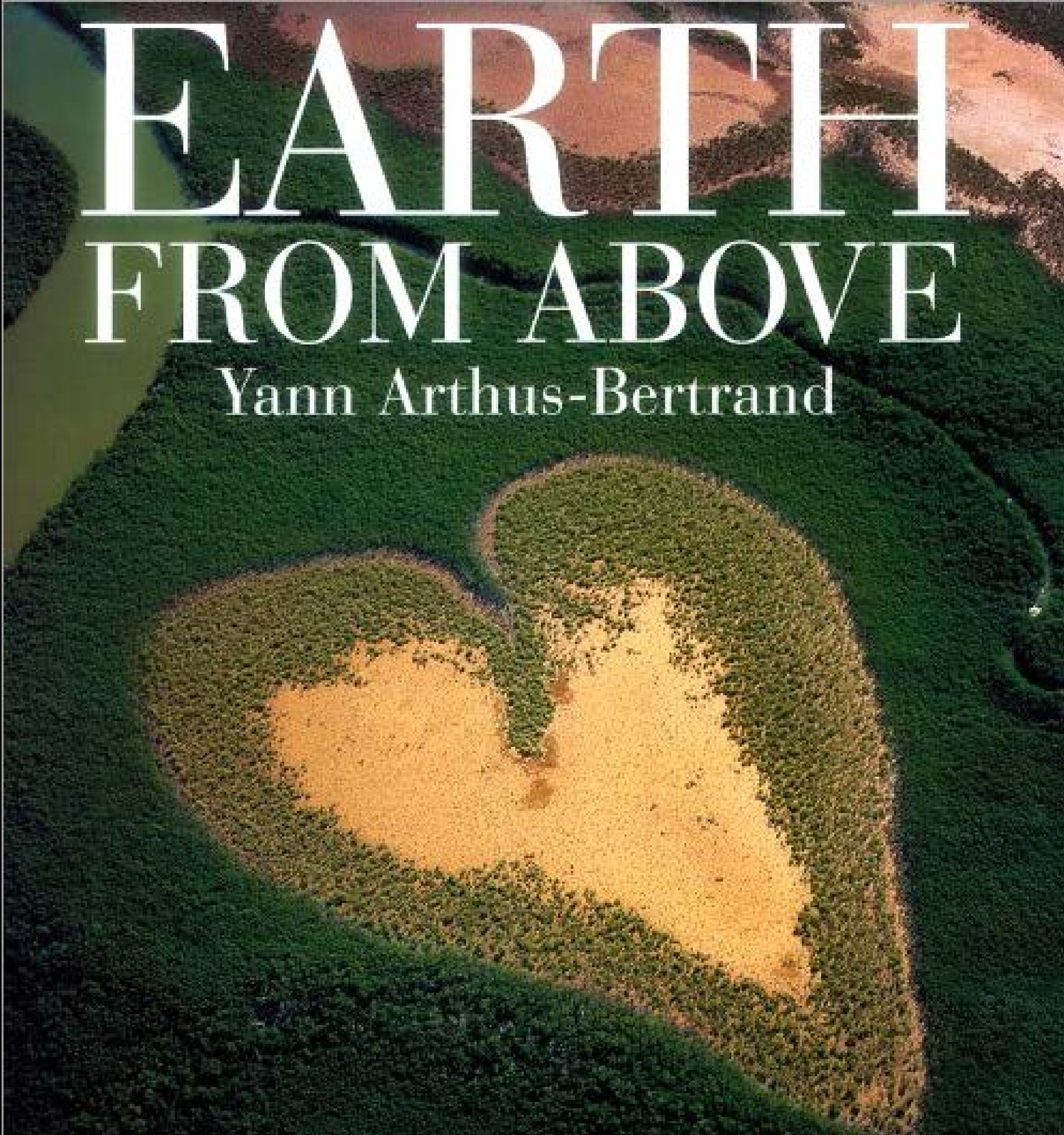
Maps & Macroscopes: Envisioning Science, Technology, and Education

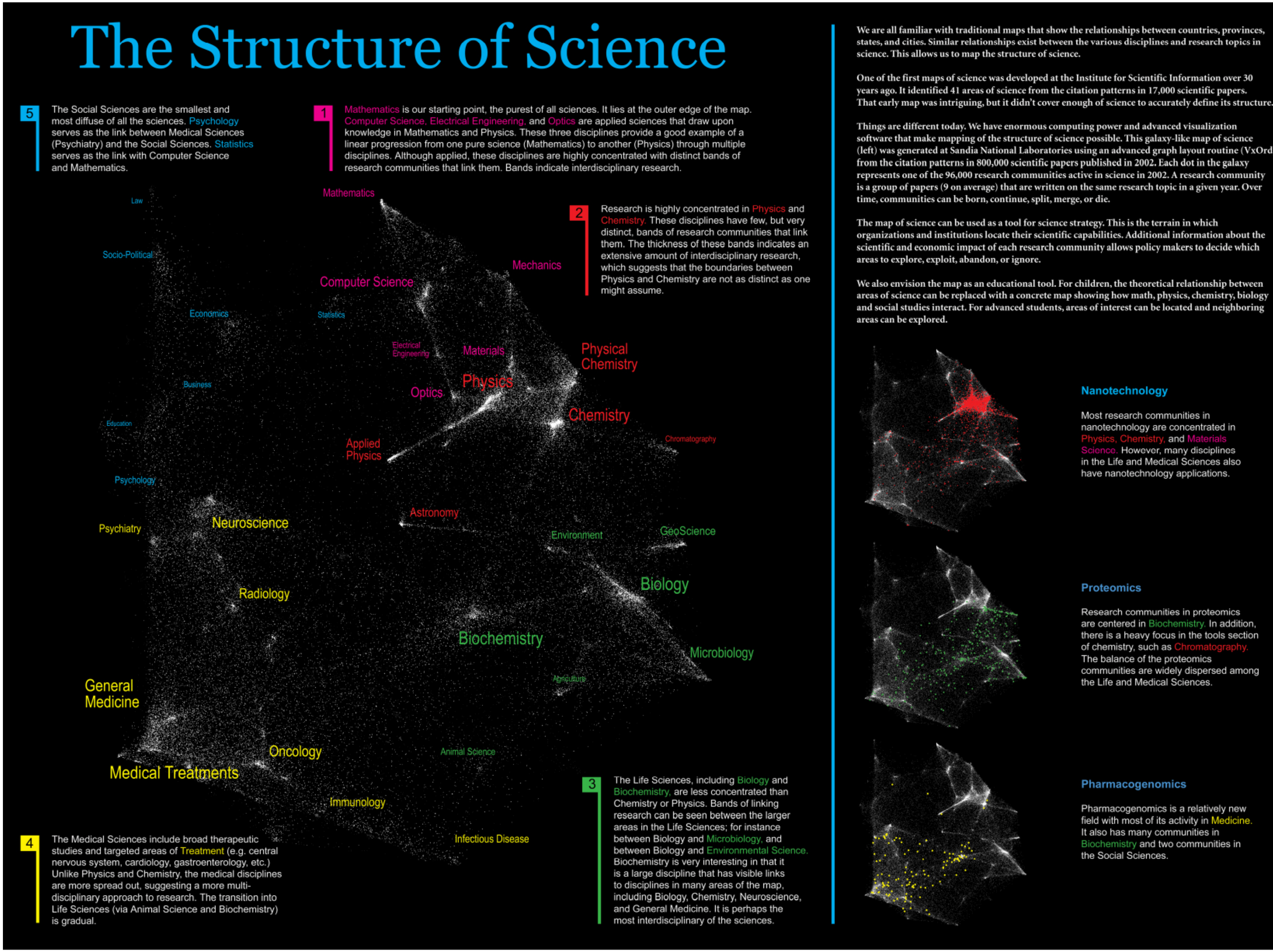
Katy Börner

Victor H. Yngve Distinguished Professor of
Intelligent Systems Engineering & Information Science
Director, Cyberinfrastructure for Network Science Center
School of Informatics and Computing
Indiana University Network Science Institute
Indiana University, USA

Third Annual Innovation Conference by JCITR
Memorial Union, Indiana University, Bloomington
Thursday, April 6, 2017


EARTH
FROM ABOVE
Yann Arthus-Bertrand

How can we communicate the beauty, structure, and dynamics of science to a general audience?



The Structure of Science - Kevin Boyack, Richard Klavans - 2005

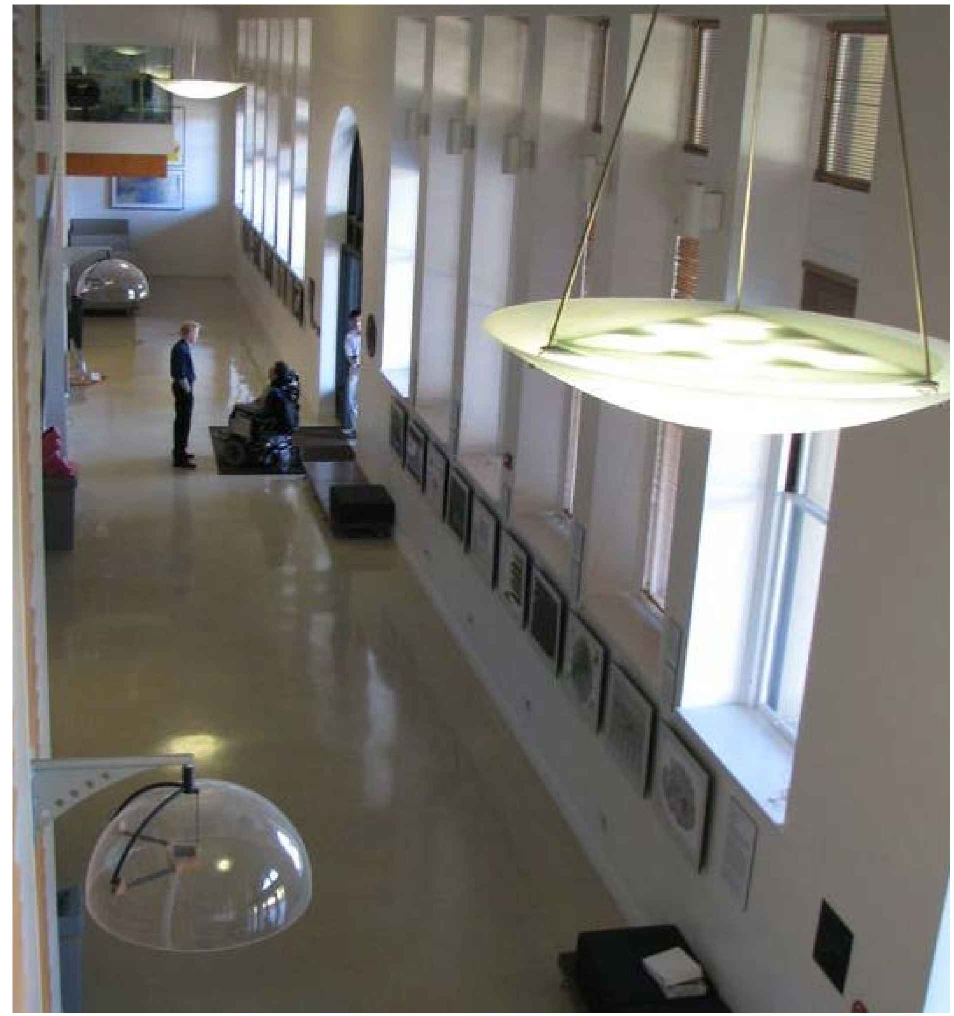
April, 2005: 101st Annual Meeting of the
Association of American Geographer, Denver, Colorado.

