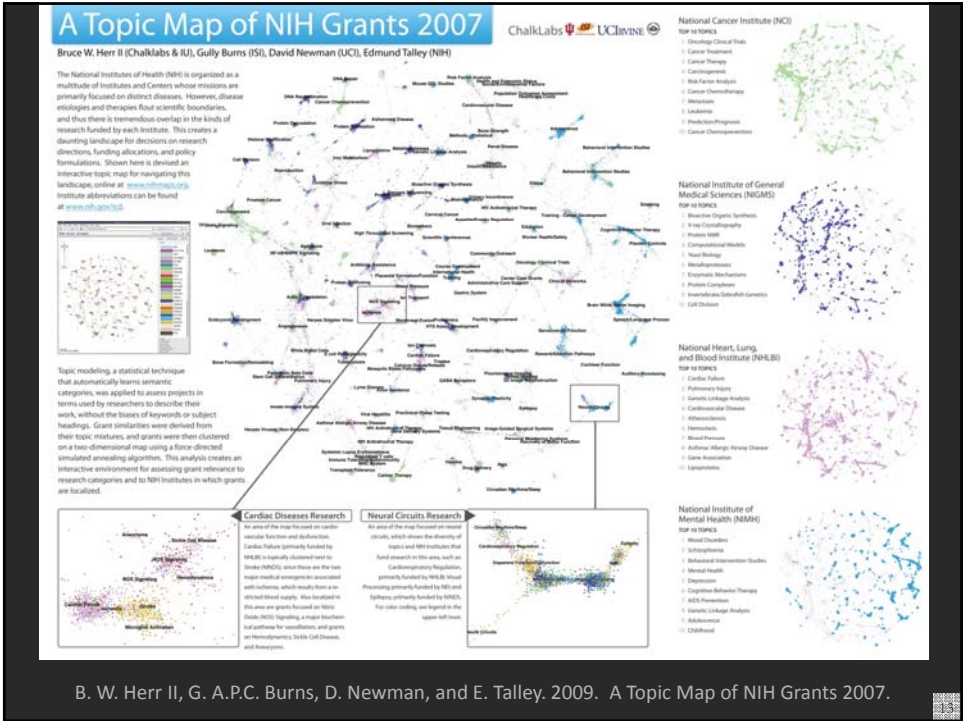
Bodyworlds by Gunther von Hagens

Seeing Patterns and Trends

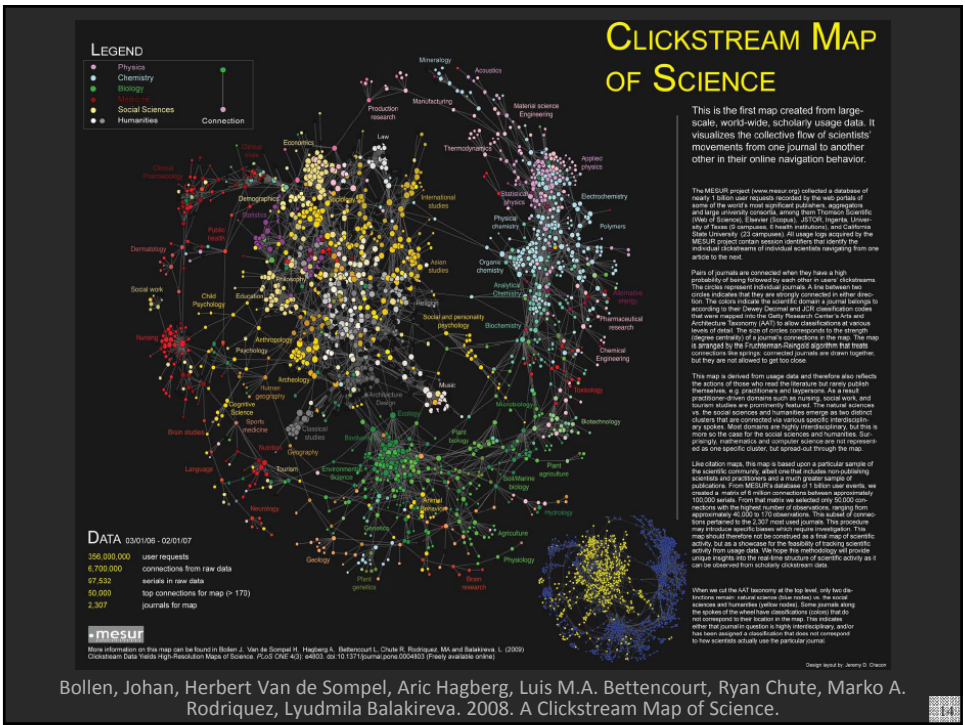
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Connecting Experts

