

Actionable Data Visualizations

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2018 Humboldt Fellow, TU Dresden, Germany

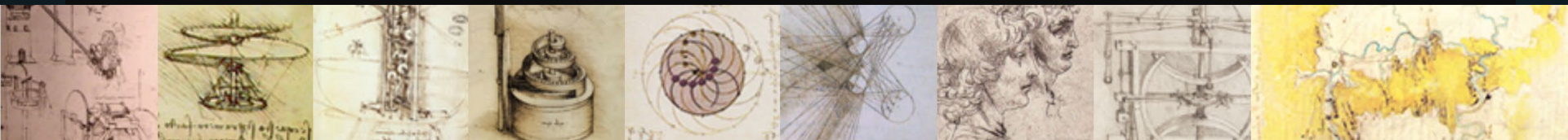


Data Science Meets Social Science

(formerly presented at The European Summer University in Digital Humanities, July 17, 2018)

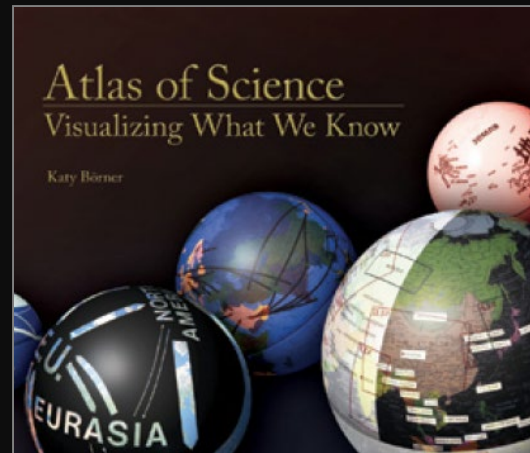
Social Science Research Commons (SSRC), IUB

September 27, 2018



Maps of Science & Technology

Using large scale datasets, advanced data mining and visualization techniques, and substantial computing resources.



Maps of Science & Technology

<http://scimaps.org>



101st Annual Meeting of the Association of American Geographers, Denver, CO.
April 5th - 9th, 2005 (First showing of Places & Spaces)



University of Miami, Miami, FL.
September 4 - December 11, 2014.



Duke University, Durham, NC.
January 12 - April 10, 2015



The David J. Sencer CDC Museum, Atlanta, GA.
January 25 - June 17, 2016.

100 maps and 12 macrosopes by 215 experts on display at 354 venues in 28 countries.



100 Maps of Science on Display in Hörsaalzentrum (Augustusplatz), Uni Leipzig, July 13-30, 2018



Opening of the
Exhibition is on
7/18, 2018, 18:15



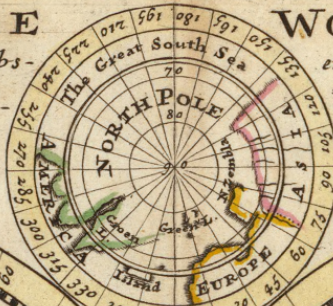
ESU Summer Workshops

- [XML-TEI document encoding, structuring, rendering and transformation](#)
- [Hands on Humanities Data Workshop - Creation, Discovery and Analysis](#)
- [Collocations from a multilingual perspective: theory, tools, and applications](#)
- [Reflected Text Analysis in the Digital Humanities](#)
- [Humanities Data and Mapping Environments](#)
- [Building and analysing multimodal corpora](#)
- [Stylometry](#)
- [Asking questions to data in the humanities: right, correct, efficient \(Introducing and comparing XQuery, SQL, SPARQL for data from the humanities\)](#)
- [Computer Vision Intervention. How digital methods help to visually understand corpora of art and cultural heritage](#)
- [Integrating Human Science Data using CIDOC-CRM as Formal Ontology: a practical approach](#)
- [The humanities scholar's perspective on rule based machine translation](#)
- [Word Vectors and Corpus Text Mining with Python](#)
- [Text Mining with Canonical Text Services](#)
- [How Research Infrastructures empower eHumanities and eHeritage Research\(ers\)](#)
- [Introduction to Project Management](#)

A New Map of the **WHOLE**
According to y^e latest and most Exact Obs-

WORLD with the Trade winds
ervations By H. Moll Geographer

In this Maps is inserted A View of y^e General & Coasting Trade Winds, Monsoons or y^e Shifting Trade winds Note that y^e Arrows among y^e Lines shew y^e Course of those General & Coasting Winds. and y^e Arrows in y^e void Spaces shew y^e Course of y^e Shifting Trade winds, and y^e Abbreviation Sep: &c. Shew y^e Times of y^e Year when such Winds Blow.

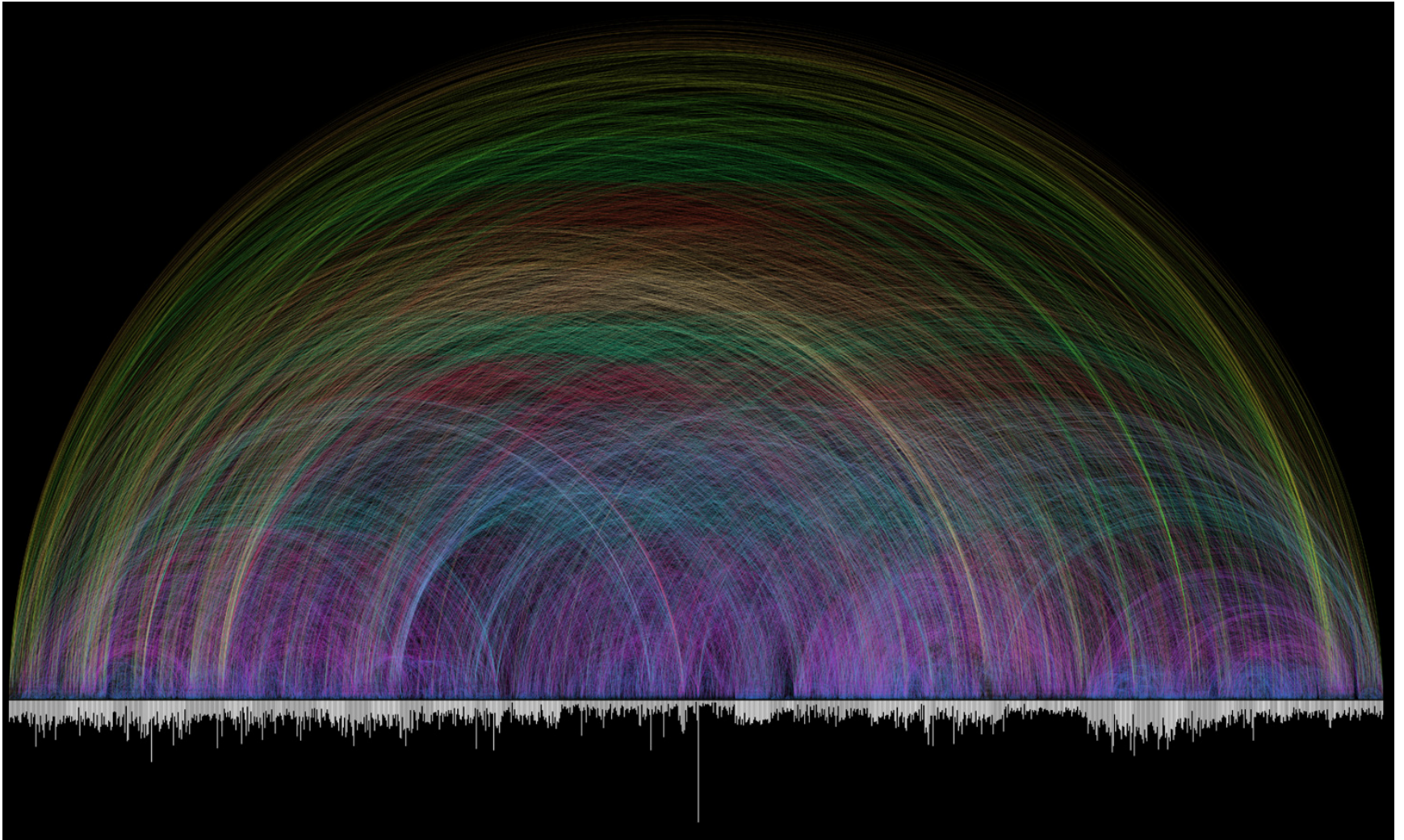


The Signs of the Zodiac. The First 6 are Northern, the other Southern Signs
 ♈ Aries . March
 ♉ Taurus . April
 ♊ Gemini . May
 ♋ Cancer . June
 ♌ Leo . July
 ♍ Virgo . August
 ♎ Libra . September
 ♏ Scorpio . October
 ♐ Sagittarius . November
 ♑ Capricornus . December
 ♒ Aquarius . January
 ♓ Pisces . February



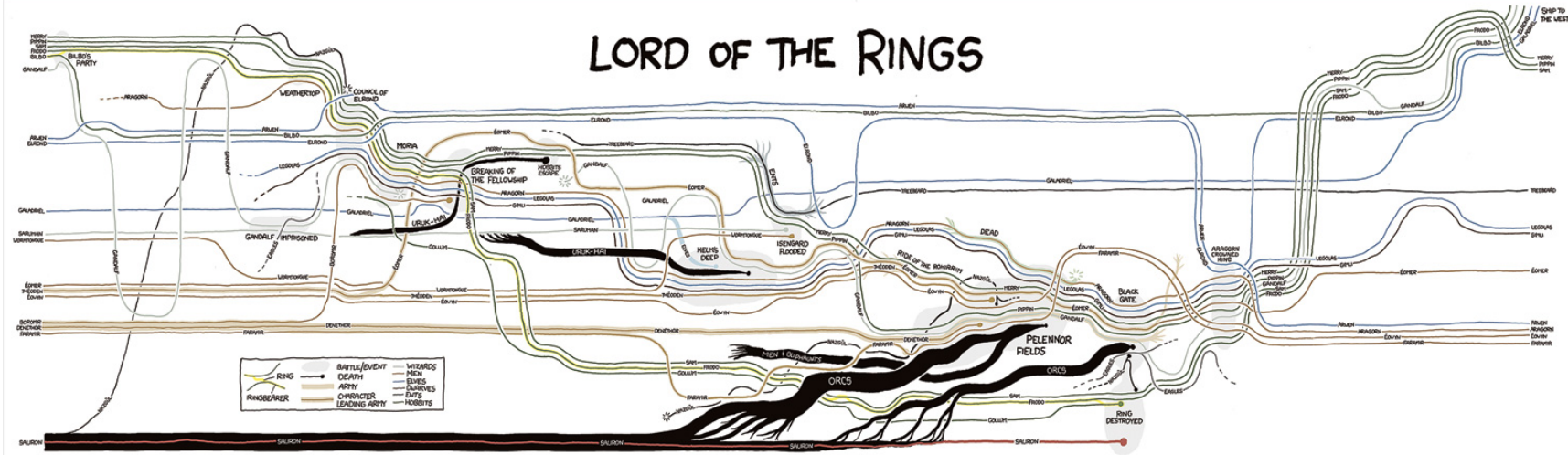
Printed for Tho: Bowles Print and Map Seller next y^e Charter House in S^t. Pauls Church yard; and John Bowles Print and Map Seller at the Black Horse in Cornhill London.