05: 101st Annual Meeting
American Geographer, De


INDIANA
UNIVERSITY
PLACES AND SPACES
EXHIBIT

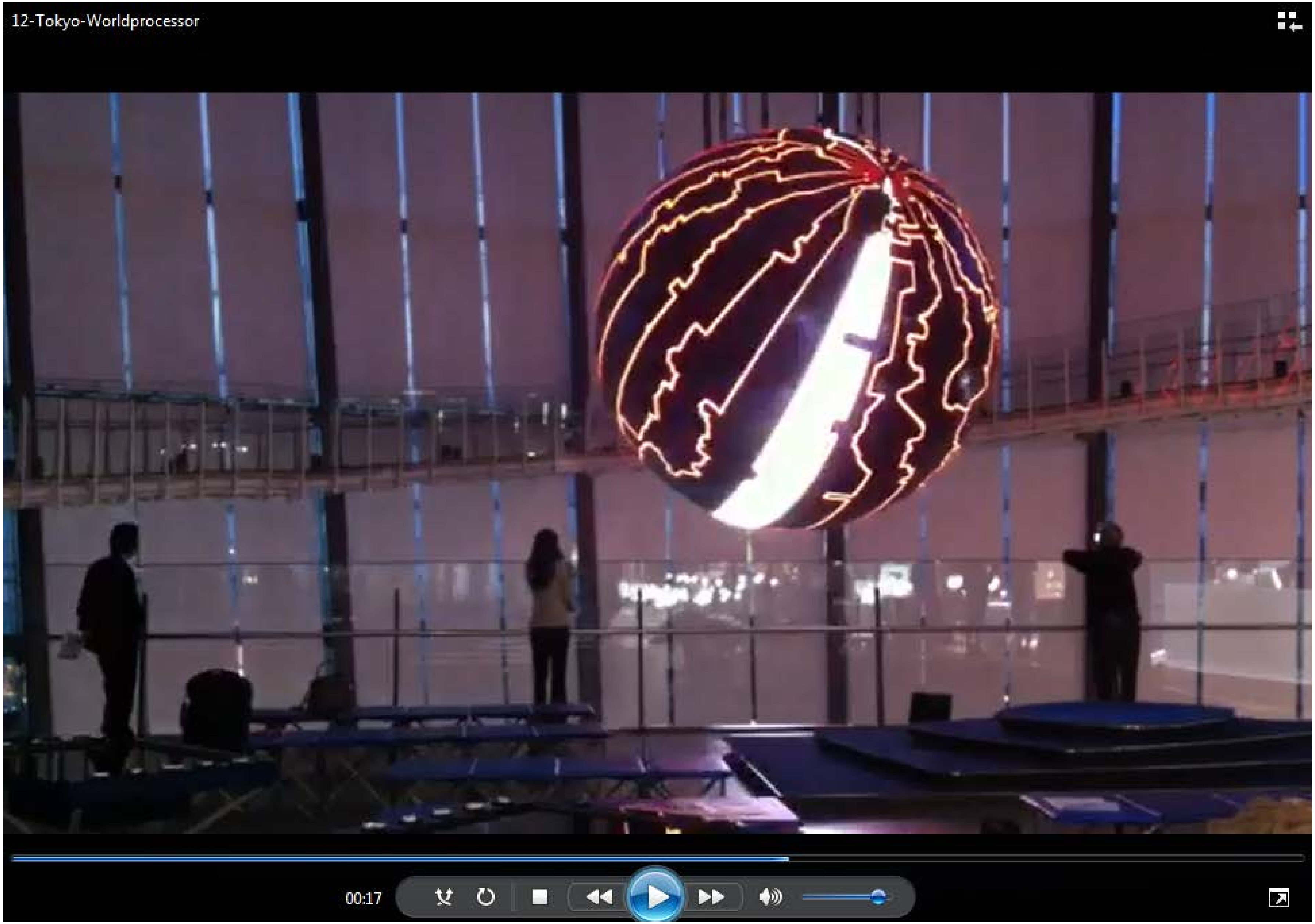

Chemical Research & Development
Powers the U.S. Innovation Engine
Literary Empires
LEGEND
The Human Connectome


HUMANSPEECHOMEPROJECT

Debut of 5th Iteration of the Mapping Science Exhibit at MEDIA X in 2009 at Wallenberg Hall, Stanford University.

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



Ingo Gunther's Worldprocessor globe design on display at the Museum of Emerging Science and Innovation in Tokyo, Japan.

Places & Spaces Digital Display in North Carolina State's Immersion Theater

Exhibit Advisors and Ambassadors

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.

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

Places & Spaces Exhibit at Vanderbilt University, Nashville, TN.
January 23-April 23, 2017 http://scimaps.org/vanderbilt

Maps

PLACES & SPACES
MAPPING SCIENCE

scimaps.org

10 iterations over 10 years

equal

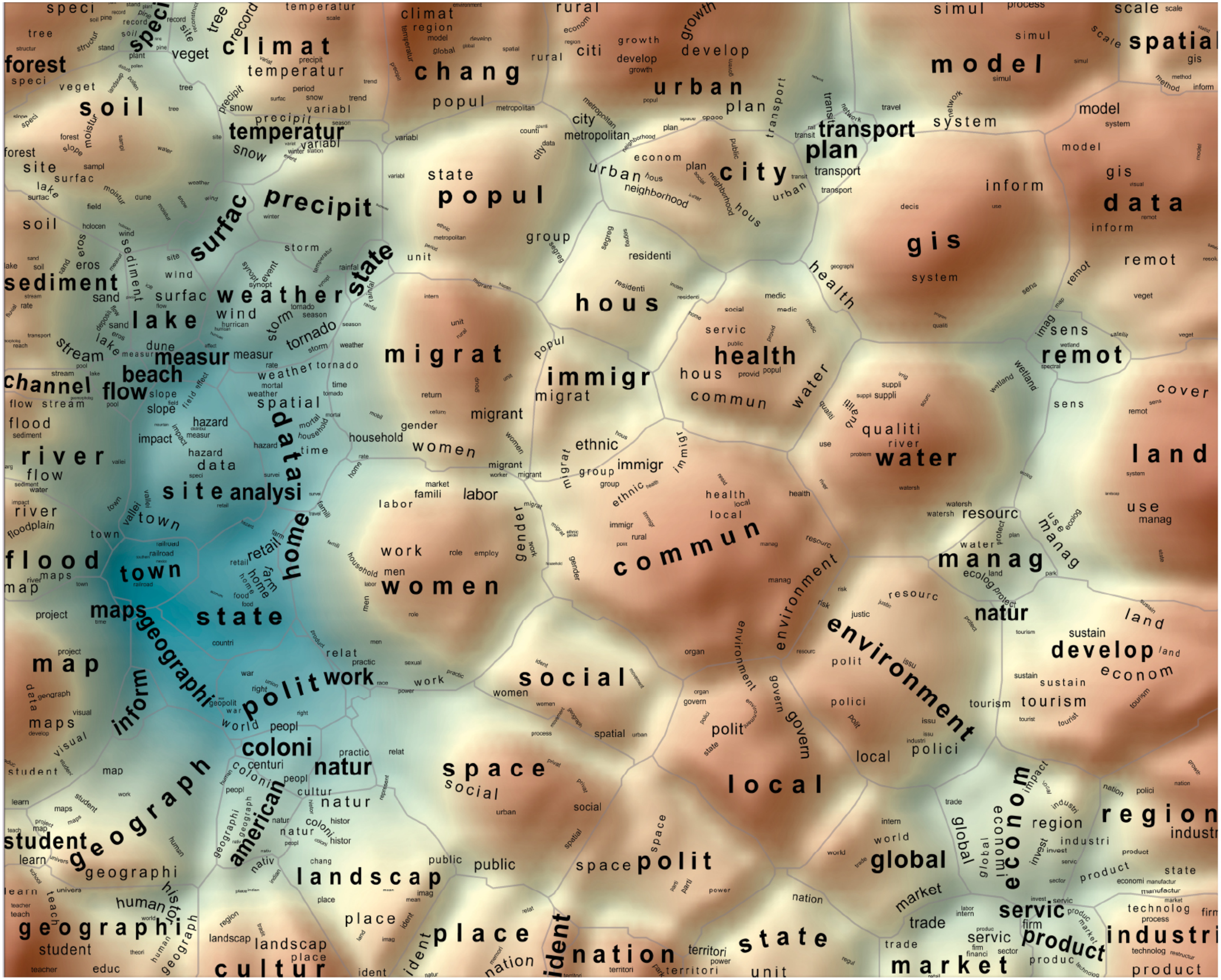
10 x 10 = 100 maps!

Maps that show

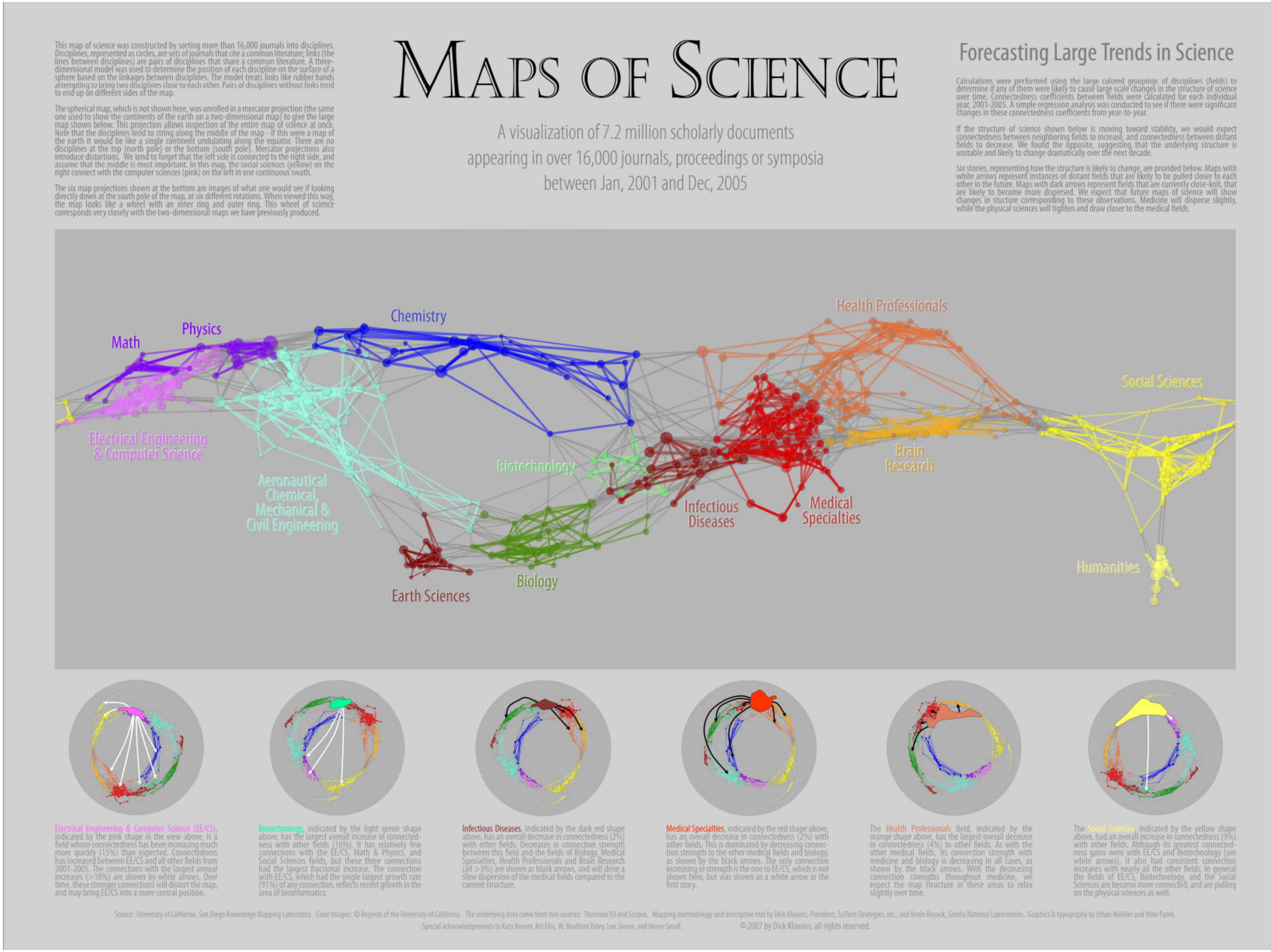
STRUCTURE

scimaps.org

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



In Terms of Geography - Andre Skupin - 2005

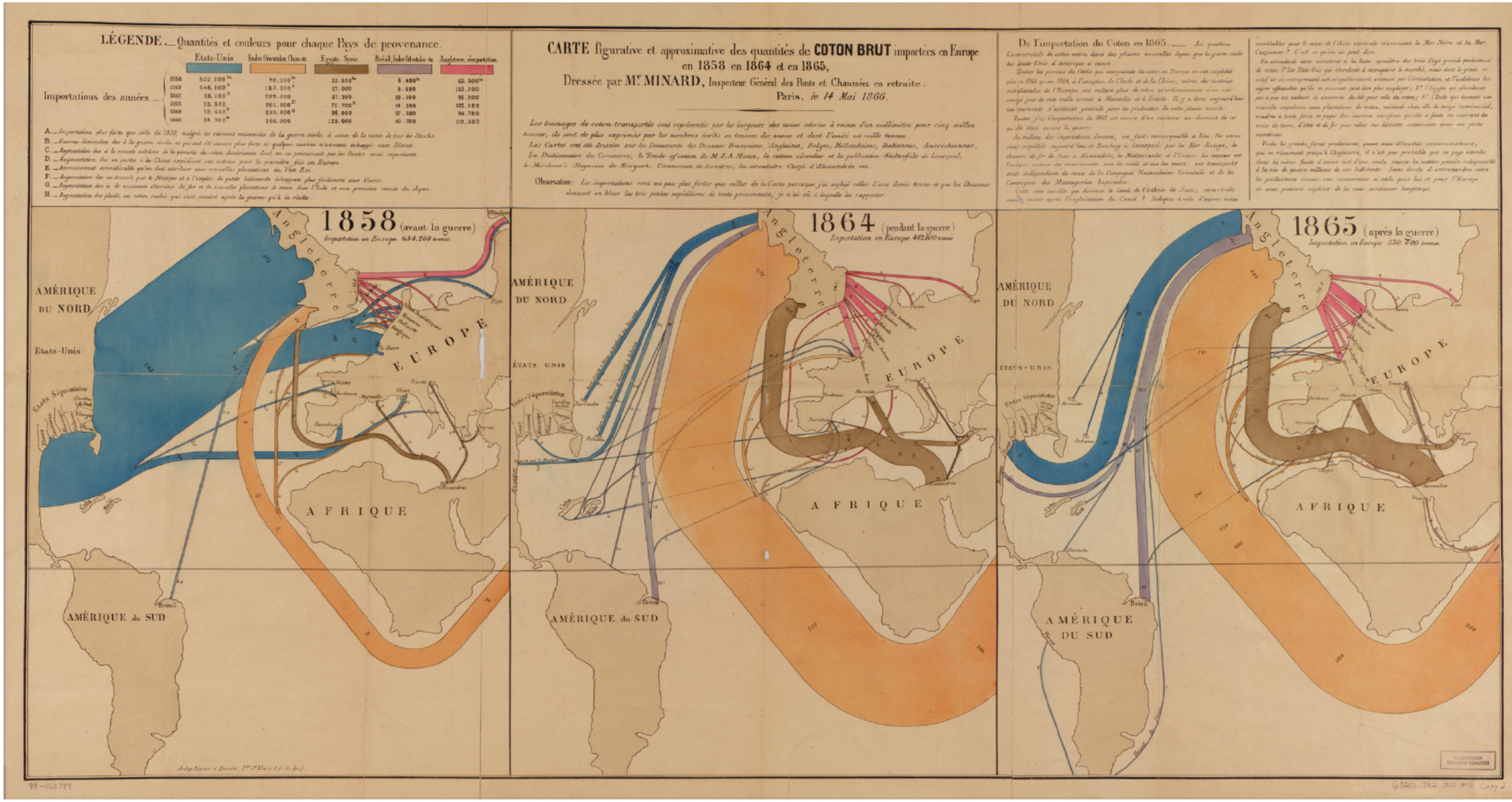


Maps of Science: Forecasting Large Trends in Science - Richard Klavans, Kevin Boyack - 2007