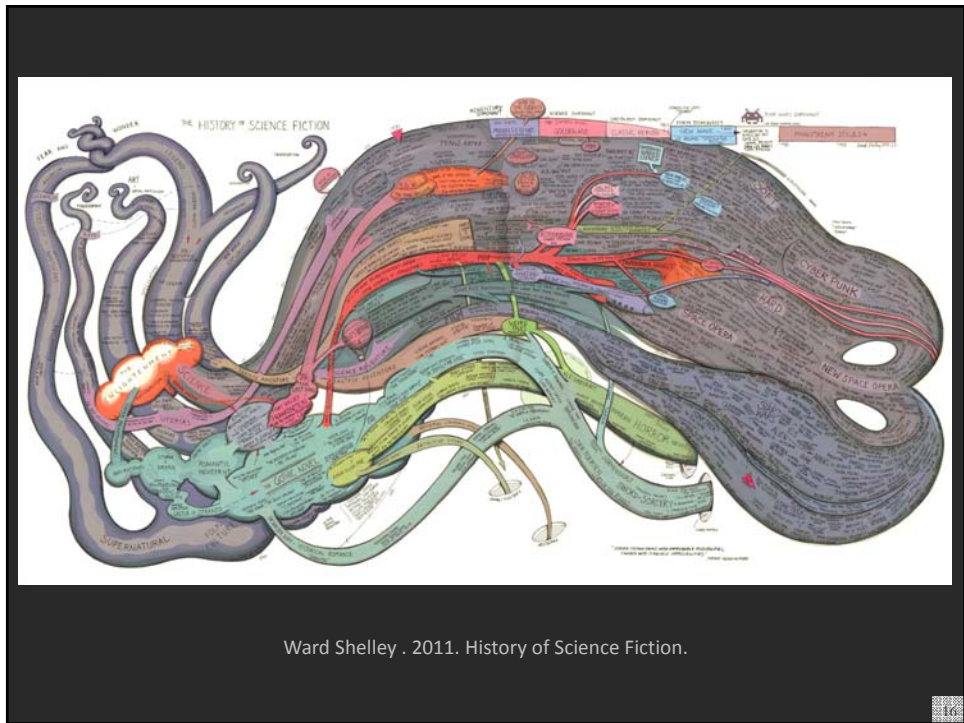
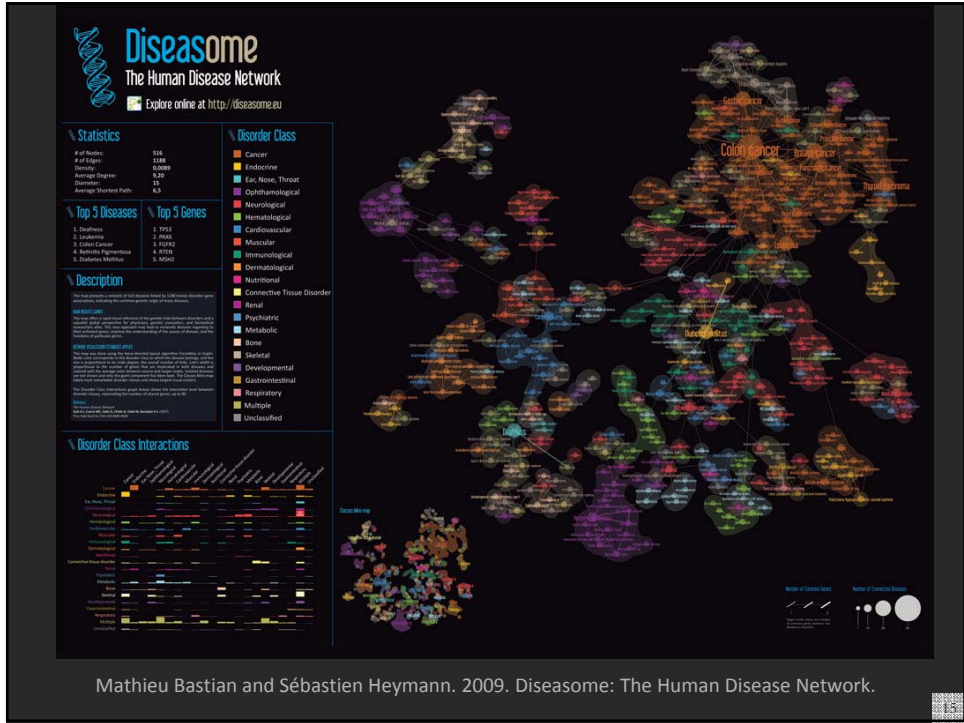