1.3 A New Map of the Whole World with Trade Winds According to the Latest and Most Exact Observations - Herman Moll - 1736

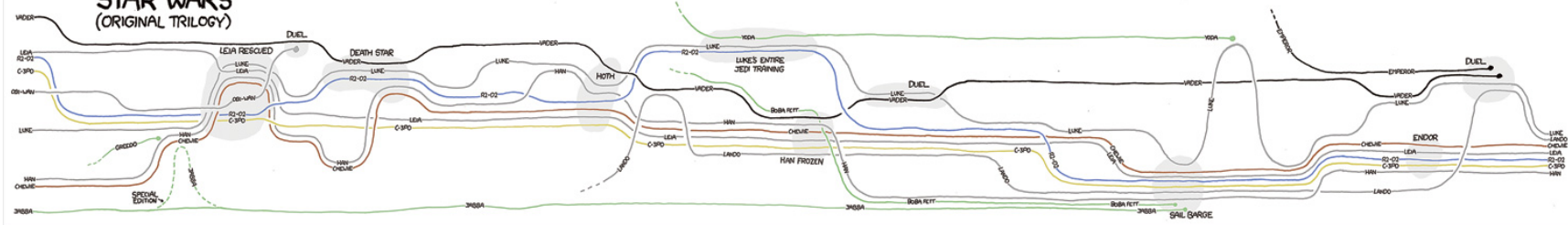


THESE CHARTS SHOW MOVIE CHARACTER INTERACTIONS.
 THE HORIZONTAL AXIS IS TIME. THE VERTICAL GROUPING OF THE
 LINES INDICATES WHICH CHARACTERS ARE TOGETHER AT A GIVEN TIME.

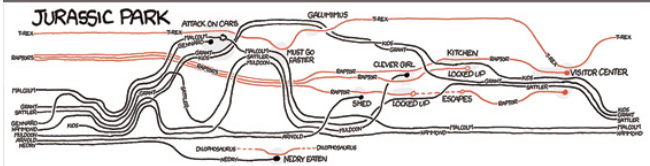
LORD OF THE RINGS



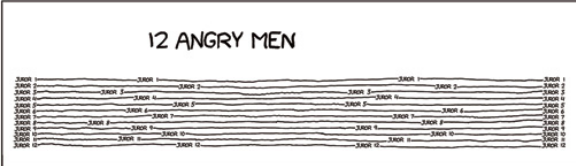
STAR WARS (ORIGINAL TRILOGY)



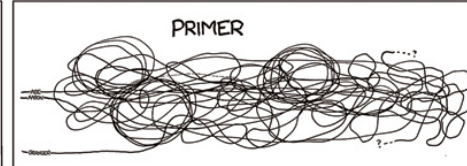
JURASSIC PARK



12 ANGRY MEN



PRIMER

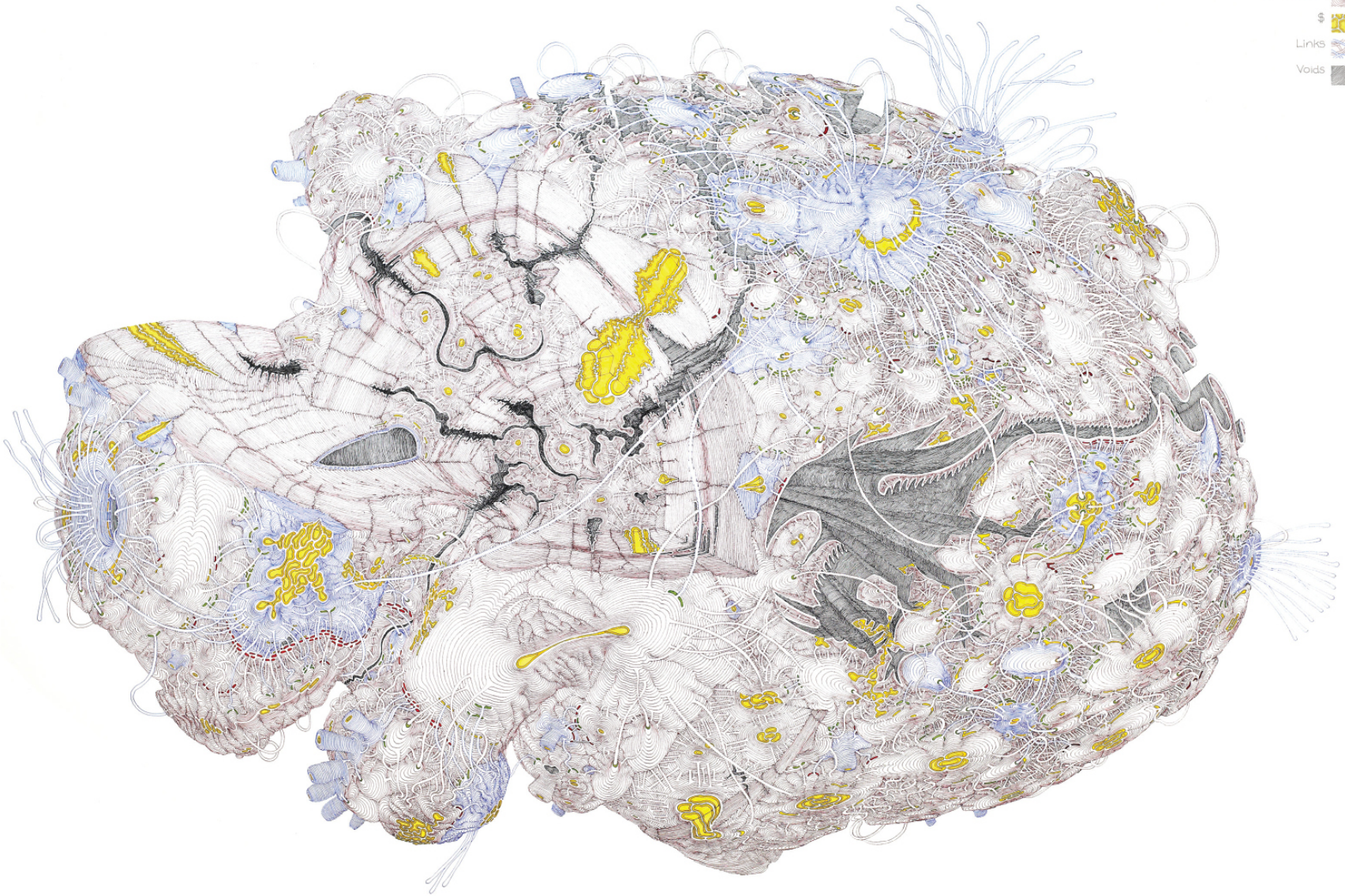


Map of Scientific Collaborations from 2005-2009



Computed Using Data from Elsevier's Scopus

- Emerging
- Established
- Links
- Voids



One of Many Possible Interpretations

Daniel Zeller 2007

Check out our **Zoom Maps** online!

VII.10
History of Science Fiction, by Ward Shelley

BROOKLYN, NY 2011
Courtesy of Ward Shelley Studios

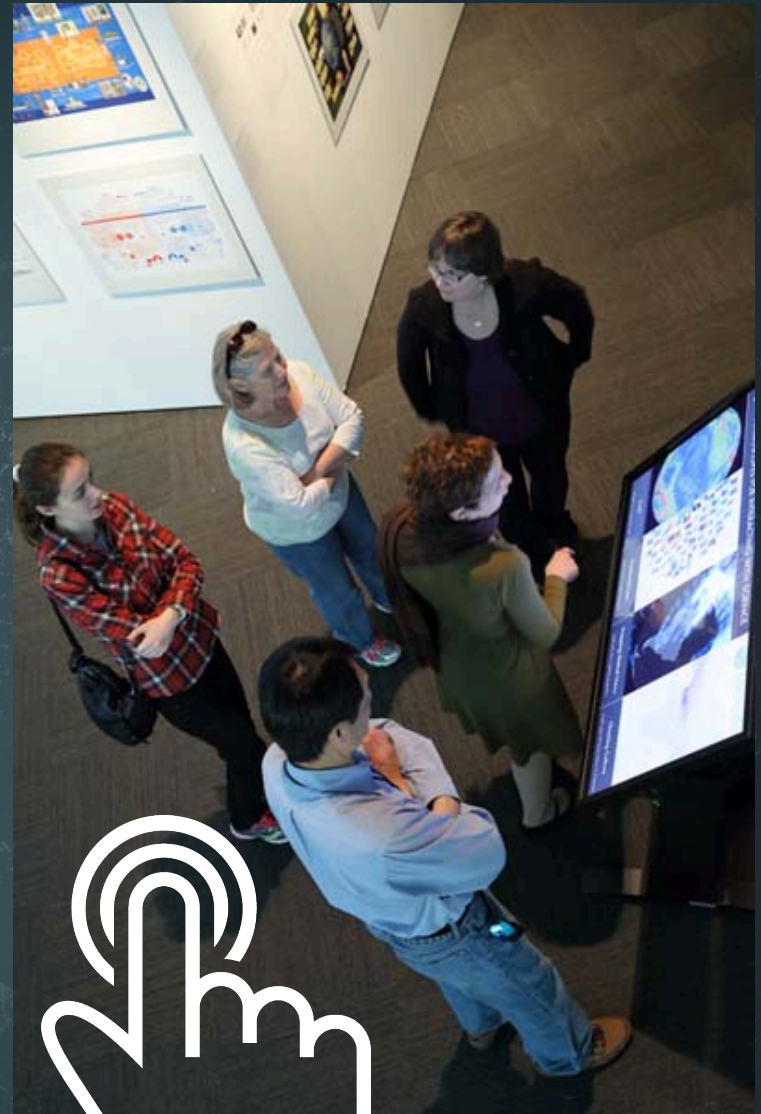
Ward Shelley is an artist identified with the Williamsburg scene in Brooklyn, New York. This map plots the science fiction literary genre from its nascent roots in the 18th century, emerging out of the data, here the narrative structure precedes and organizes the data. The map's structure is like trace roots to pre-historical sources and whose body of work, which birthed gothic fiction, source not only of Sci-Fi, but also of critical theory. The map progressed through a number of distinct periods, which are charted, citing hundreds of authors and works.