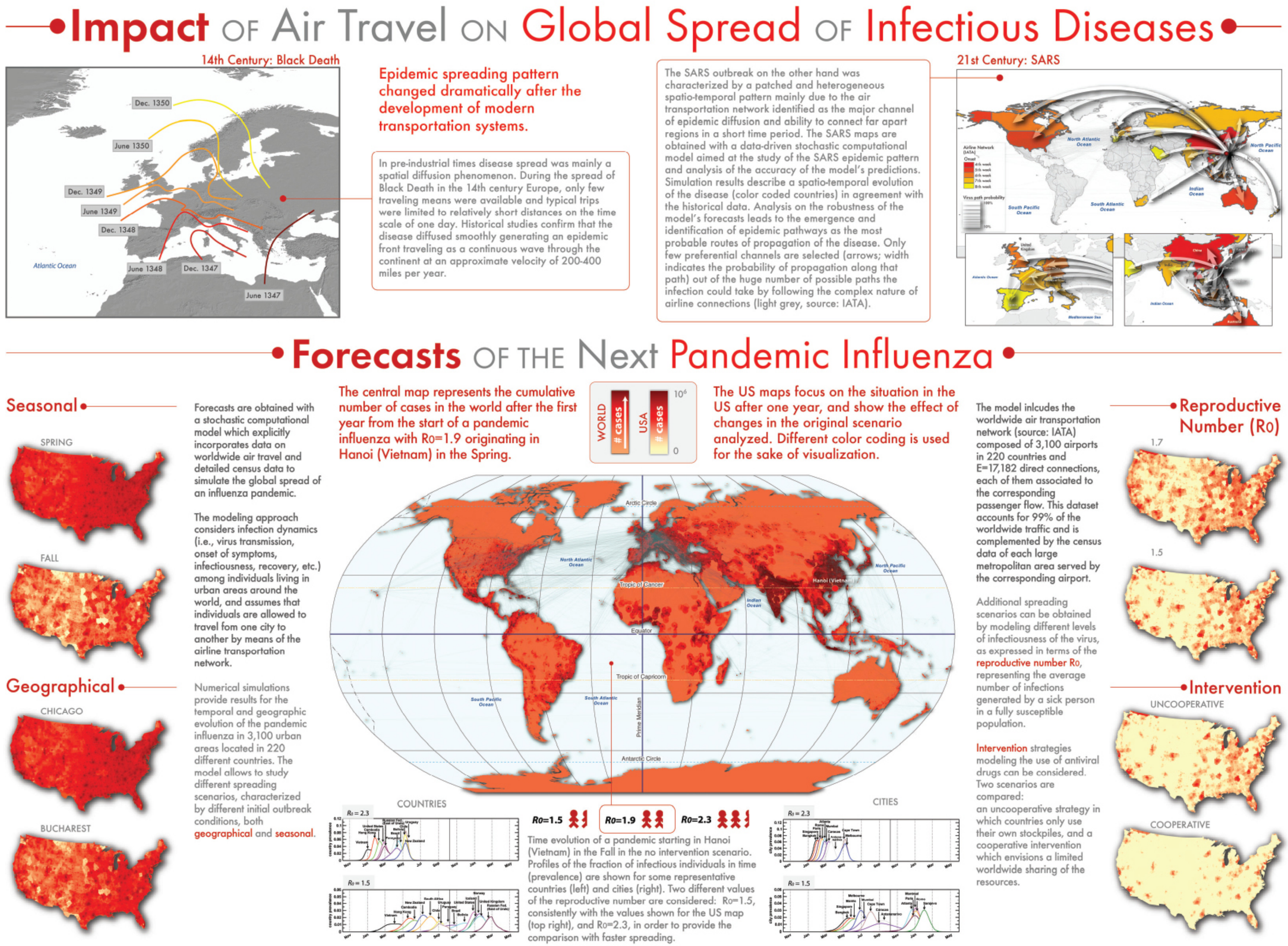
Maps that show

FLOWS

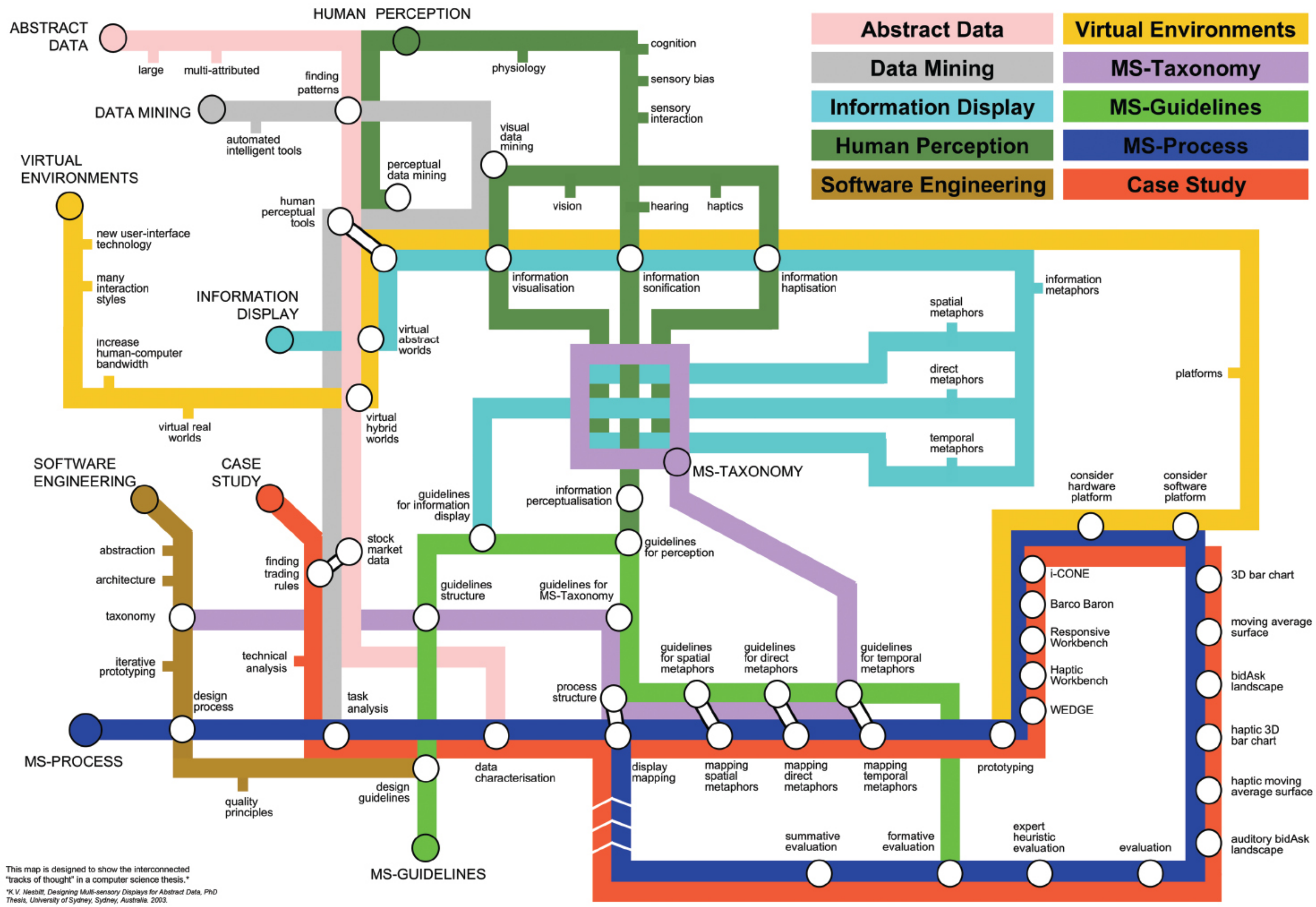
scimaps.org



Europe Raw Cotton Imports in 1858, 1864 and 1865 - Charles Joseph Minard - 1866



Impact of Air Travel on Global Spread of Infectious Diseases - Vittoria Colizza, Alessandro Vespignani - 2007