B. W. Herr II, G. A.P.C. Burns, D. Newman, and E. Talley. 2009. A Topic Map of NIH Grants 2007.



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



Visualization Design

&

Interactivity Design

Different Question Types



Terabytes of data

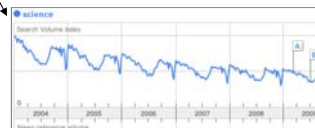
Descriptive &
Predictive
Models



Find your way



Find collaborators, friends



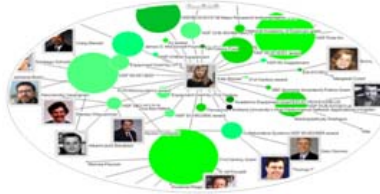
Identify trends

Different Levels of Abstraction/Analysis

Macro/Global
Population Level



Meso/Local
Group Level



Micro
Individual Level

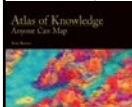


Tasks

LEVELS

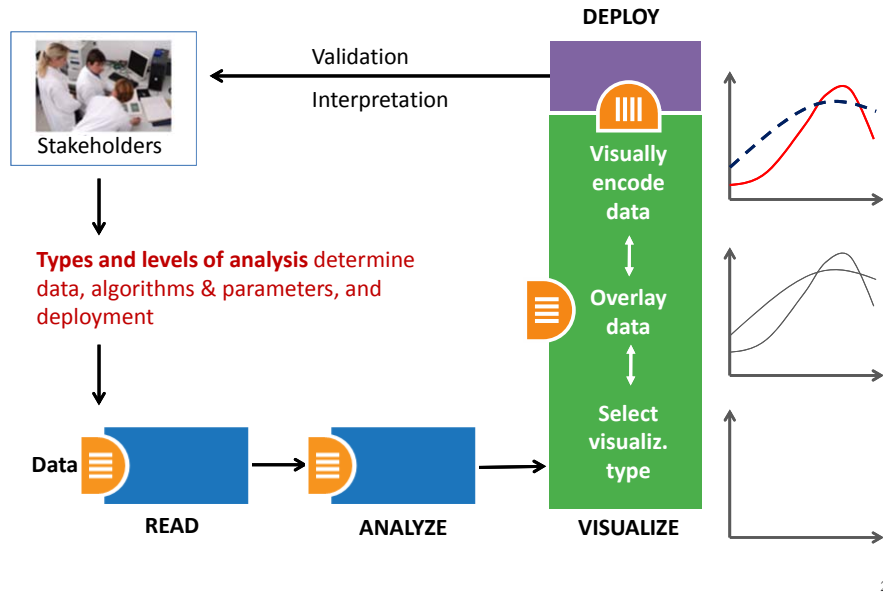
TYPES

	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			
WHEN: Temporal Analysis page 48			
WHERE: Geospatial Analysis page 52			
WHAT: Topical Analysis page 56			
WITH WHOM: Network Analysis page 60			