PLACES & SPACES
MAPPING STUDIOS
http://scimaps.org

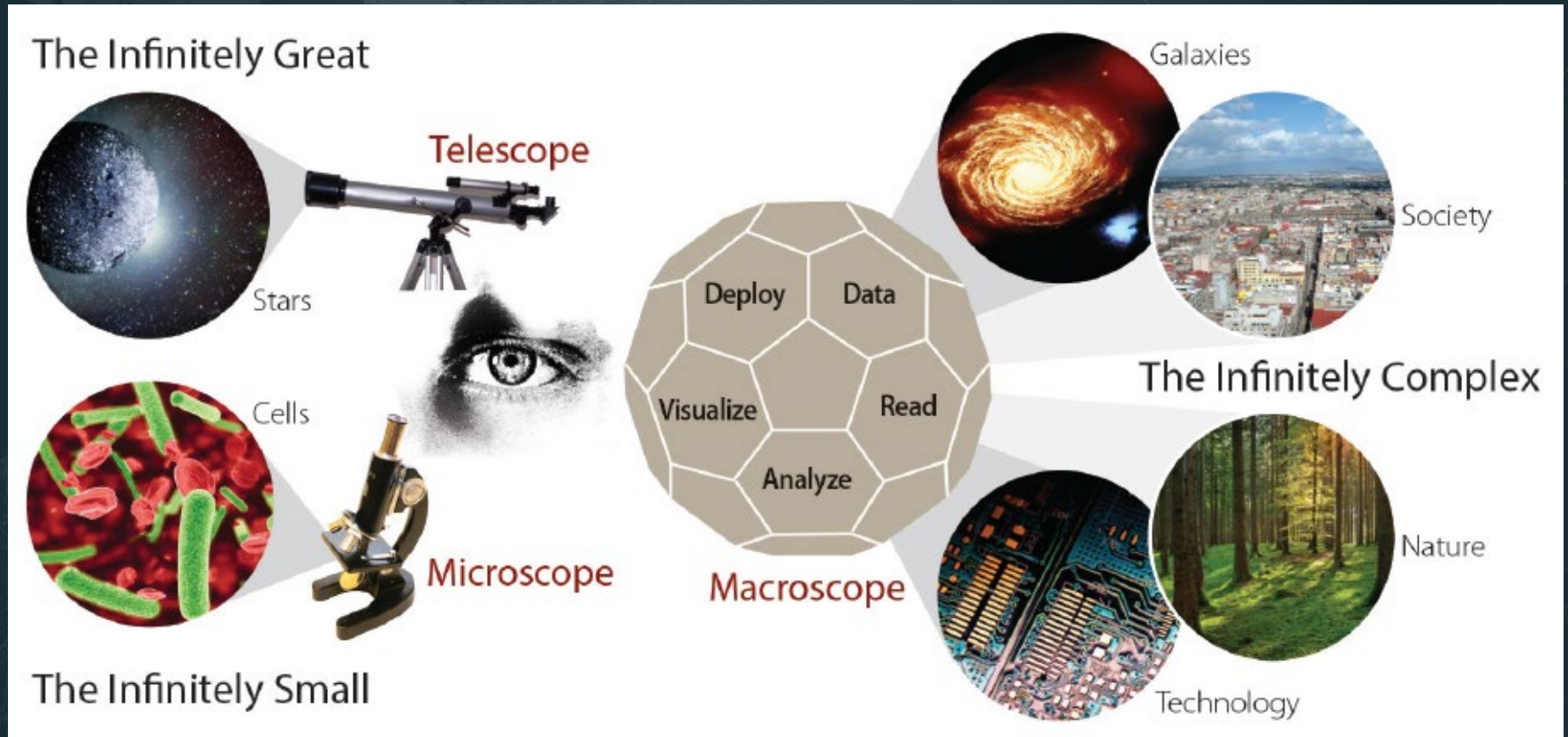
Visit scimaps.org and check out all our maps in stunning detail!