Ph.D. Thesis Map - Keith B. Nesbitt - 2004

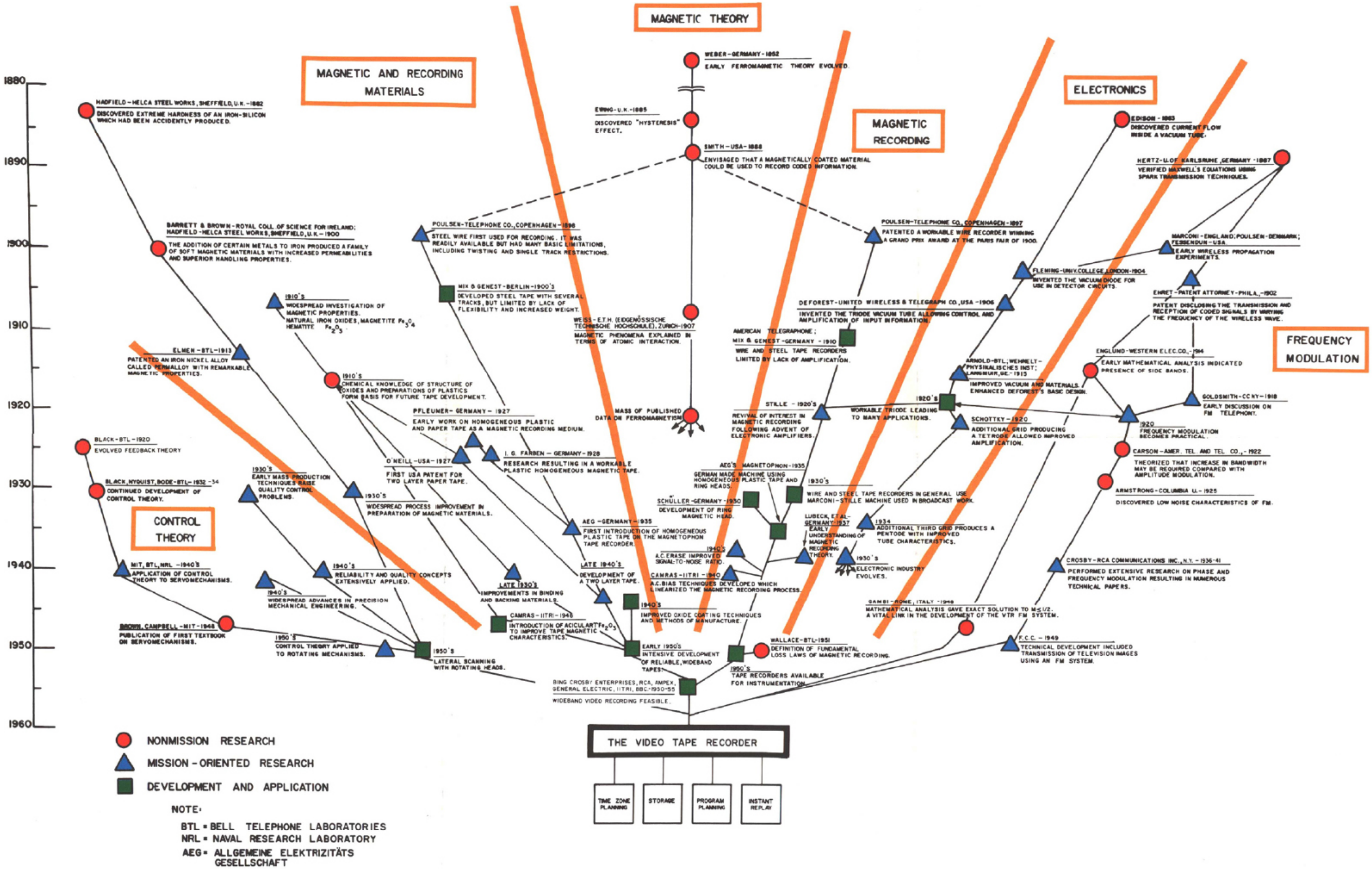
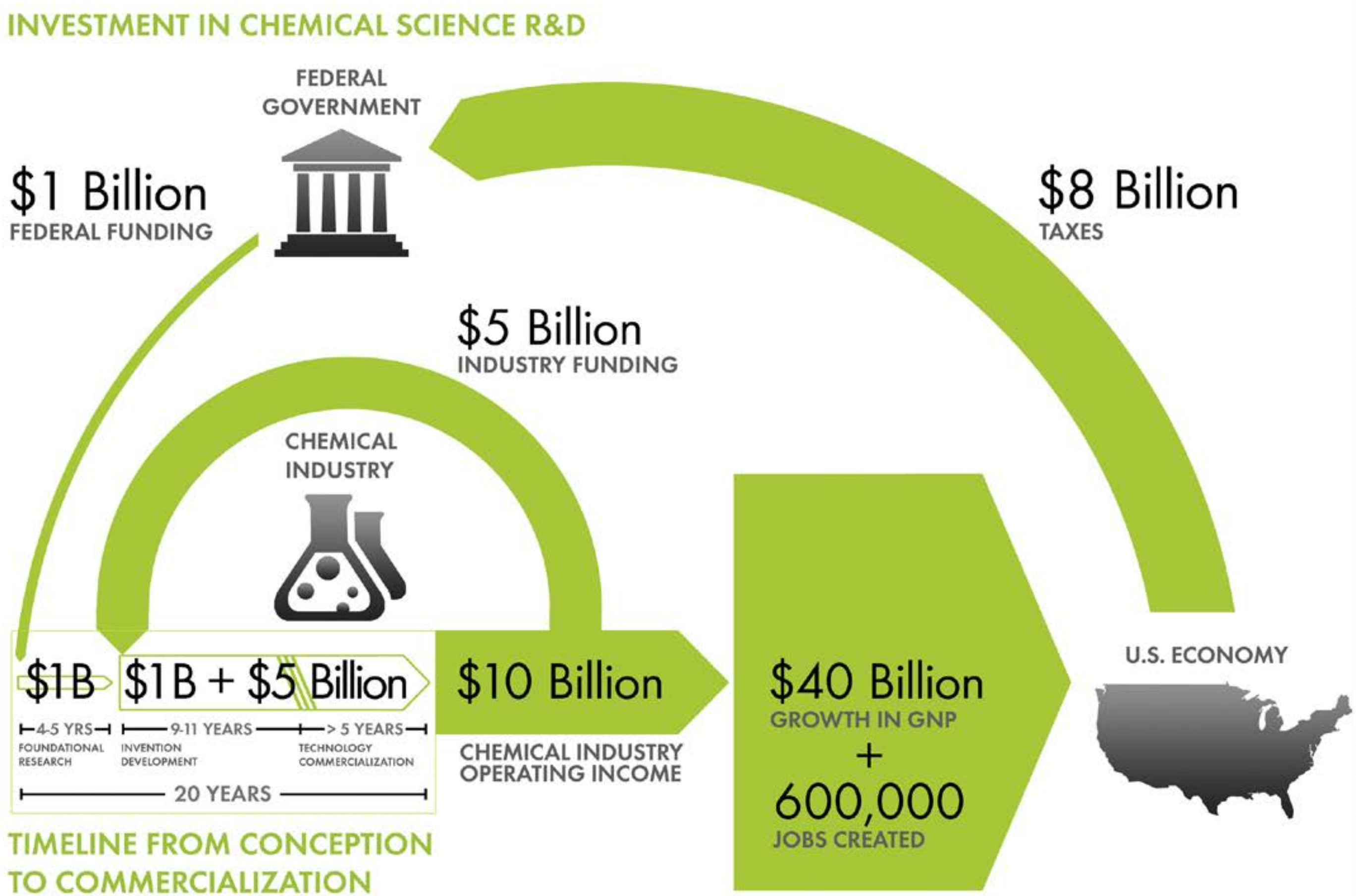


FIG. 7. THE VIDEO TAPE RECORDER

Tracing of Key Events in the Development of the Video Tape Recorder - Mr. G. Benn, Francis Narin - 1968

Chemical Research & Development
Powers the U.S. Innovation Engine

Macroeconomic Implications of Public and Private R&D Investments in Chemical Sciences



The Council for Chemical Research (CCR) has provided the U.S. Congress and government policy makers with important results regarding the impact of Federal Research & Development (R&D) investments on U.S. innovation and global competitiveness through its commissioned 5-year two phase study. To take full advantage of typically brief access to policy makers, CCR developed the graphic below as a communication tool that distills the complex data produced by these studies in direct, concise and clear terms.

The design shows that an input of $1B in federal investment, leveraged by $5B industry investment, brings new technologies to market and results in $10B of operating income for the chemical industry, $40B growth in the Gross National Product (GNP) and further impacts the US economy by generating approximately 600,000 jobs, along with a return of $8B in taxes. Additional details, also reported in the CCR studies, are depicted in the map to the left. This map clearly shows the two R&D investment cycles; the shorter industry investment at the innovation stage to commercialization cycle; and the longer federal investment cycle which begins in basic research and culminates in national economic and job growth along with the increase tax base that in turn is available for investment in basic research.

Chemical R&D Powers the U.S. Innovation Engine - The Council for Chemical Research - 2009

Maps that show

TRENDS

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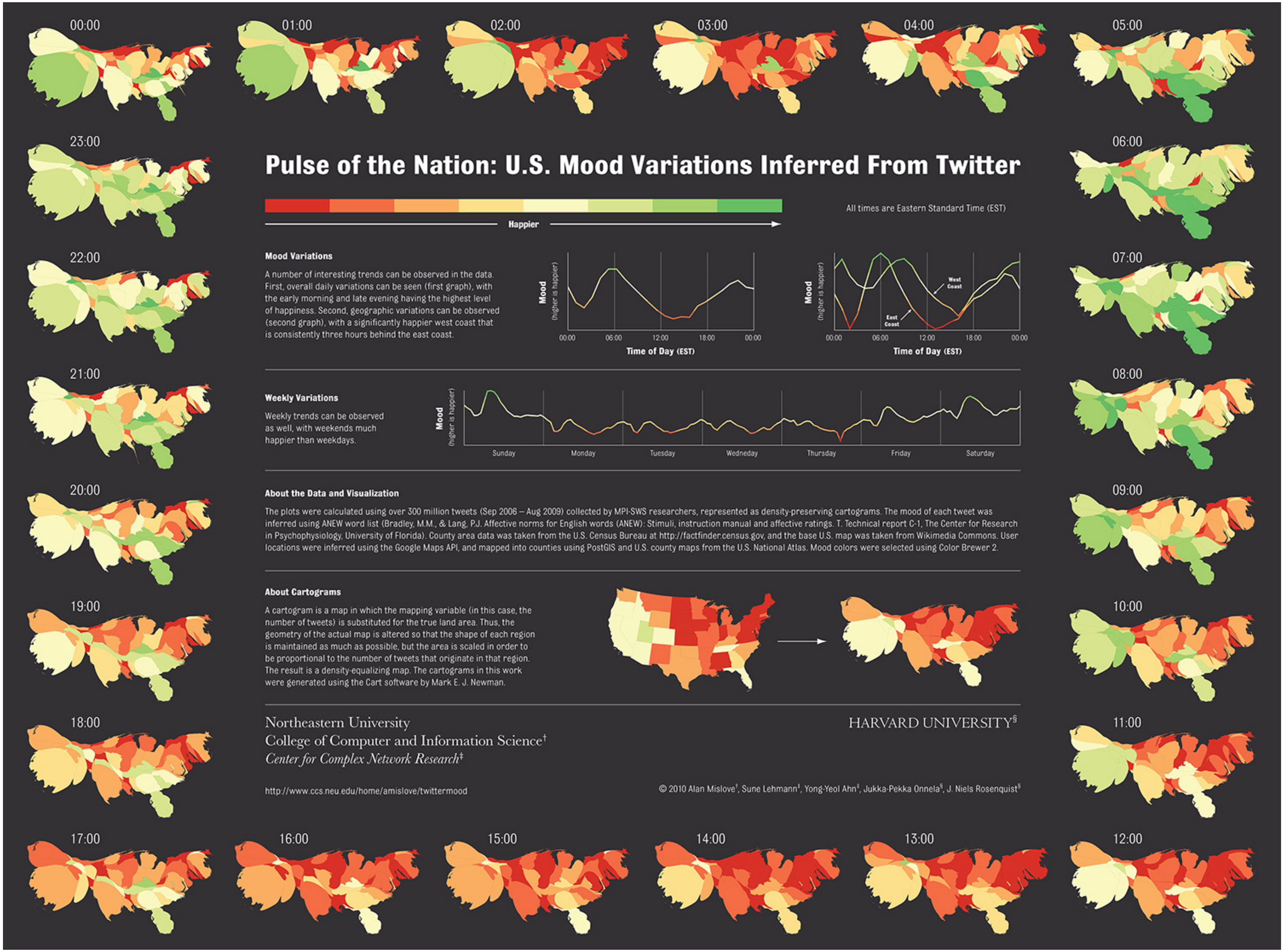
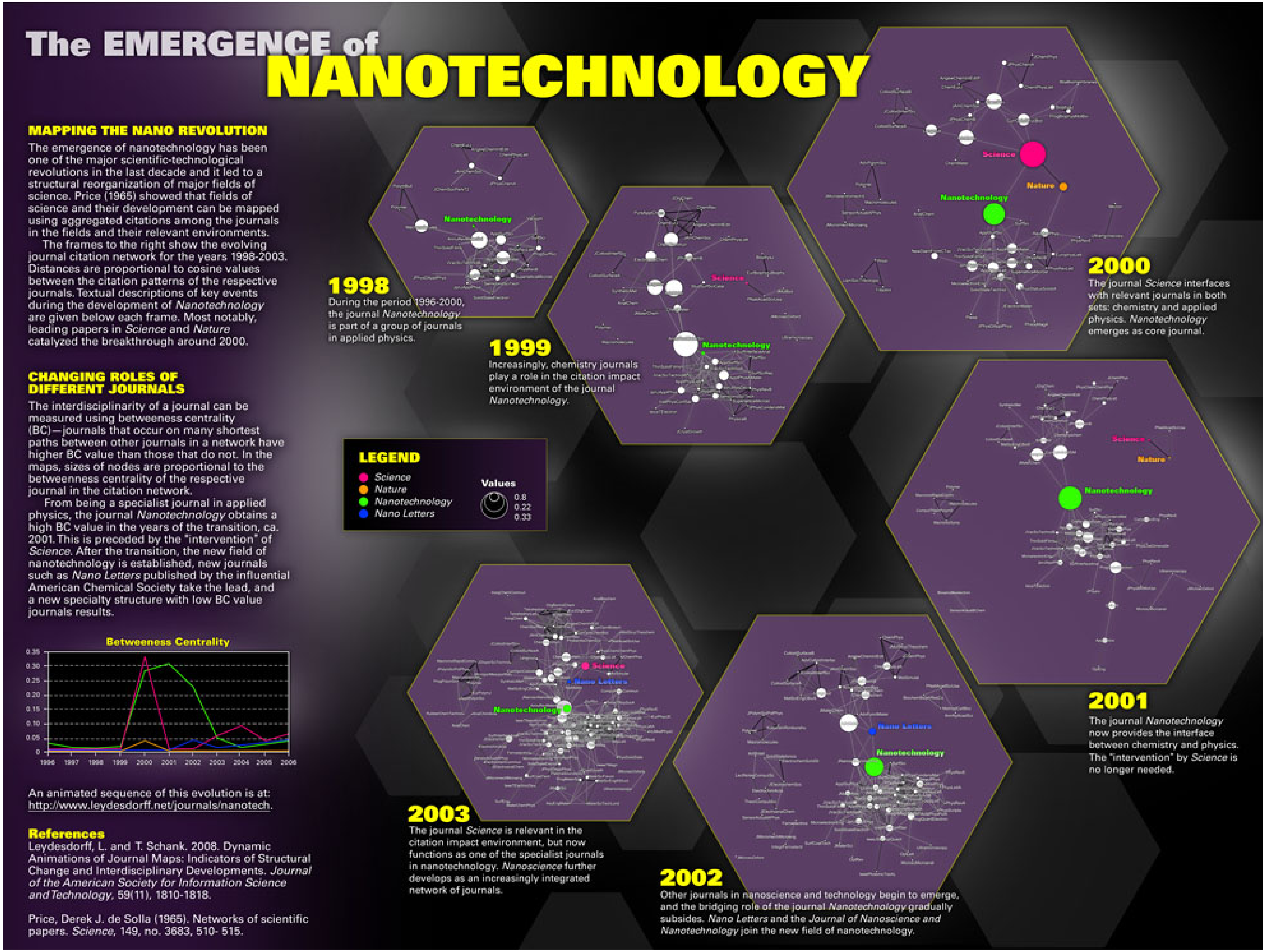