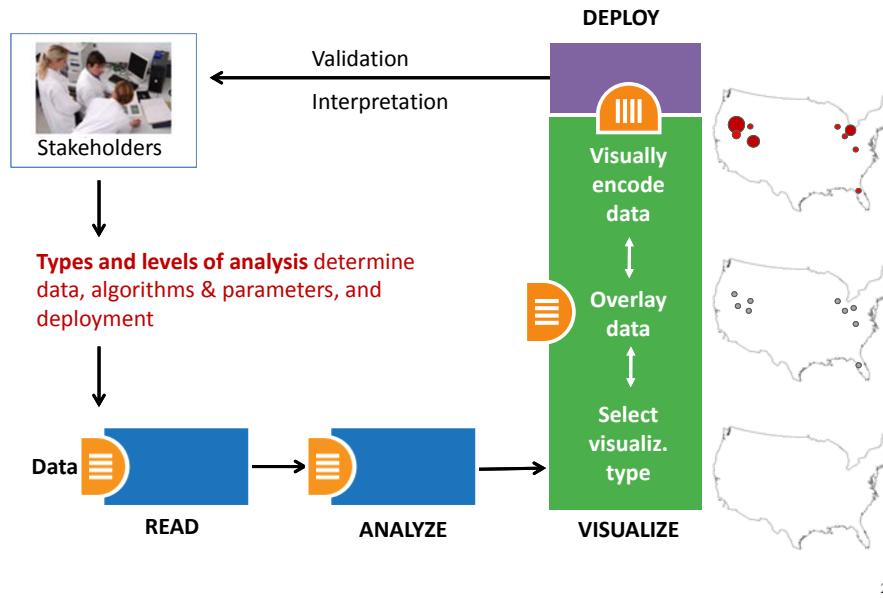
See page 5

Needs-Driven Workflow Design



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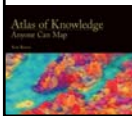
Needs-Driven Workflow Design



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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
<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"> point line area surface volume linguistic symbols <ul style="list-style-type: none"> text numerals punctuation marks pictorial symbols <ul style="list-style-type: none"> images icons statistical glyphs 	<ul style="list-style-type: none"> spatial <ul style="list-style-type: none"> position retinal <ul style="list-style-type: none"> form color optics motion 	<ul style="list-style-type: none"> overview zoom search and locate filter details-on-demand history extract link and brush projection distortion



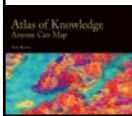
See page 24

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

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"> • point • line • area • surface • volume • linguistic symbols <ul style="list-style-type: none"> • text • numerals • punctuation marks • pictorial symbols <ul style="list-style-type: none"> • images • icons • statistical glyphs 	<ul style="list-style-type: none"> • spatial <ul style="list-style-type: none"> • position • retinal <ul style="list-style-type: none"> • form • color • optics • motion 	<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