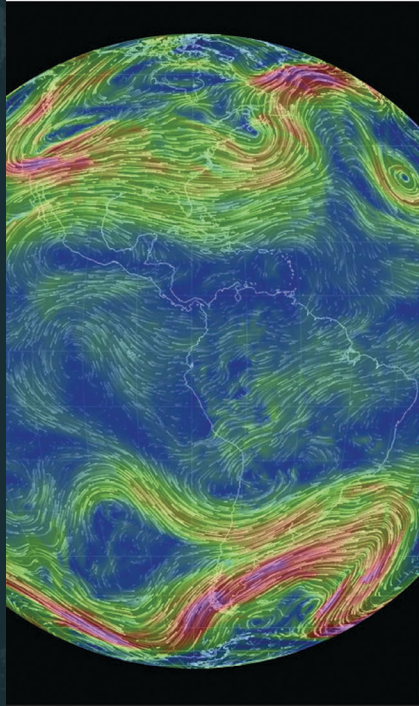
MAPS
vs.
MACROSCOPES



Microscopes & Telescopes vs. MACROSCOPES

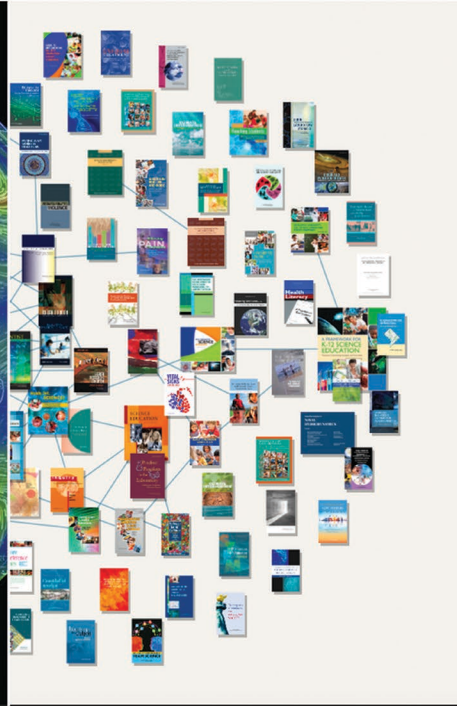


i **MACROSCOPES FOR INTERACTING WITH SCIENCE**



Earth

Weather on a worldwide scale



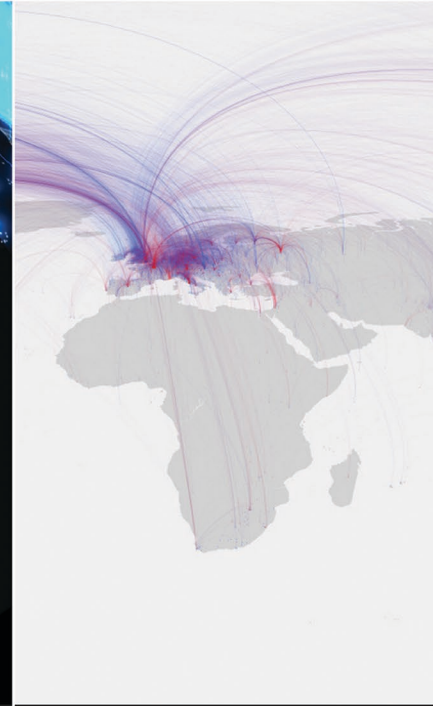
AcademyScope

Exploring the scientific landscape



Mapping Global Society

Local news from a global perspective

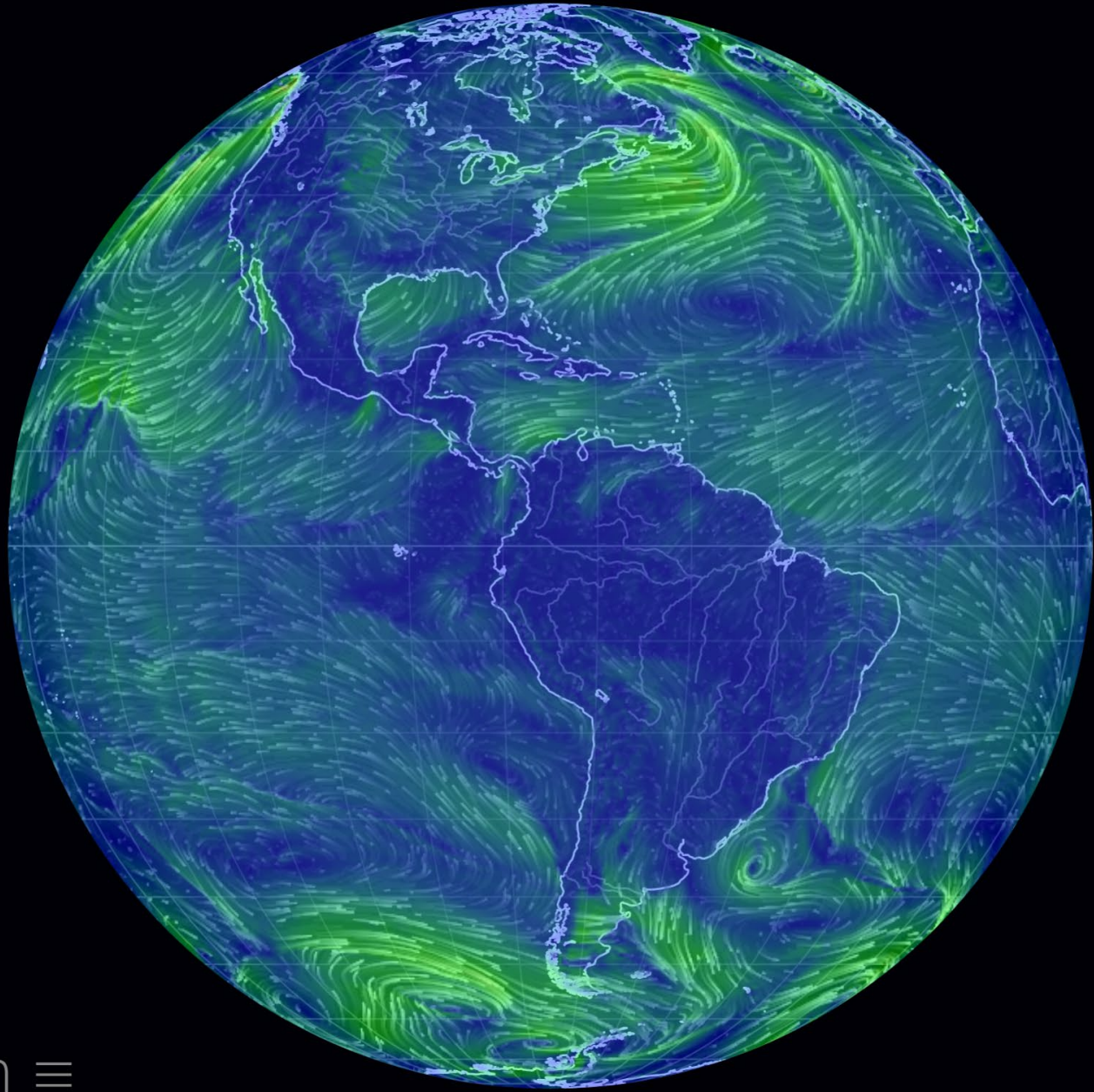


Charting Culture

2,600 years of human history in 5 minutes

Iteration XI (2015): Macroscopes for Interacting with Science

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



earth \equiv

Earth – Cameron Beccario

Top downloads



- Agriculture
- Behavioral and Social Sciences
- Biography and Autobiography
- Biology and Life Sciences
- Computers and Information Technology
- Conflict and Security Issues
- Earth Sciences
- Education
- Energy and Energy Conservation
- Engineering and Technology
- Environment and Environmental Studies
- Explore Science
- Food and Nutrition
- Health and Medicine
- Industry and Labor
- Math, Chemistry and Physics
- Policy for Science and Technology
- Space and Aeronautics
- Transportation

opic=282

The News Co-occurrence Globe

An interactive visualization of how countries are mentioned together in the world's news media

+ - UNITED KINGDOM SEARCH ABOUT



2.92K
COOCCUR%

UNITED KINGDOM cooccurrences in: 2,922%
cooccurrences out: 80%

Timeline navigation: Feb 22, Mar 1, Mar 8, Mar 15, Mar 22, Mar 29, Apr 5, Apr 12, Apr 19, Apr 26, May 3, May 10, May 17, May 24