Pulse of the Nation - Alan Mislove, Sune Lehmann, Yong-Yeol Ahn, Jukka-Pekka Onnela, and James Niels Rosenquist - 2010



The Emergence of Nanoscience & Technology - Loet Leydesdorff - 2010

Macroscopes

PLACES & SPACES
MAPPING SCIENCE

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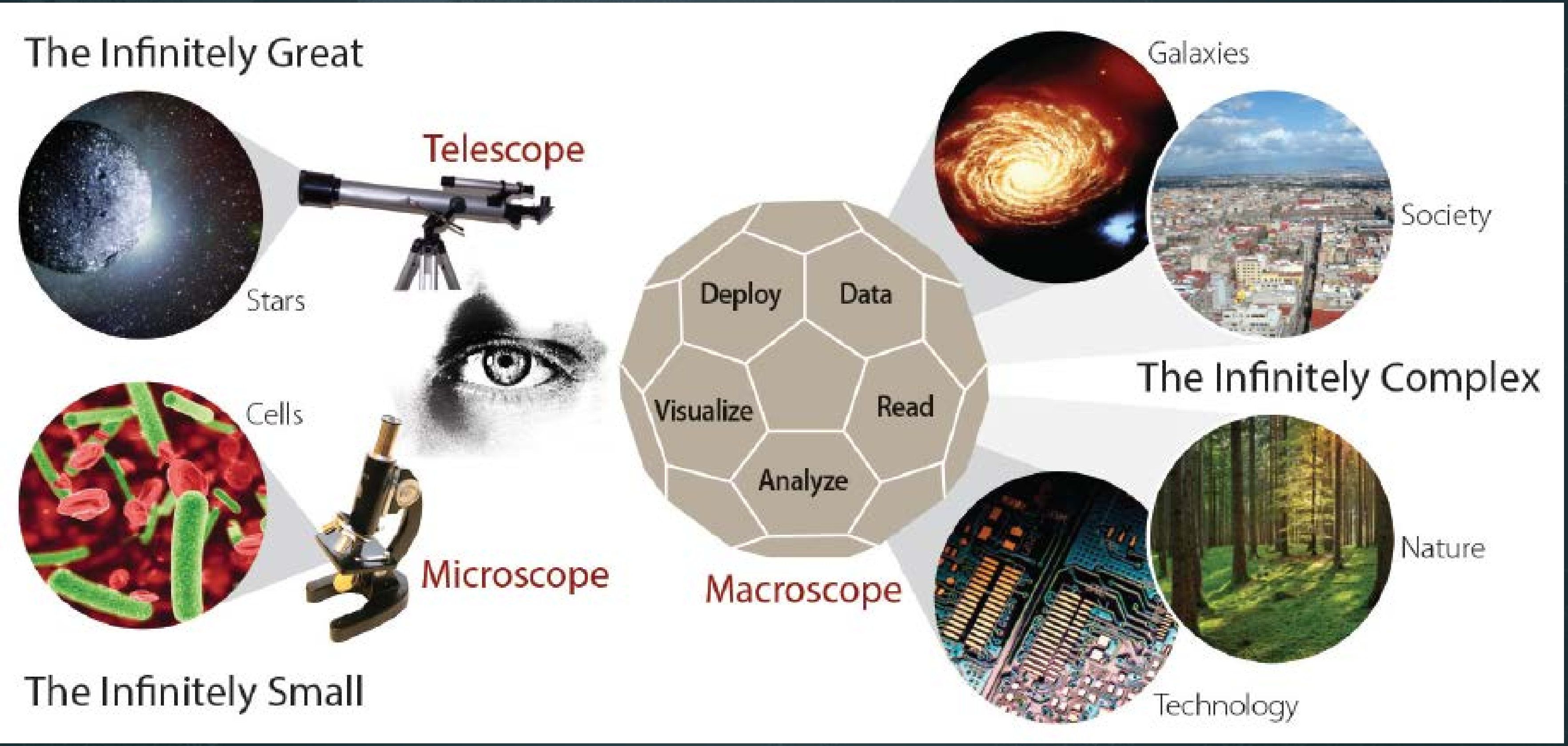
MAPS

vs.