Graphic Variable Types Versus Graphic Symbol Types

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

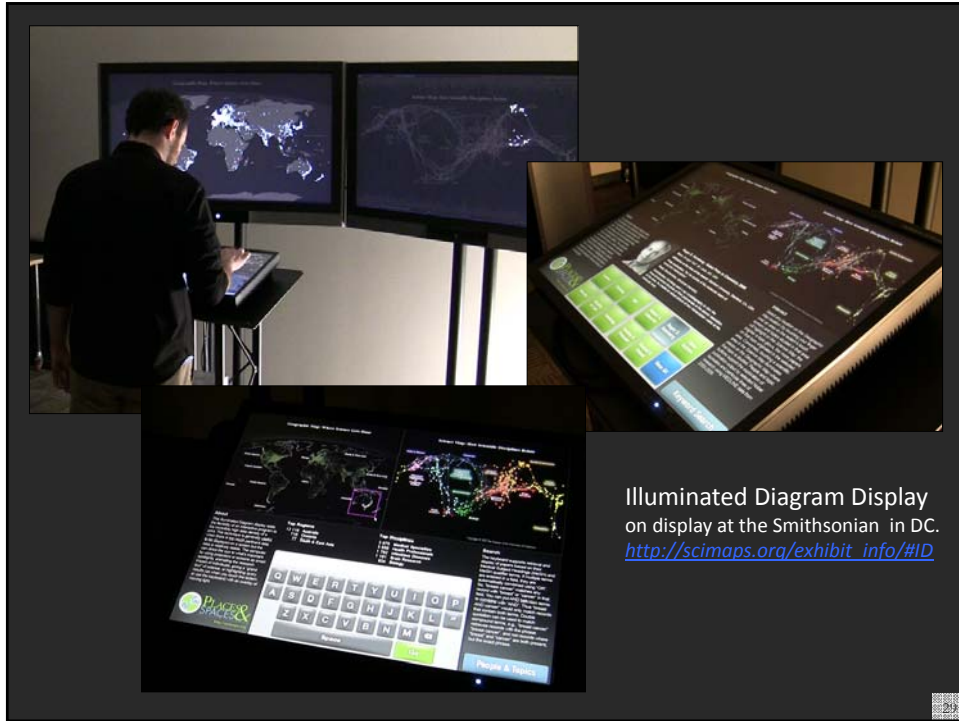
Graphic Variable Types Versus Graphic Symbol Types

		Geometric Symbols				Alphabetic Symbols				Pictorial Symbols			
		point	line	area	surface	volume	text, Network, Punctuation Marks	text, Network, Punctuation Marks	text, Network, Punctuation Marks	text, Network, Punctuation Marks	text, Network, Punctuation Marks	text, Network, Punctuation Marks	text, Network, Punctuation Marks
FORM	size												
	shape												
	orientation												
	angle												
	closure												
COLOR	hue												
	saturation												
	value												
	transparency												
	texture												
TEXTURE	spacing												
	consistency												
	repetition												
	direction												
	size												
MOTION	temporality												
	velocity												
	acceleration												
	directionality												
	visibility												

IVMOOC 2016
MENU

Information Visualization MOOC
ivmooc.cns.iu.edu

Register for free: <http://ivmooc.cns.iu.edu>.



Geographic Map: Where Science Gets Done

North America, Europe, North & East Asia, South & East Asia, Oceania, South America, Africa, Australia, Americas

Science Map: How Scientific Disciplines Relate

Math & Physics, Chemistry, Health Professions, Social Sciences, Medicine, Agricultural, Chemical, Mechanical & Civil Engineering, Electrical Engineering & Computer Science, Biotechnology, Infectious Diseases, Brain Research, Earth Sciences, Biology, Humanities

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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.

<http://scimaps.org>

Top Five Continents

- North America - 4,000 records
- South & East Asia - 3,589
- Australia - 2,421
- Africa - 2,208
- South America - 1,562

Top Five Scientific Disciplines

- Math & Physics - 4,000 records
- Health Professions - 3,589
- Social Sciences - 2,431
- Aeronautical, Chemical, Mechanical & Civil Engineering - 2,208
- Humanities - 1,562

Input your search query here

Space Go

Search

The keyboard supports retrieval and display of papers based on their Medical Subject Headings (MeSH) and MeSH qualifier terms. If multiple terms are entered in a field, they are automatically combined using "OR". So, "breast cancer" matches any record with "breast" or "cancer" in that field. You can put AND between terms to combine with "AND". Thus "breast AND cancer" would only match records that contain both terms. Double quotation can be used to match compound terms, e.g., "breast cancer" retrieves records with the phrase "breast cancer", and not records where "breast" and "cancer" are both present, but the exact phrase.

People & Topics

Geographic Map: Where Science Gets Done

Science Map: How Scientific Disciplines Relate

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.

Cancer	Cloning	HIV	Robert G. Edwards	Roger D. Kornberg	Elinor Ostrom
Obesity	Quality of Life	Smoking	Stanley B. Prusiner	Ahmed H. Zewail	View All

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.