COOCCUR

IN%

OUT%



Smelly Maps

Charting urban smellscapes



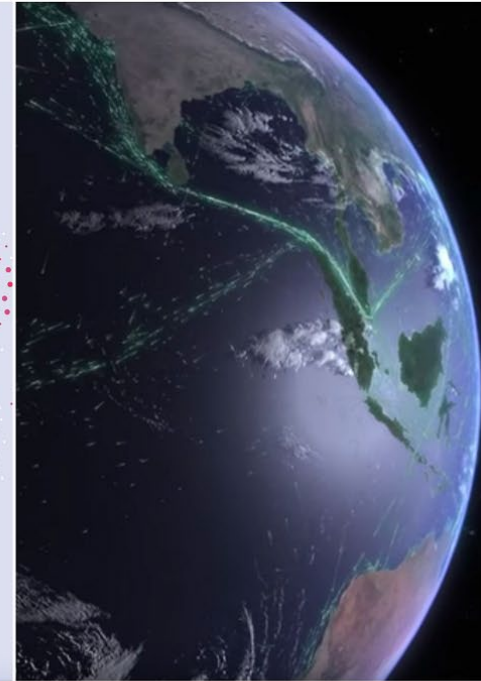
HathiTrust

Storehouse of knowledge



Excellence Networks

Publish or perish together

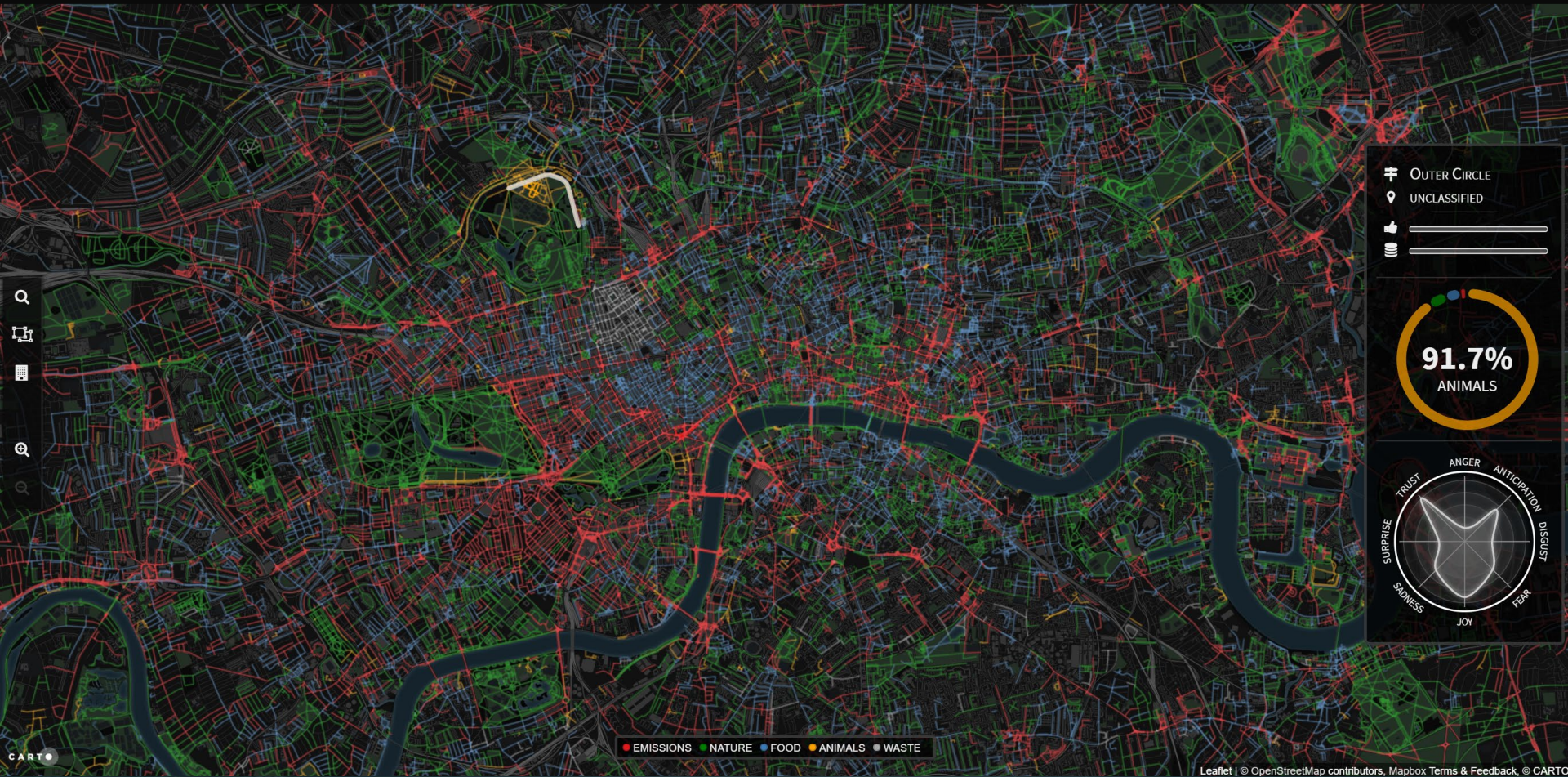


FleetMon Explorer

Tracking the seven seas

Iteration XII (2016): Macrosopes for Making Sense of Science

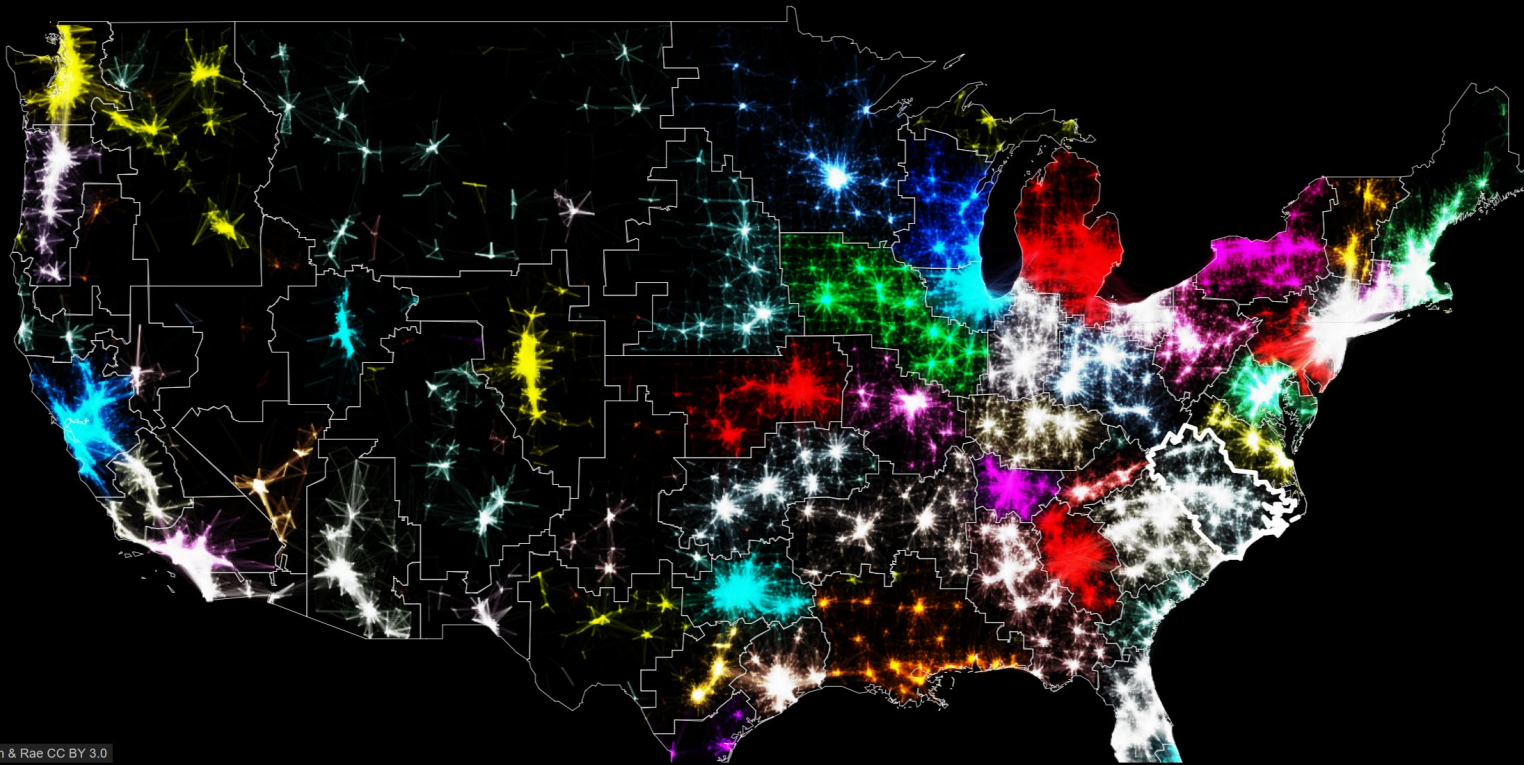
<http://scimaps.org/iteration/12>



Smelly Maps – Daniele Quercia, Rossano Schifanella, and Luca Maria Aiello – 2015

THE MEGAREGIONS OF THE US

Explore the new geography of commuter connections in the US.
Tap to identify regions. Tap and hold to see a single location's commuted.



Leaflet | Nelson & Rae CC BY 3.0



This is the Roanoke (Raleigh) megaregion.

 **FleetMon**
Tracking the Seven Seas



Monday, September 10, 2012

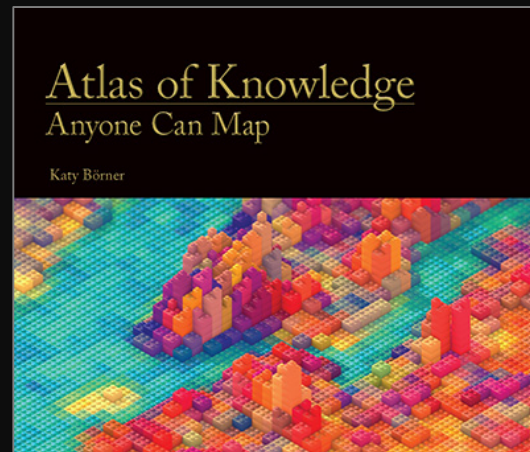
00:08

01:31

FleetMon Explorer – FleetMon – 2012

Making Science & Technology Visualizations

Using a theoretically grounded visualization framework that defines key terminology and processes together with valid workflows and data mappings.





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

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 ?

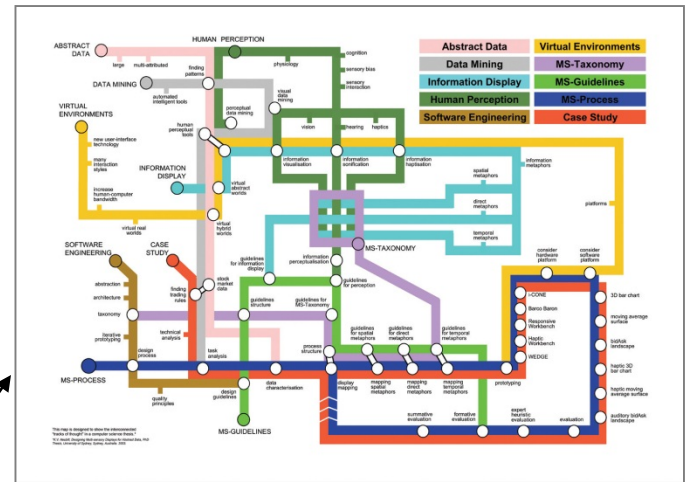


Different Question Types



Terabytes of data

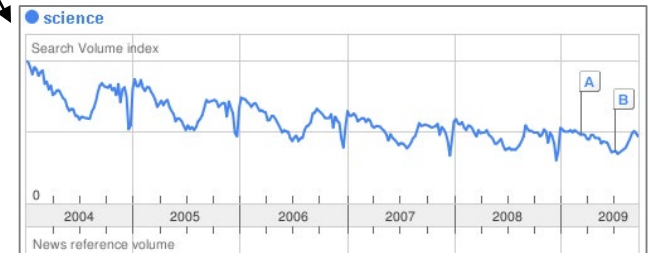
Descriptive & Predictive Models



Find your way



Find collaborators, friends



Identify trends



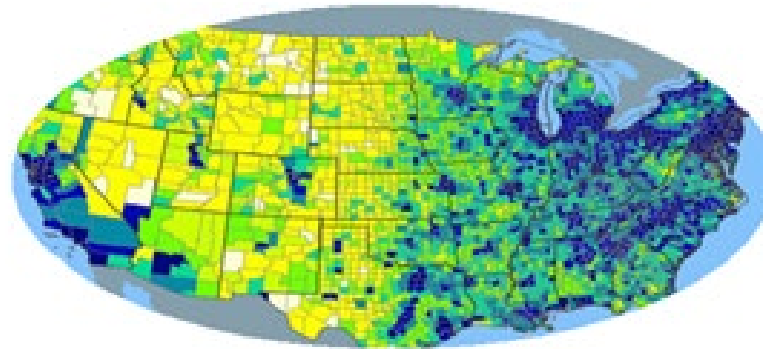
Different Question Types

- Monitor Data Quality
- Customer Complaints
- Customer/Supplier/Learner Churn
- Optimizing Supplier Chains
- Improving (Traffic/Communication) Network Resilience
- Optimizing Traffic/Communication Flows
- Optimizing Work Cells/Built Process
- Workforce Development

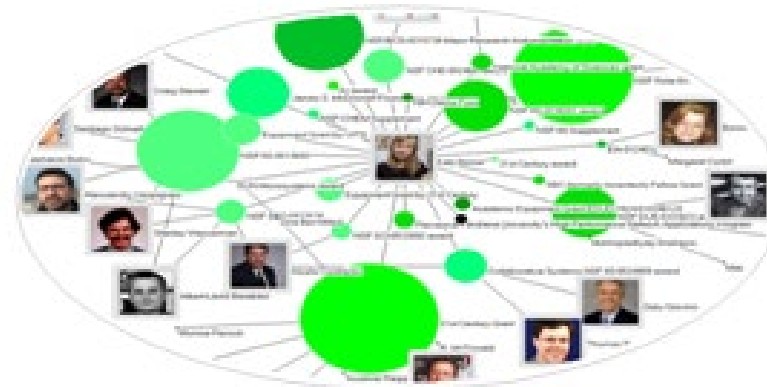
And other **WHEN, WHERE, WHAT, WITH WHOM** questions.