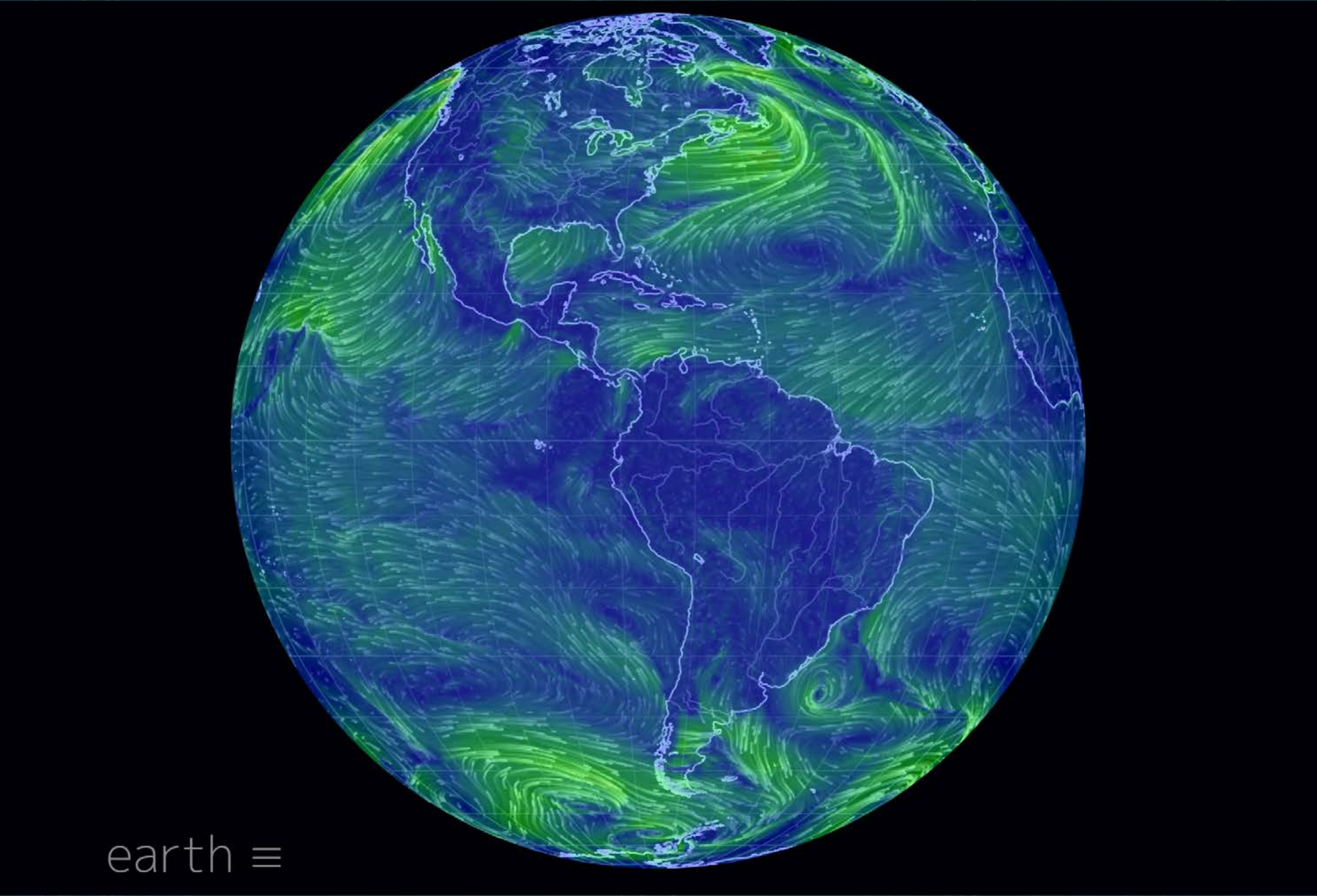
MACROSCOPES

Microscopes & Telescopes vs. MACROSCOPES

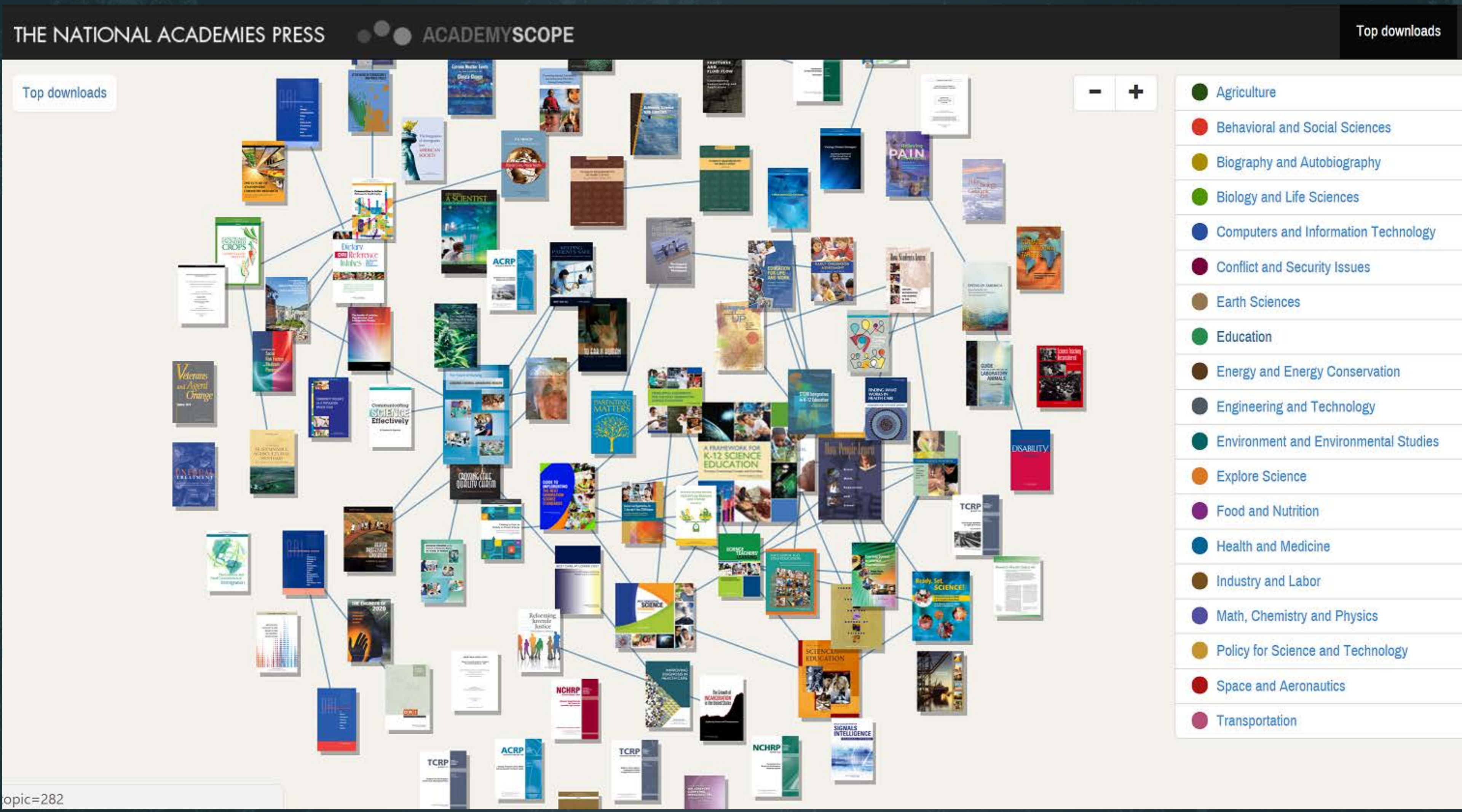


Iteration XI (2015): Macroscopes for Interacting with Science

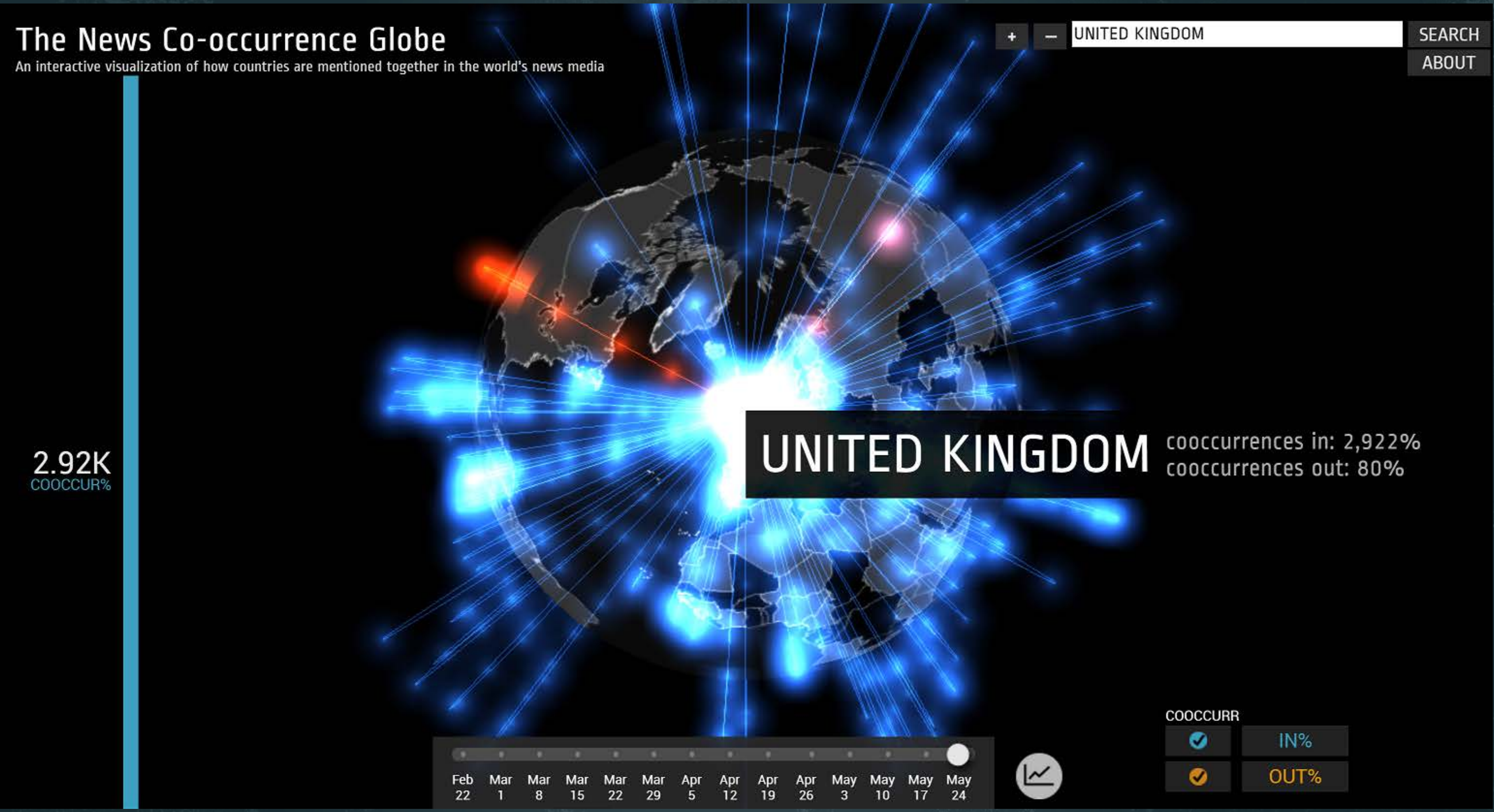
http://scimaps.org/iteration/11



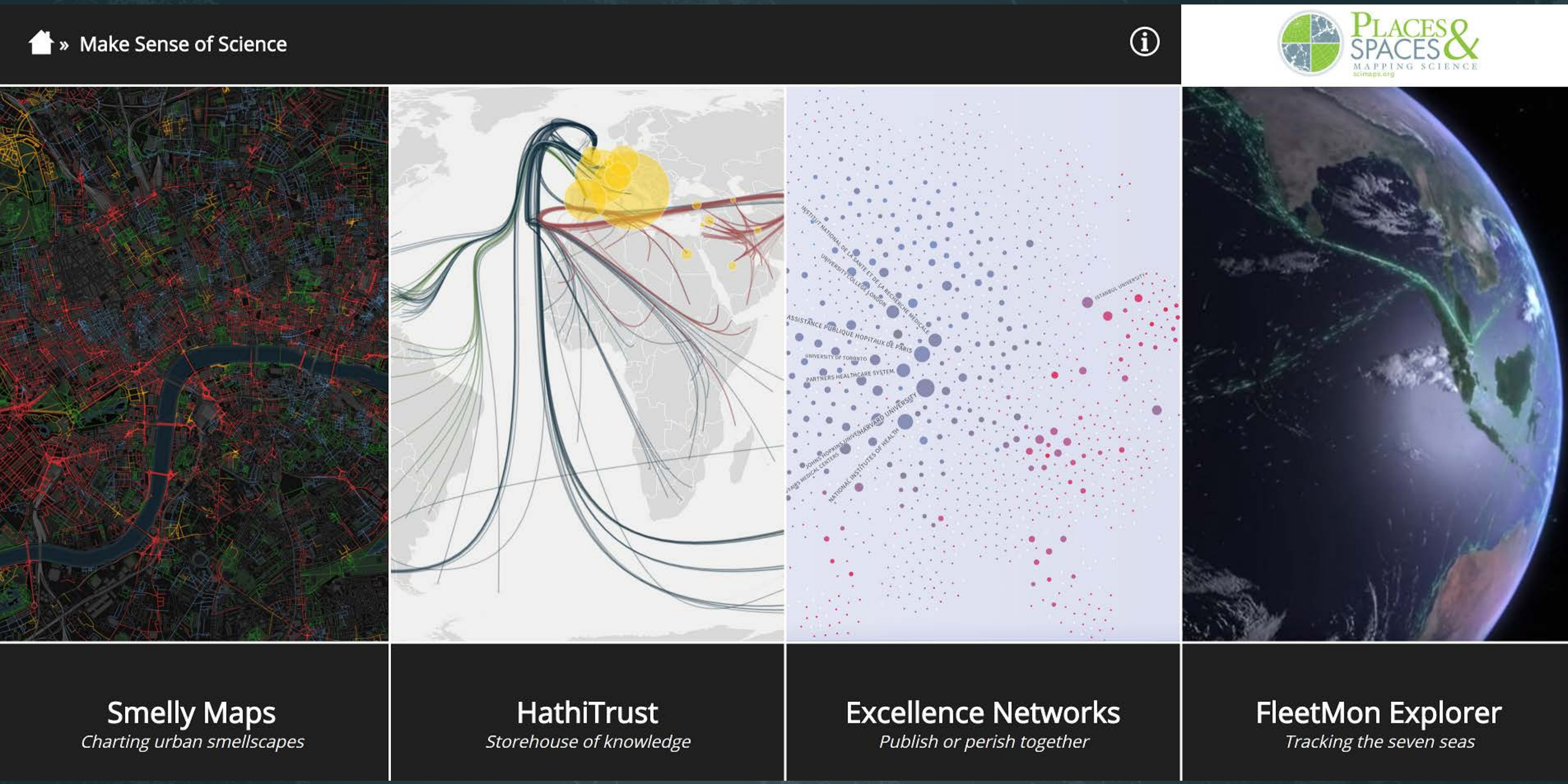
Earth – Cameron Beccario



AcademyScope – National Academy of the Sciences & CNS

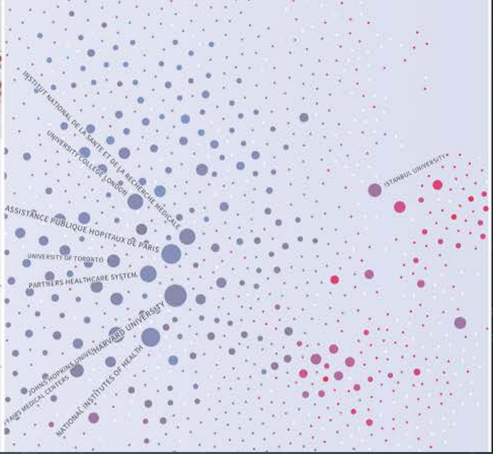


Mapping Global Society –Kalev Leetaru



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

http://scimaps.org/iteration/12



Four new macroscopes debut at Vanderbilt University:

1. **Smelly Maps:** Features a "smellscape" of 12 cities mapped by smell using social media
2. **HathiTrust:** Highlights the diversity of publications collected in digital form by HathiTrust.
3. **Excellence Networks:** Compares how research institutions, such as Indiana and Vanderbilt universities, collaborate with one another.
4. **FleetMon:** Shows how the amount of shipping traffic that navigates the Strait of Malacca compared to other major shipping lanes of the world.

http://scimaps.org/vanderbilt

A visitor explores the macroscope kiosk at the Eskenazi Museum of Art at Indiana University.

Call for Macroscope Tools for the *Places & Spaces: Mapping Science* Exhibit (2017) http://scimaps.org/call

Background and Goals

The *Places & Spaces: Mapping Science* exhibit is designed to open people's hearts and minds to the value, complexity, and beauty of maps of science and technology.

Drawing from across cultures and across scholarly disciplines, the *Places & Spaces: Mapping Science* exhibit demonstrates the

IVMOOC.cns.iu.edu

PLACES & SPACES

MAPPING SCIENCE

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IVMOOC 2017

MENU

Register for free: http://ivmooc.cns.iu.edu. Class started Jan 10, 2017.

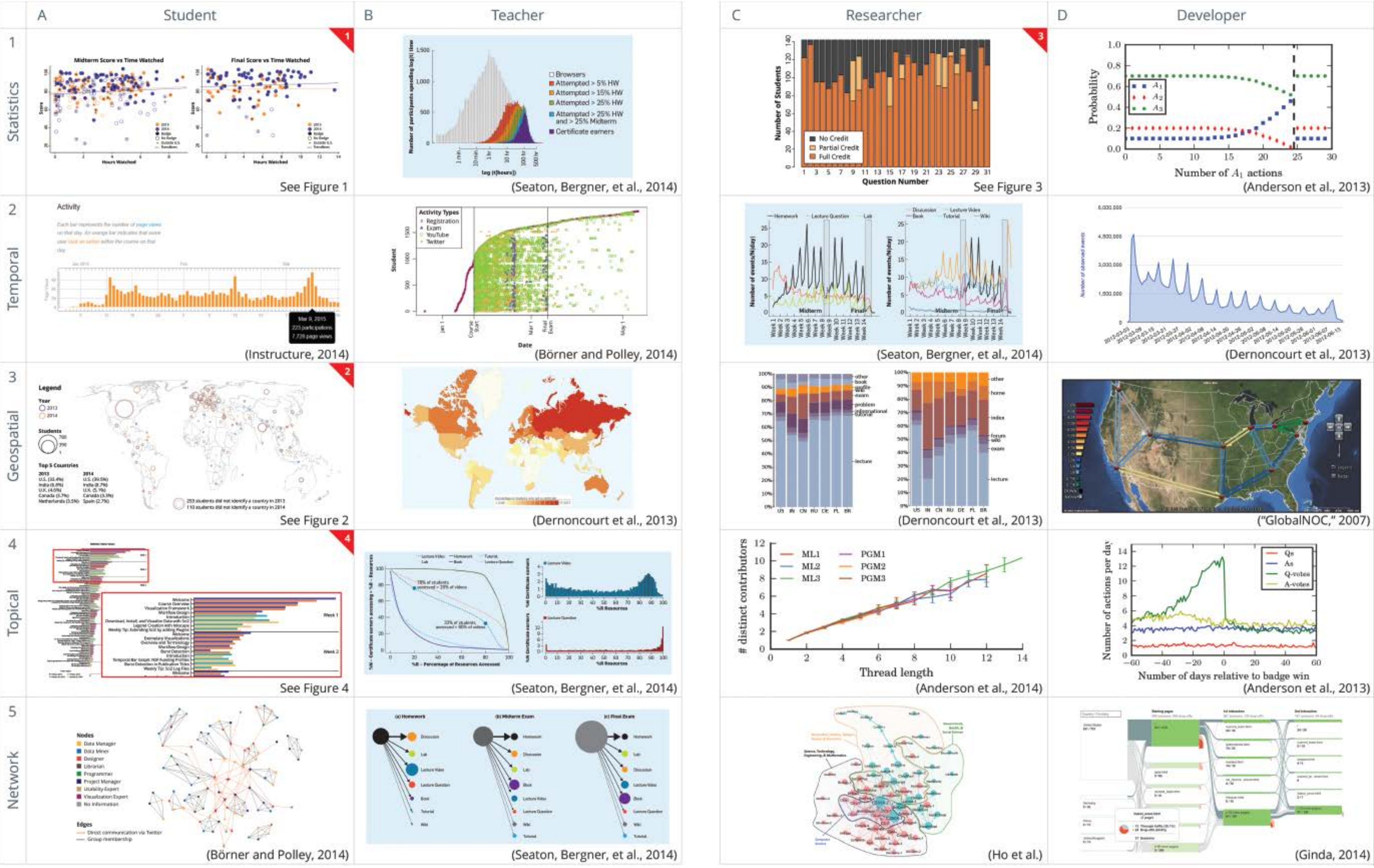
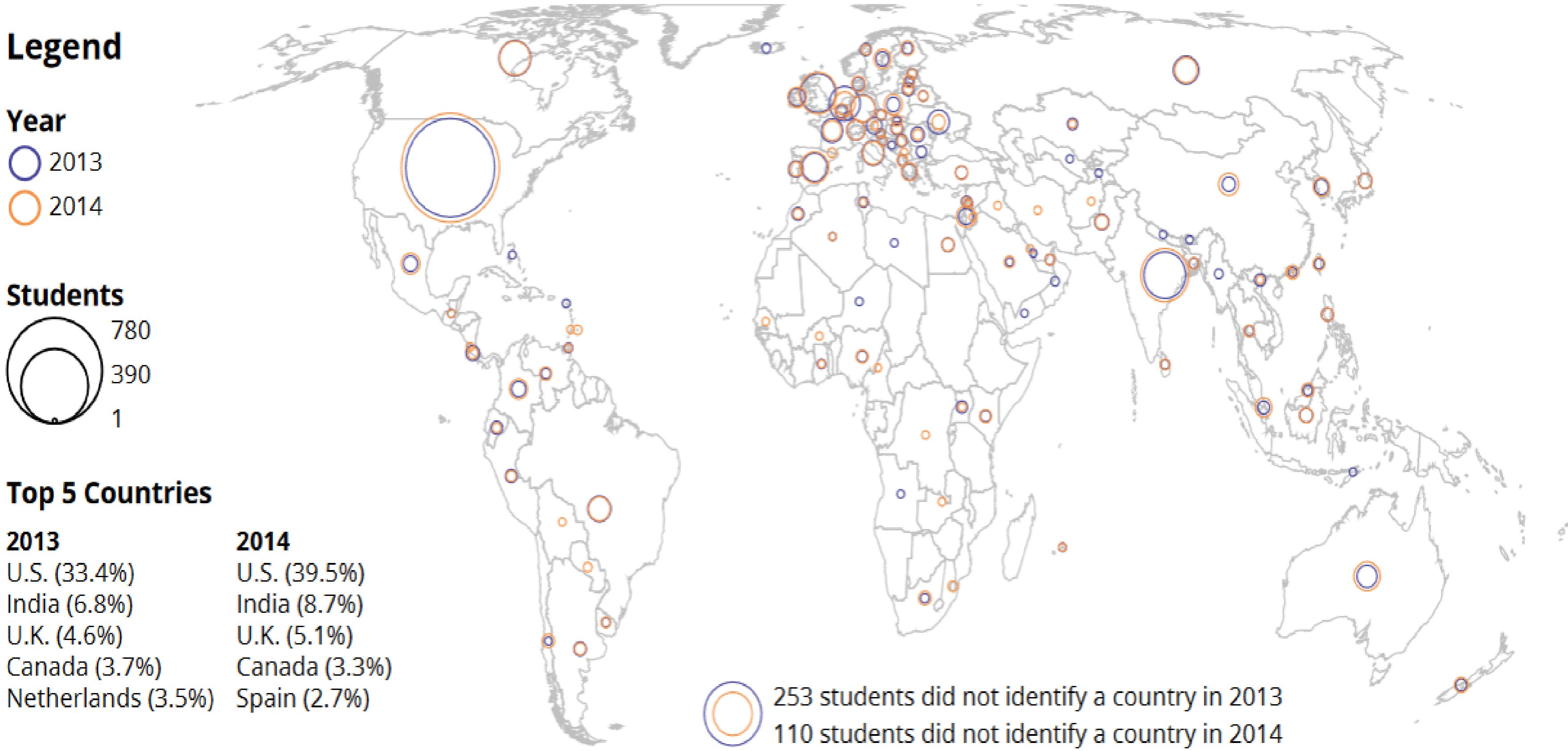