<http://scimaps.org>

Keyword Search


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

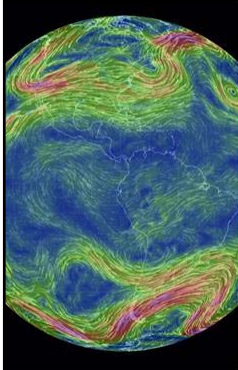
CDC Opening Event: Maps of Health Tutorial and Symposium

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① **MACROSCOPES FOR INTERACTING WITH SCIENCE**







Earth



AcademyScope



Mapping Global Society




Charting Culture


<http://scimaps.org/iteration/11>

Microscopes, Telescopes, Macroscopes Plug-and-Play Macroscopes


The Infinitely Great



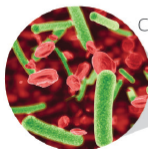
Telescope



Stars




Microscope




Cells

The Infinitely Small




Macroscope

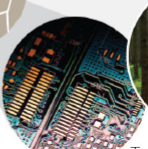
The Infinitely Complex




Galaxies



Society



Technology



Nature


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PLACES & SPACES
MAPPING SCIENCE

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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 Macroscopic 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

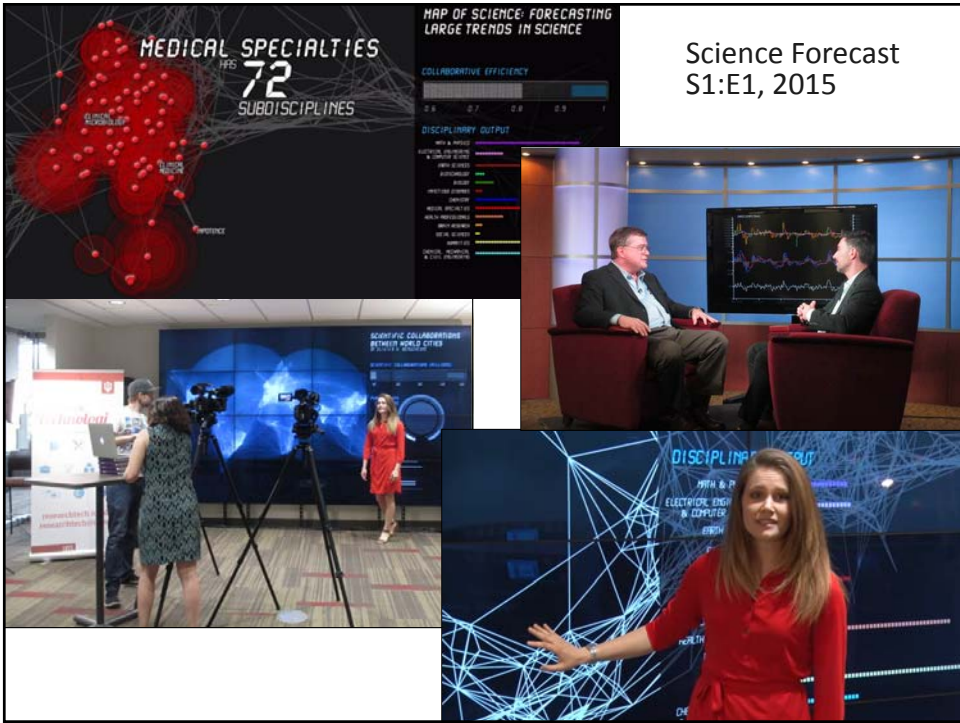
communicate human activity and scientific progress on a globe that enable the close inspection of large-scale maps in public conferences; (2) novel, interactive macroscopic tools that let

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

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Science Forecast S1:E1, 2015



MAP OF SCIENCE: FORECASTING LARGE TRENDS IN SCIENCE

COLLABORATIVE EFFICIENCY

DISCIPLINARY OUTPUT

SCIENTIFIC COLLABORATIONS BETWEEN WORLD CITIES

DISCIPLINARY OUTPUT

WITH & P

ELECTRONIC ENERGY

COMPUTER

ENERGY

PERFORM

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>



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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>

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

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

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