Different Levels of Abstraction/Analysis

Macro/Global
Population Level



Meso/Local
Group Level

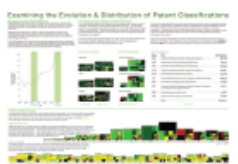




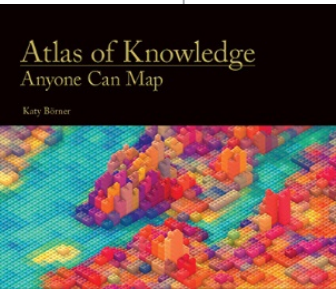
Micro
Individual Level



Tasks

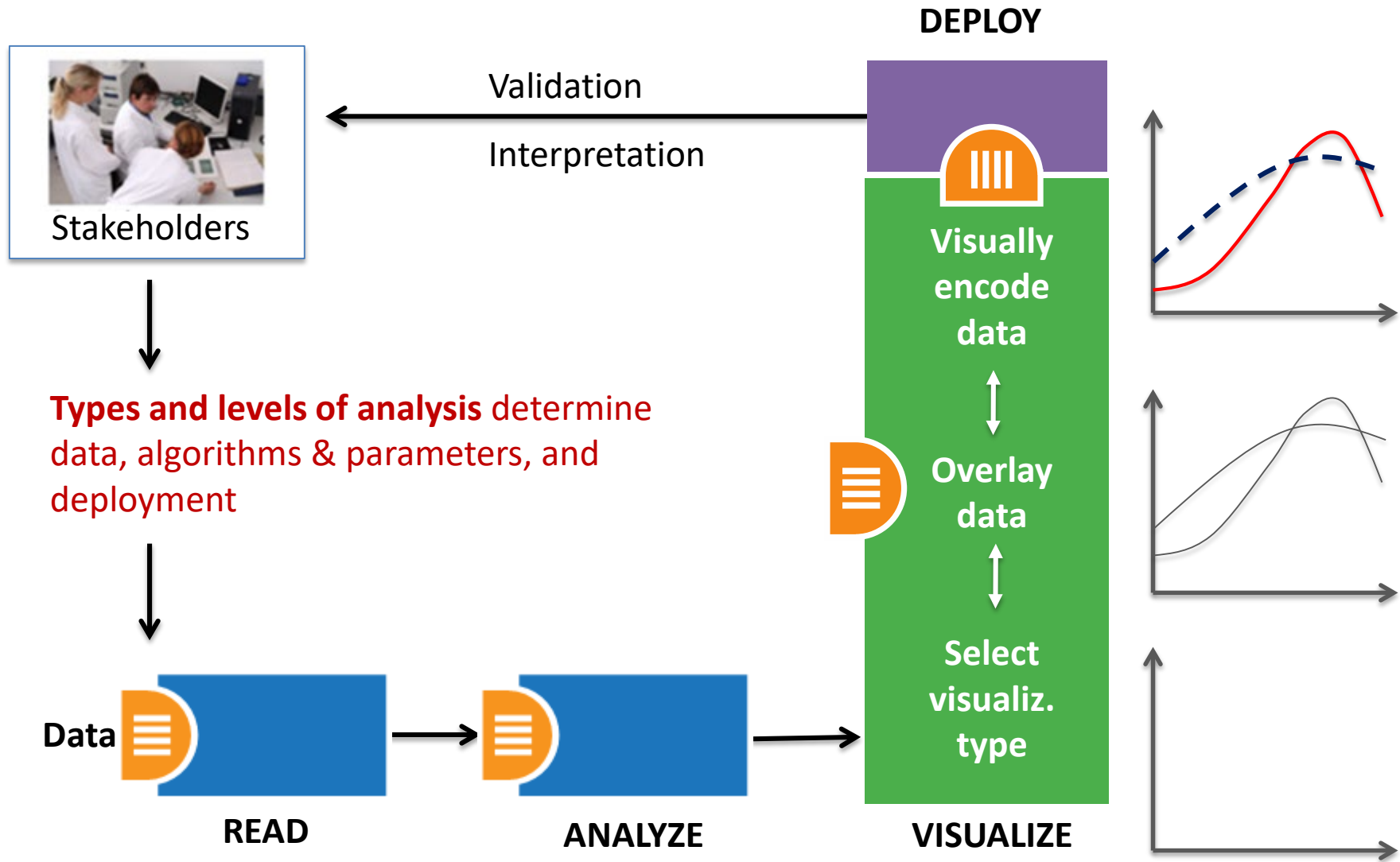
LEVELS

	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			
Statistical Analysis page 44	 Knowledge Cartography page 135	 Productivity of Russian life sciences research teams page 105	 Science and Society in Equilibrium 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

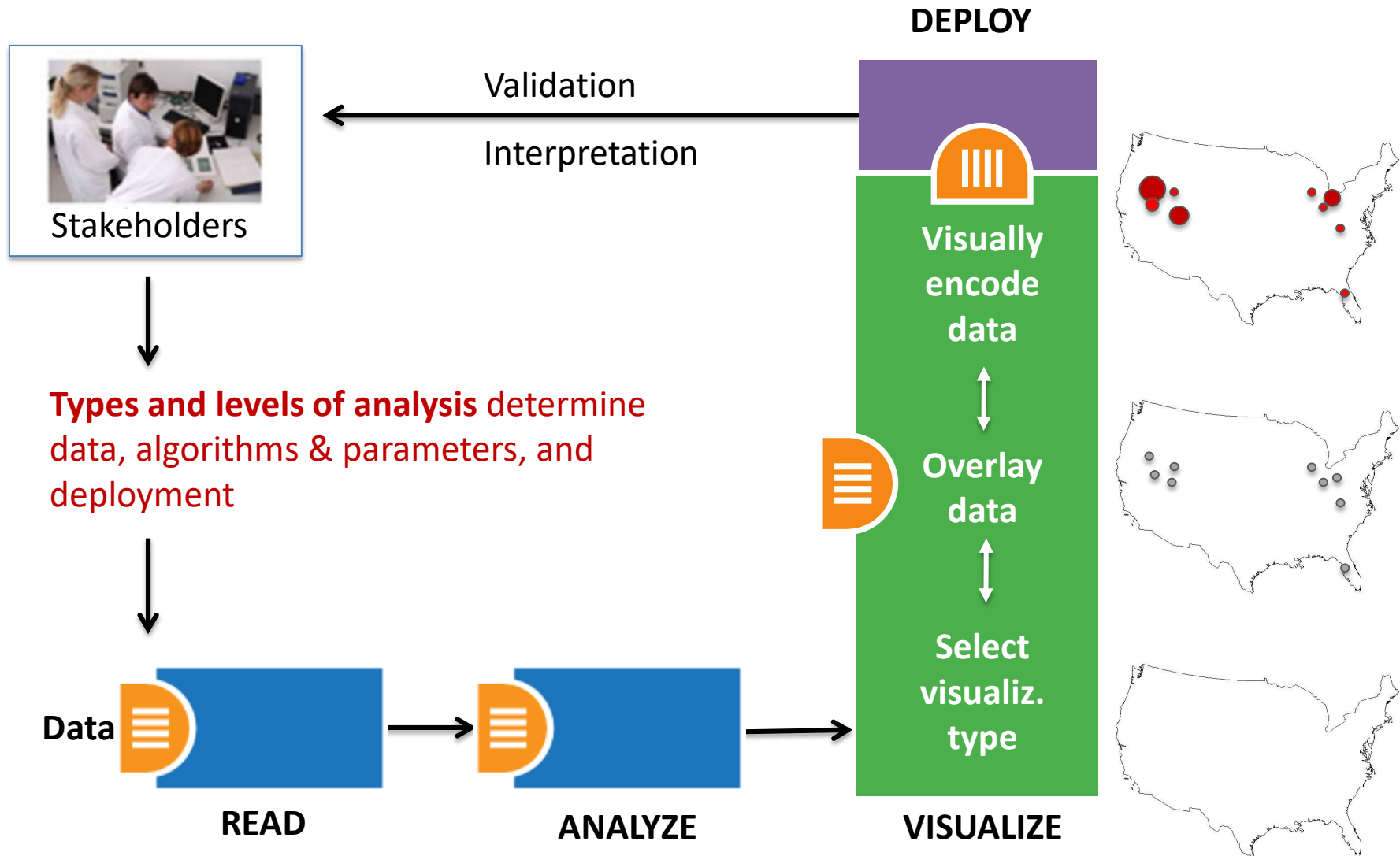


See *Atlas of Science: Anyone Can Map*, page 5

Needs-Driven Workflow Design

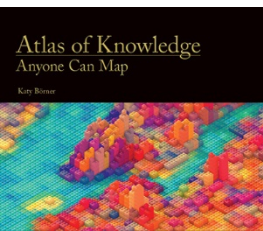


Needs-Driven Workflow Design



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">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



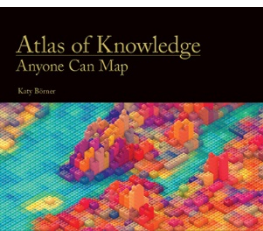
See page 24

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">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

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					

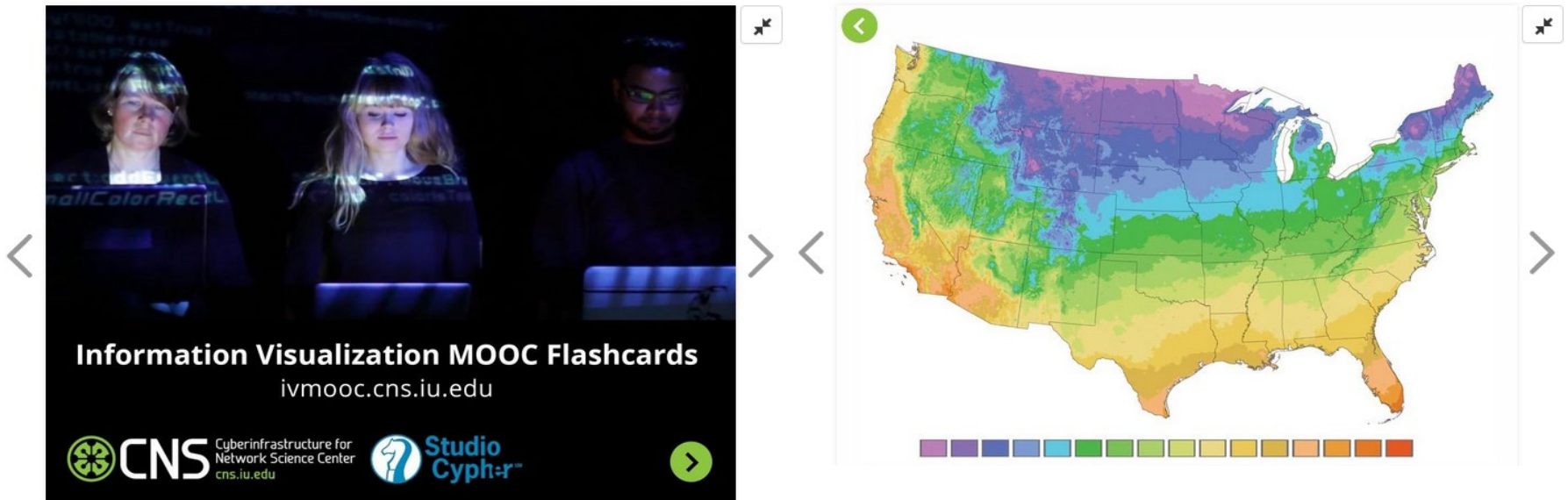
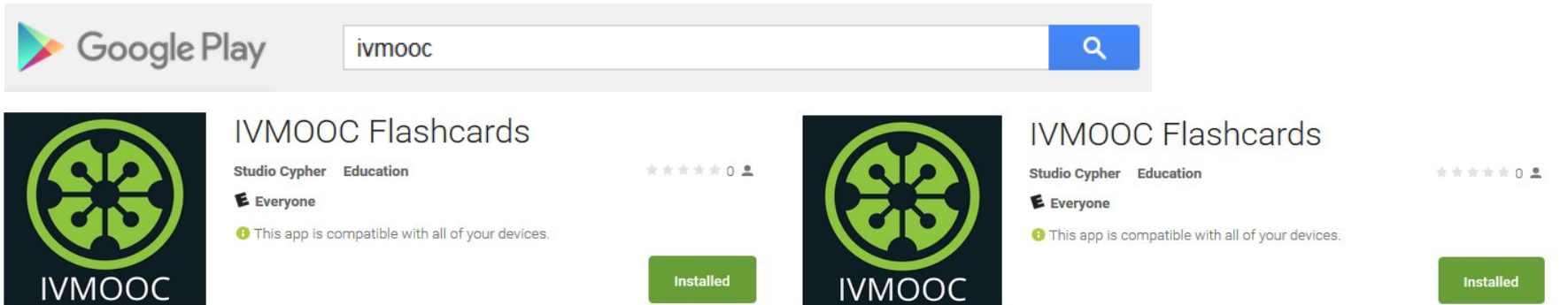
Graphic Variable Types Versus Graphic Symbol Types