Figure 1: Analysis types vs. user needs, taken from

Emmons, Light, and Börner. "MOOC Visual Analytics: Empowering Teachers, Students, Researchers, and Developers of Massively Open Online Courses". *Journal of the Association for Information Science and Technology (in press)*.

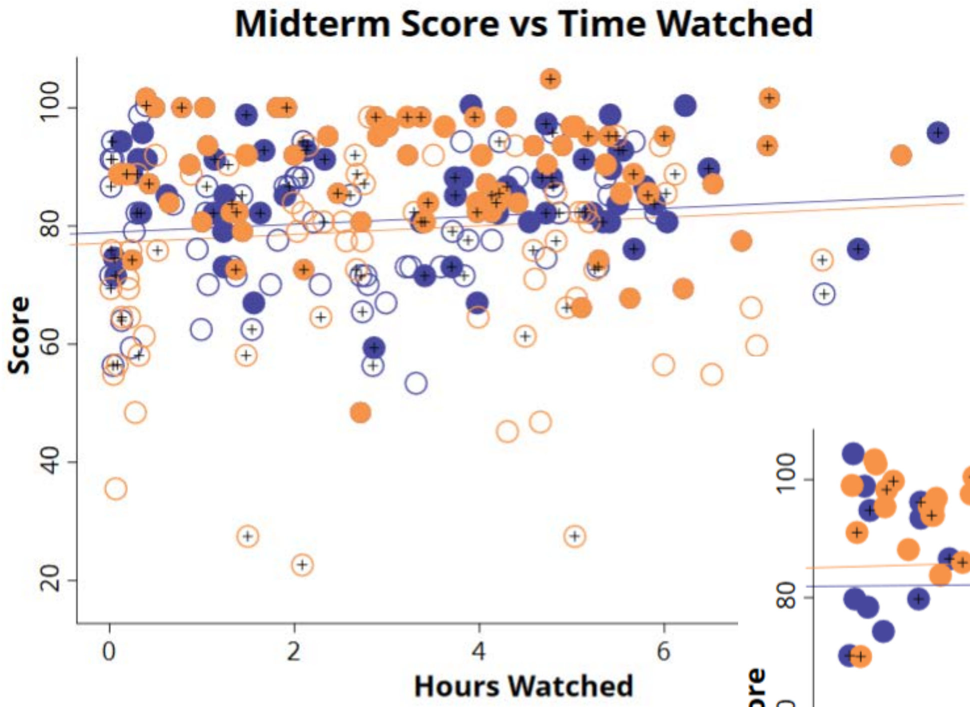
IVMOOC

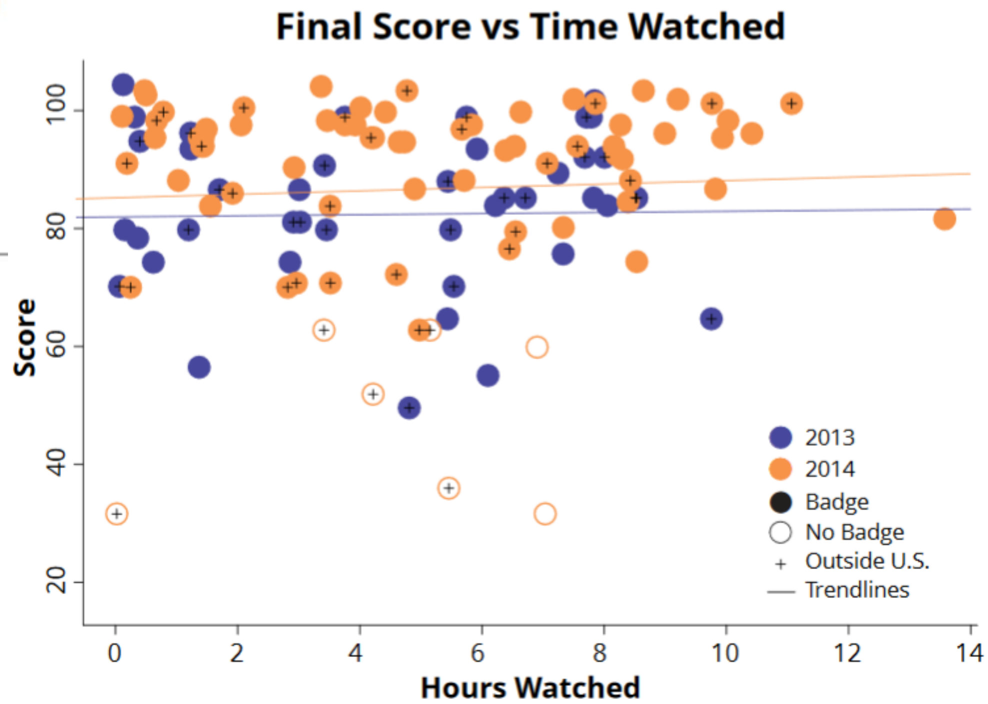
Students' Countries



Proportional symbol map of the world showing the location of IVMOOC students from 2013 (blue) and 2014 (orange). Circles are area size coded by the number of students per country.

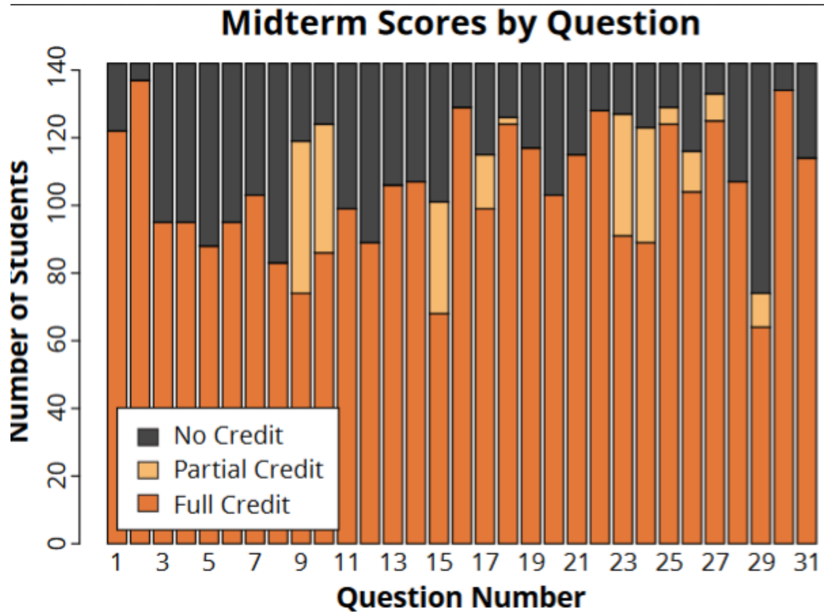
Student Final Score vs. Hours Watched

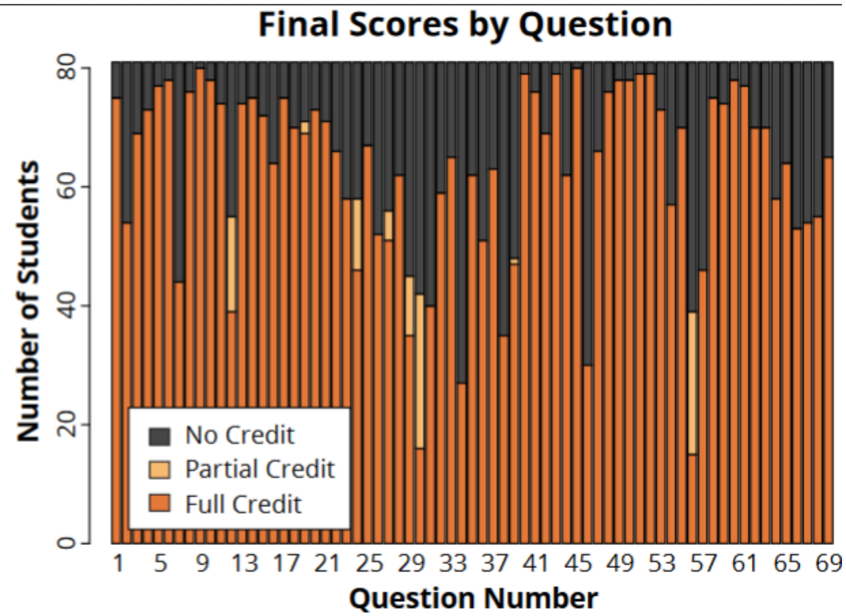




Scores vs. time invested watching course videos for students who took the 2013 (blue) and 2014 (orange) IVMOOC midterm (left) and final exam (right) and got at least 50% correct.