			Geometric Symbols			Linguistic Symbols Text, Numerals, Punctuation Marks		Pictorial Symbols Images, Icons, Statistical Glyphs	
Spatial	x	quantitative							
	y	quantitative							
	z	quantitative							
Form	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							

			Geometric Symbols			Linguistic Symbols Text, Numerals, Punctuation Marks		Pictorial Symbols Images, Icons, Statistical Glyphs	
Texture	Spacing	quantitative							
	Granularity	quantitative							
	Pattern	qualitative							
	Orientation	quantitative	NA						
	Gradient	quantitative							
	Blur	quantitative							
	Transparency	quantitative							
Optics	Shading	quantitative							
	Stereoscopic Depth	quantitative	Point in foreground -- background	Line in foreground -- background	Area in foreground -- background	Surface in foreground -- background	Volume in foreground -- background	Text in foreground -- background	Icons in foreground -- background
	Speed	quantitative							
Motion	Velocity	quantitative							
	Rhythm	quantitative	Blinking point slow -- fast	Blinking line slow -- fast	Blinking area slow -- fast	Blinking surface slow -- fast	Blinking volume slow -- fast	Blinking text slow -- fast	Blinking icons slow -- fast

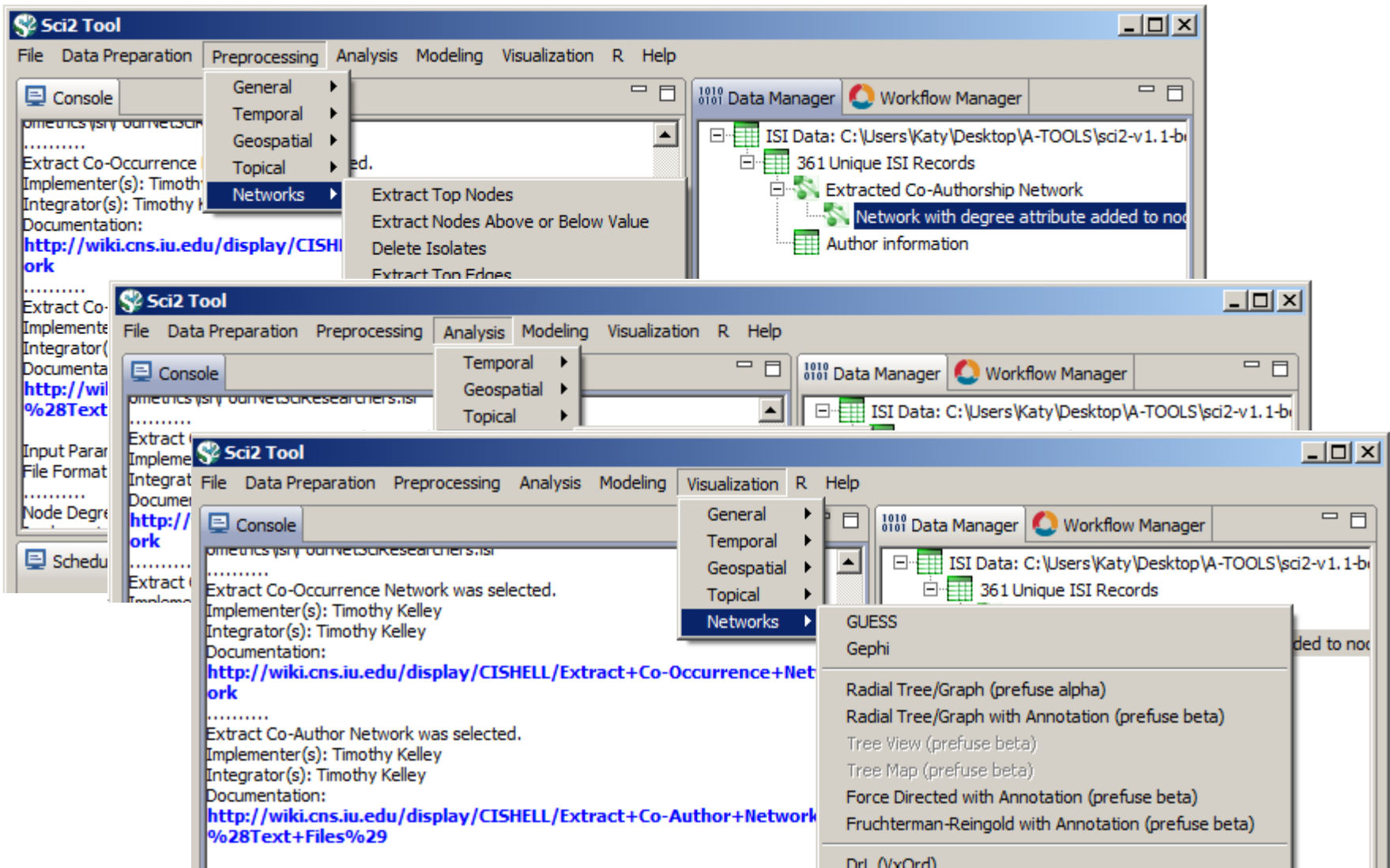
IVMOOC App

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



Sci2 Tool Interface Components Implement Vis Framework

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



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 Microscopes	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

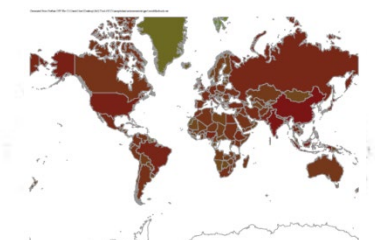
Temporal Burst Analysis—p. 48



Geospatial Analysis—p. 52



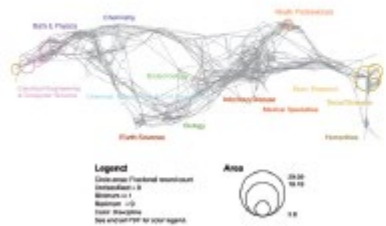
Geospatial Analysis—p. 52



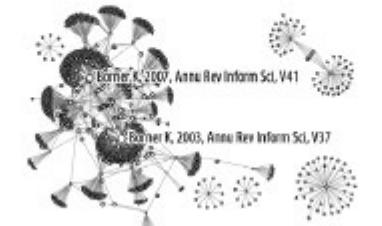
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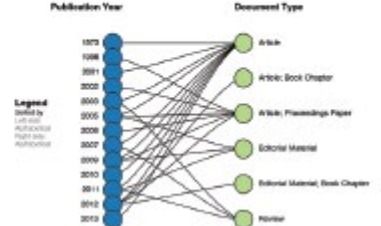
Topical Analysis—p. 56



Paper Citation Network—p. 60



Bi-Modal Network—p. 60



Co-author and many other bi-modal networks.

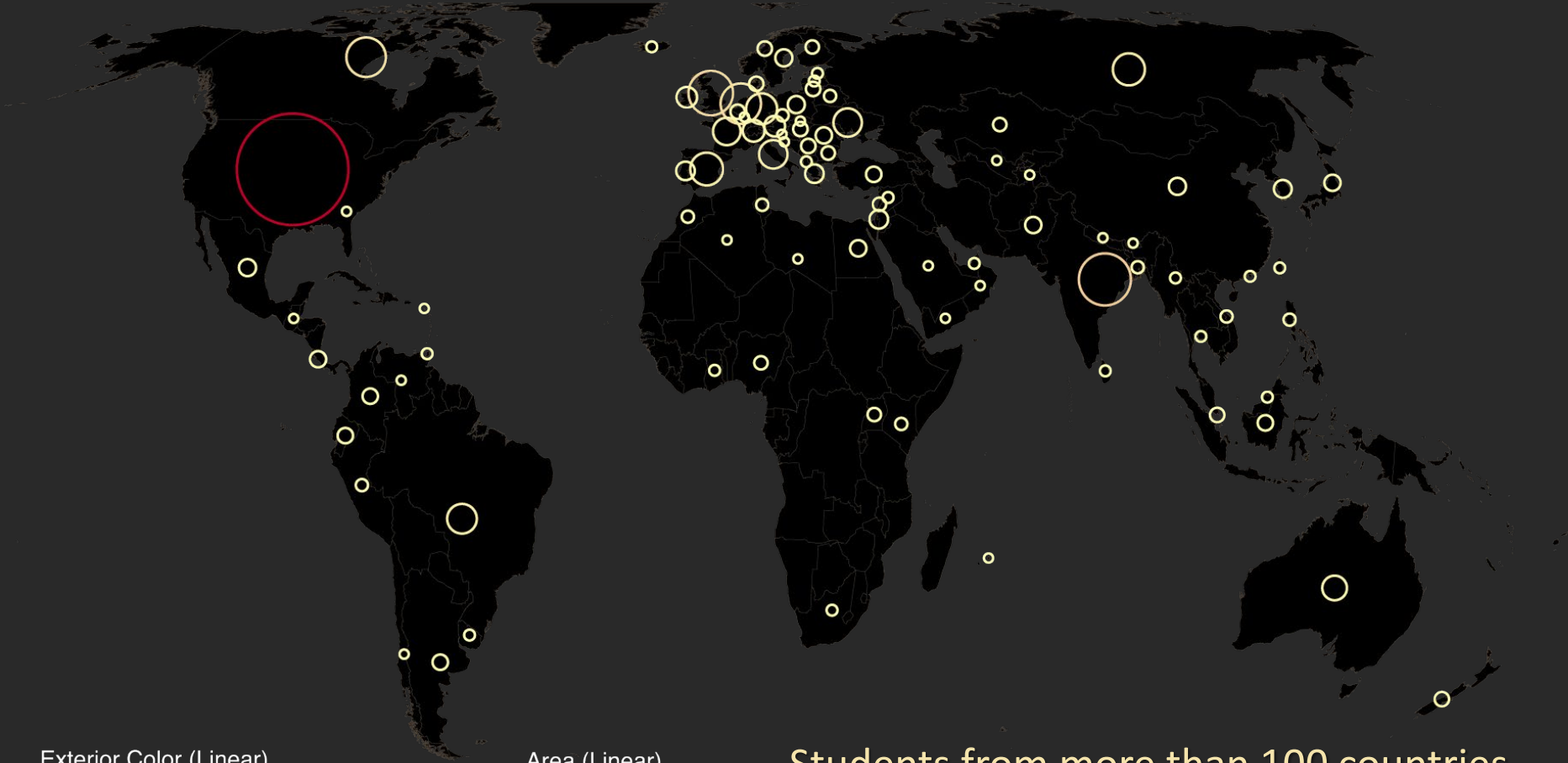


Register for free: <http://ivmooc.cns.iu.edu>. Class restarts Jan 7, 2019.



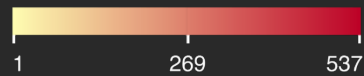
The Information Visualization MOOC

ivmooc.cns.iu.edu



Exterior Color (Linear)

count



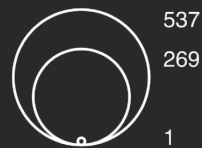
1

269

537

Area (Linear)

count



537

269

1

Students from more than 100 countries

350+ faculty members

#ivmooc

Course Schedule

Part 1: Theory and Hands-On

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

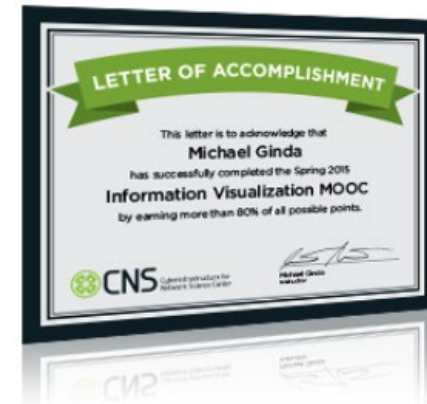
Mid-Term

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

Final Exam

Part 2: Students work in teams on client projects.

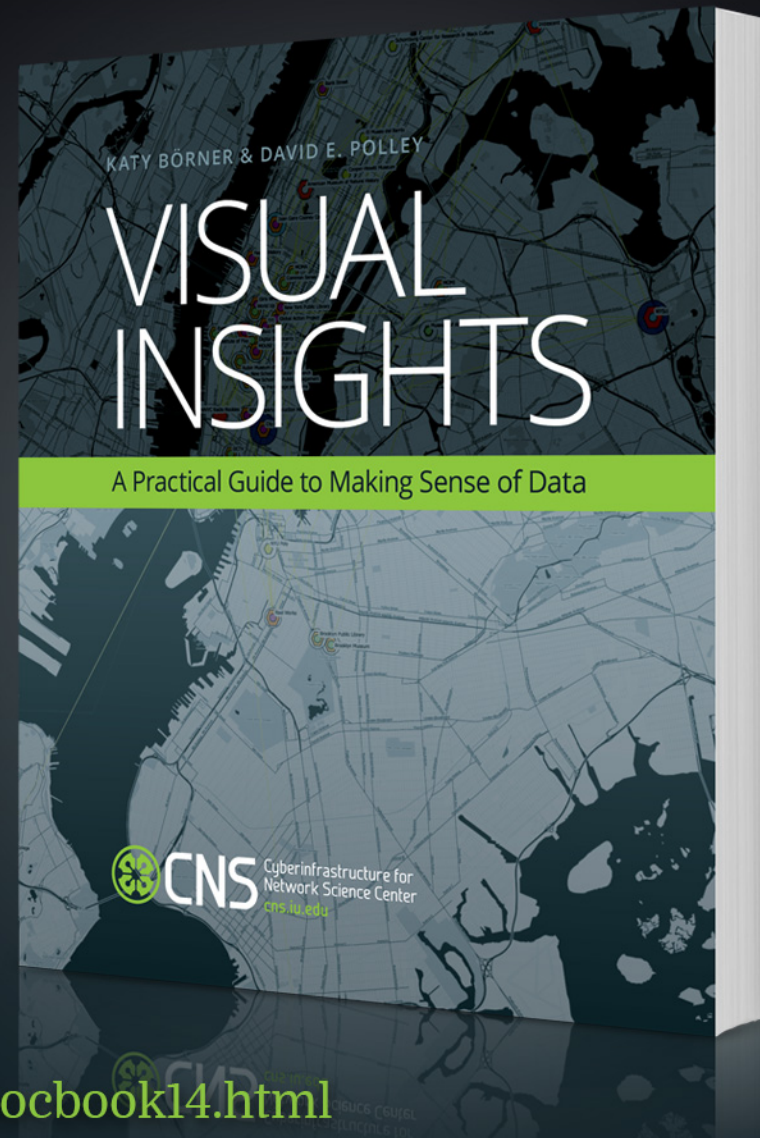
Final grade is based on Homework and Quizzes (**10%**), Midterm (**20%**), Final (**30%**), Client Project (**30%**), and Class Participation (**10%**).



The IVMOOC Companion Textbook

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

The book accompanies the Information Visualization MOOC that attracted students, scholars, and practitioners from many fields of science and more than 100 different countries.



cns.iu.edu/ivmooobook14.html

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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

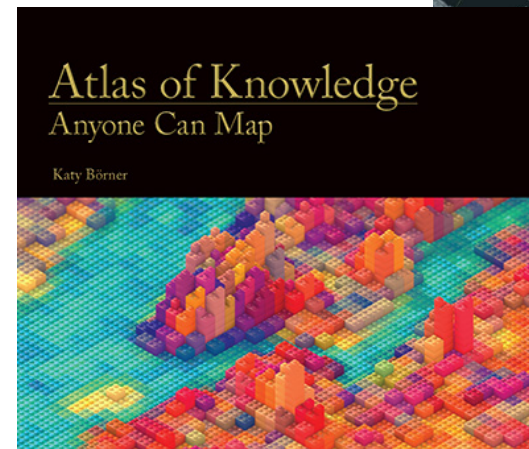
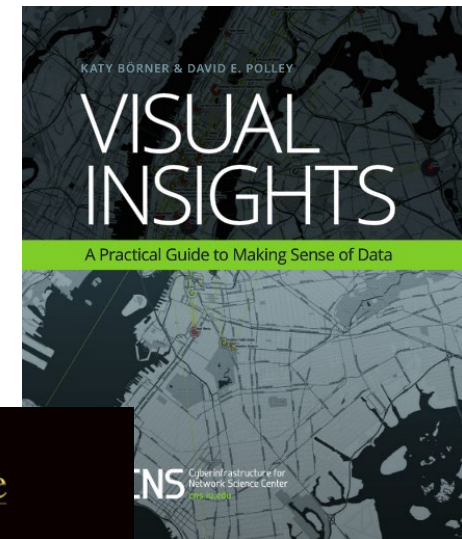
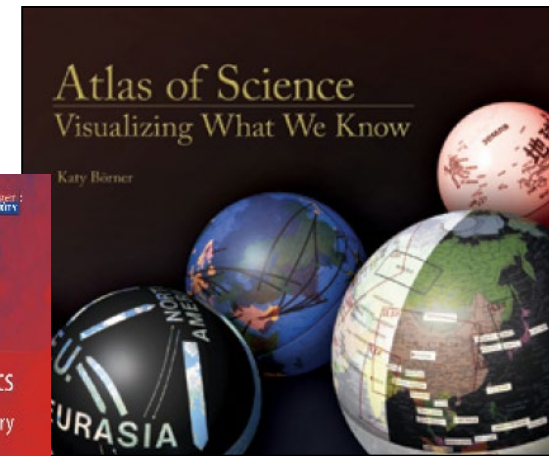
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- OCT 1** Katy Börner attends PIUG 2013 Northeast Conference
- 10.13** Katy Börner presents Mapping Science Exhibit at WSSF
- 10.15** Ted Polley & Google Team present IVMOOC at EDUCAUSE
- 10.22** Katy Börner presents at the SciELO 15 Years Conference

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November 25 – 30 , 2018, Dagstuhl Seminar 18482

Network Visualization in the Humanities

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