Exam Scores by Question

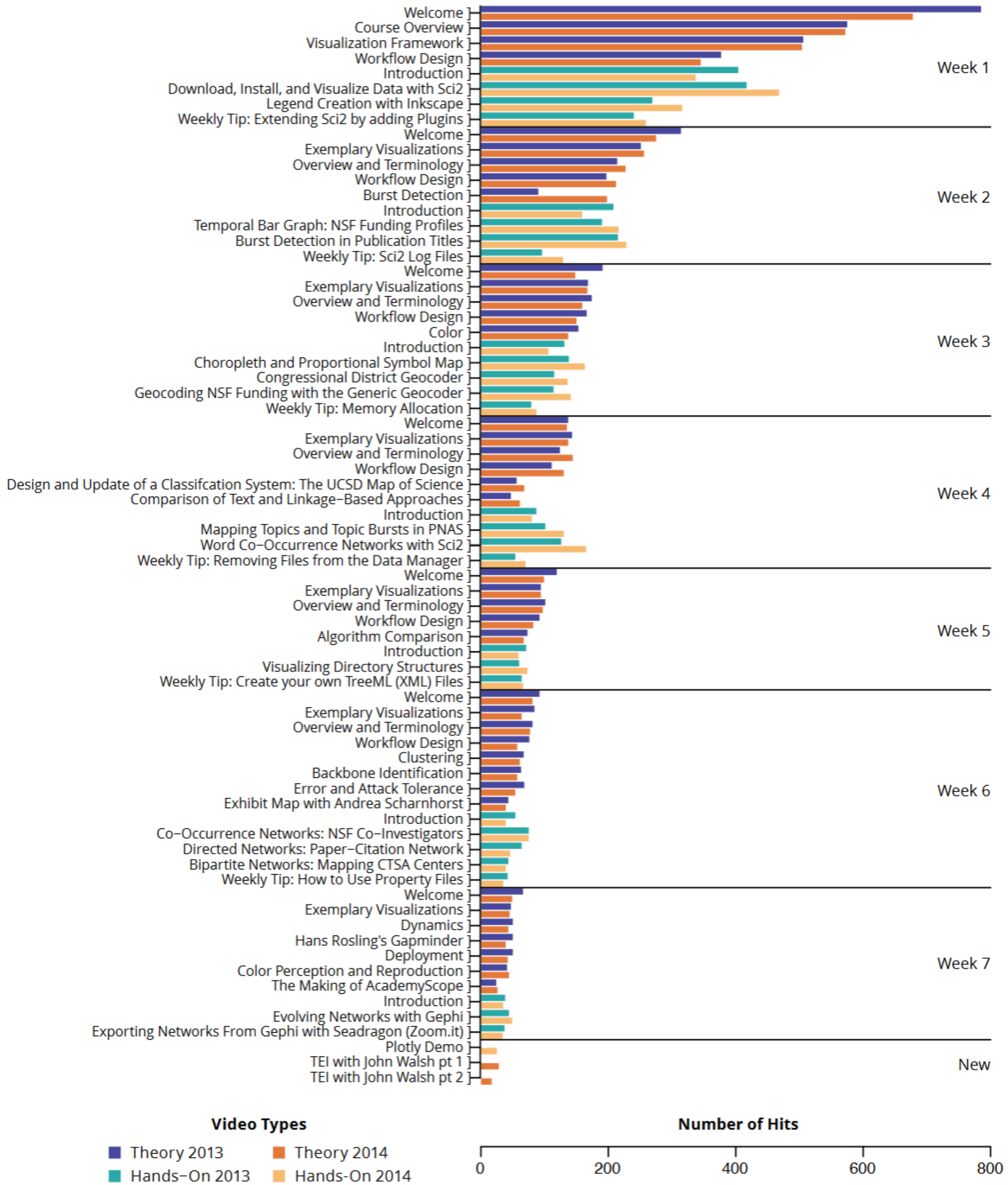




Student scores per question for midterm (left) and final exam (right) for IVMOOC 2014.

IVMOOC Video Views

IVMOOC video views in 2013 (blue) and 2014 (orange)



IVMOOC

Student Client Projects: All Interactions

IVMOOC

Student Engagement and Performance

Learning Analytics

IVMOOC 2015 Student Group Engagement and Scores

	Pre-Course	Week 1	Week 2	Week 3	Week 4	Midterm	Week 5	Week 6	Week 7	Week 8	Week 9	Final	Curr. Score
IVMOOC	26.05%	38.32%	31.32%	29.96%	27.1%	28.34%	31.07%	24.28%	16.86%	18.23%	13.08%	13.41%	20.87%
Z637-29374	33.01%	52.91%	49.89%	59.22%	50.89%	82.56%	65.04%	49.99%	39.59%	61.63%	54.91%	82.25%	82.4%
Z637-32593	25.08%	54.54%	43.58%	50.67%	53.63%	77.67%	65.7%	59.48%	52.19%	65.71%	47.27%	72.59%	75.13%
Z637-33781	29.33%	55.38%	49.26%	62.18%	77.47%	85%	87.4%	69.8%	55.56%	57.6%	45.69%	70.89%	77.94%

IVMOOC 2015 Student Group Engagement for Midterm

	Midterm	Final	Curr. Score	Overall Engagemer
Student 198	100%	85.33%	92.67%	30.34%
Student 210	100%	84%	92%	33.91%
Student 242	97.14%	98.67%	97.9%	55.89%
Student 265	95.71%	92%	93.86%	82.64%
Student 216	95.71%	24%	59.86%	34.92%
Student 257	94.29%	98.67%	96.48%	68.25%
Student 264	94.29%	89.33%	91.81%	80.47%
Student 262	94.29%	85.33%	89.81%	79.65%

Legends

Engagement

Inactive — Active — Very Active

0% 25% 50% 75% 100%

Score

F D C B A

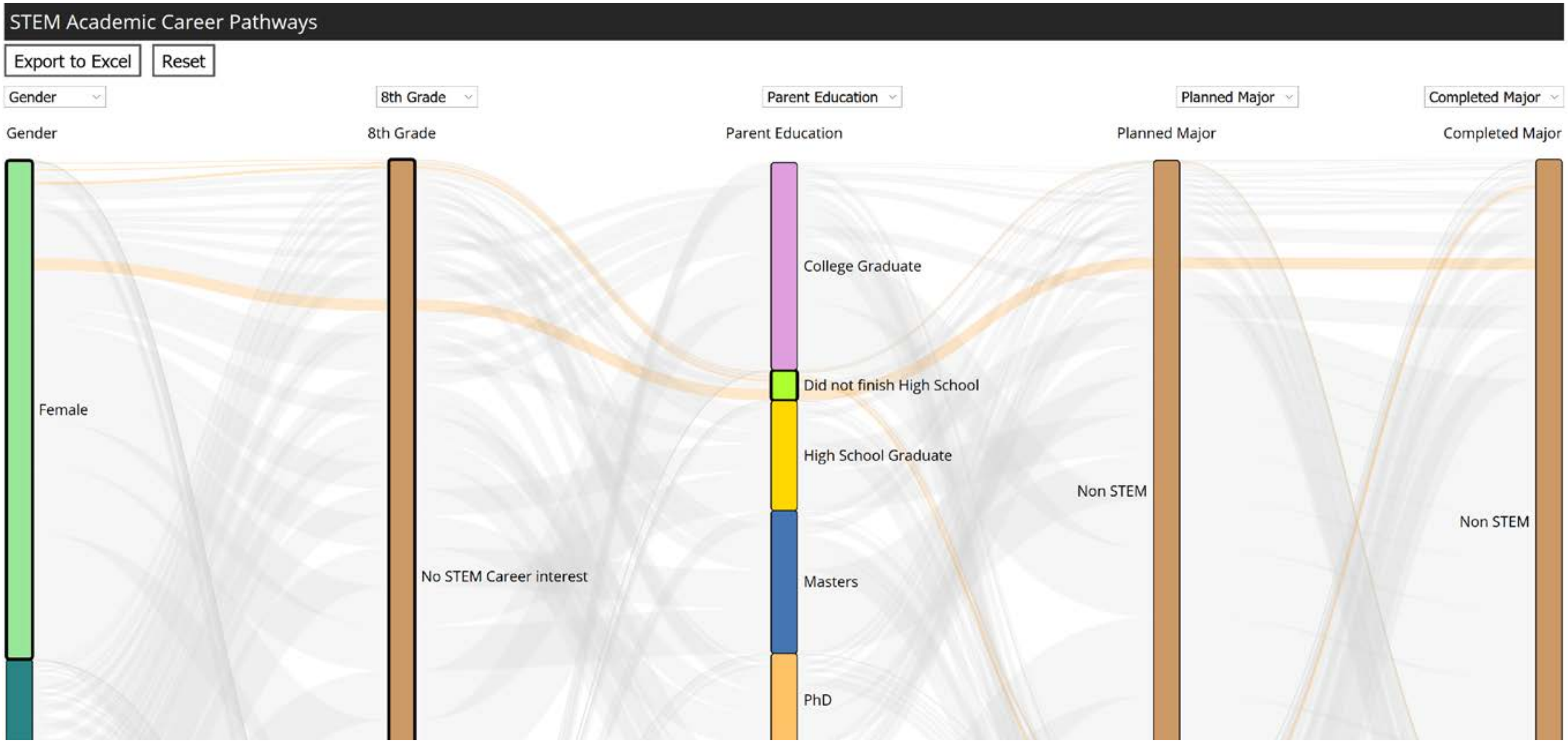
0% 60% 70% 80% 100%

Description

The heat map visualization is a representation of student engagement (magenta to blue color scale) and performance (red to green color scale) throughout a course. The visualization has two levels. The top level provides an overview of engagement and performance for groups of students, while the bottom level provides a detailed break out of student engagement statistics for individuals with an identified group.

Custom interactive visualizations of 2015 IVMOOC student engagement and performance data, explore functionality online at http://goo.gl/TYixCn

Student Flows – STEM Academic Career Pathways



Measuring and Visualizing STEM Pathways. NSF NCSE-1538763 Award (Adam Maltese, Katy Börner) Aug. 15, 2015 - Jan. 2017.

Interactive web site: http://demo.cns.iu.edu/client/stem

Forecasting S&T

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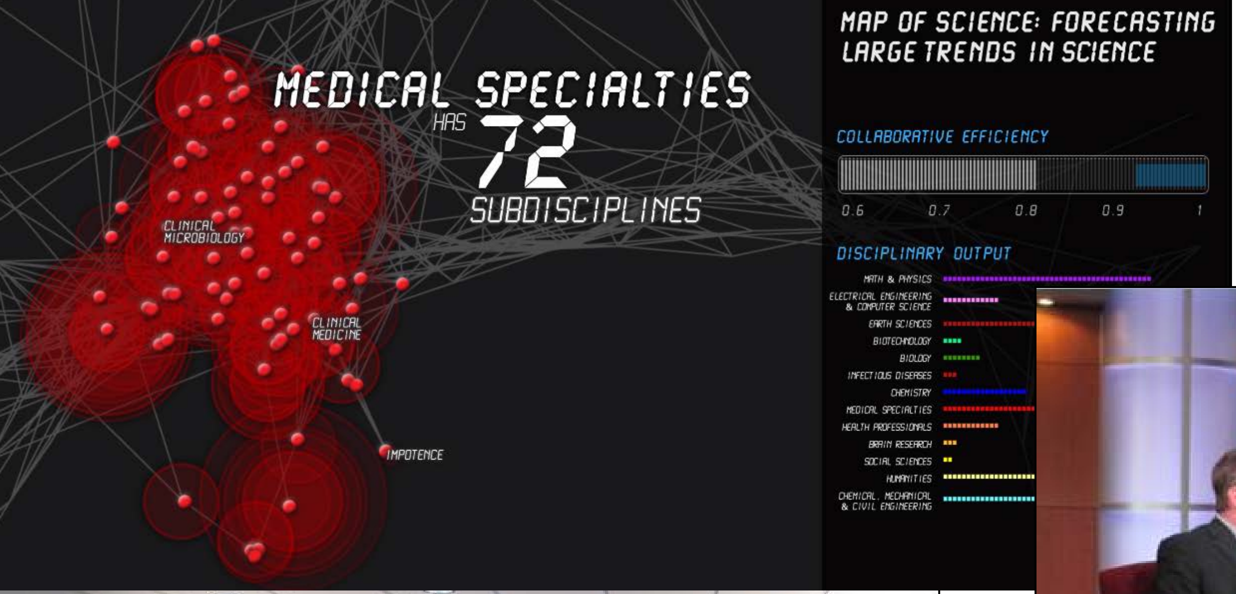
Science Forecast
S1:E1, 2015



Government, academic, and industry leaders discussed challenges and opportunities associated with using big data, visual analytics, and computational models in STI decision-making.

Conference slides, recordings, and report are available via http://modsti.cns.iu.edu/report

NSF ETE FEDERAL IT THOMSON REUTERS INDIANA UNIVERSITY NETWORK SCIENCE INSTITUTE

Arthur M. Sackler COLLOQUIA

Upcoming Colloquia

Unless otherwise indicated, most Sackler colloquia are held at the Arnold and Mabel Beckman Center, in Irvine, California.

Reproducibility of Research: Issues and Proposed Remedies

March 8-10, 2017; Washington, D.C.
Organized by David B. Allison, Richard Shiffrin and Victoria Stodden
Registration now open

Science of Science Communication III

November 15-16, 2017; Washington, D.C.
Organized by Karen Cook, Baruch Fischhoff, Alan I. Leshner and Dietram A. Scheufele
Registration will open May 2017

Modelling and Visualizing Science and Technology Developments

December 4-5, 2017; Irvine, CA
Organized by Katy Börner, William Rouse and H. Eugene Stanley
Registration will open August 2017

http://www.nasonline.org/programs/sackler-colloquia/upcoming-colloquia

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

Börner, Katy (2010) **Atlas of Science: Visualizing What We Know**. The MIT Press. http://scimaps.org/atlas

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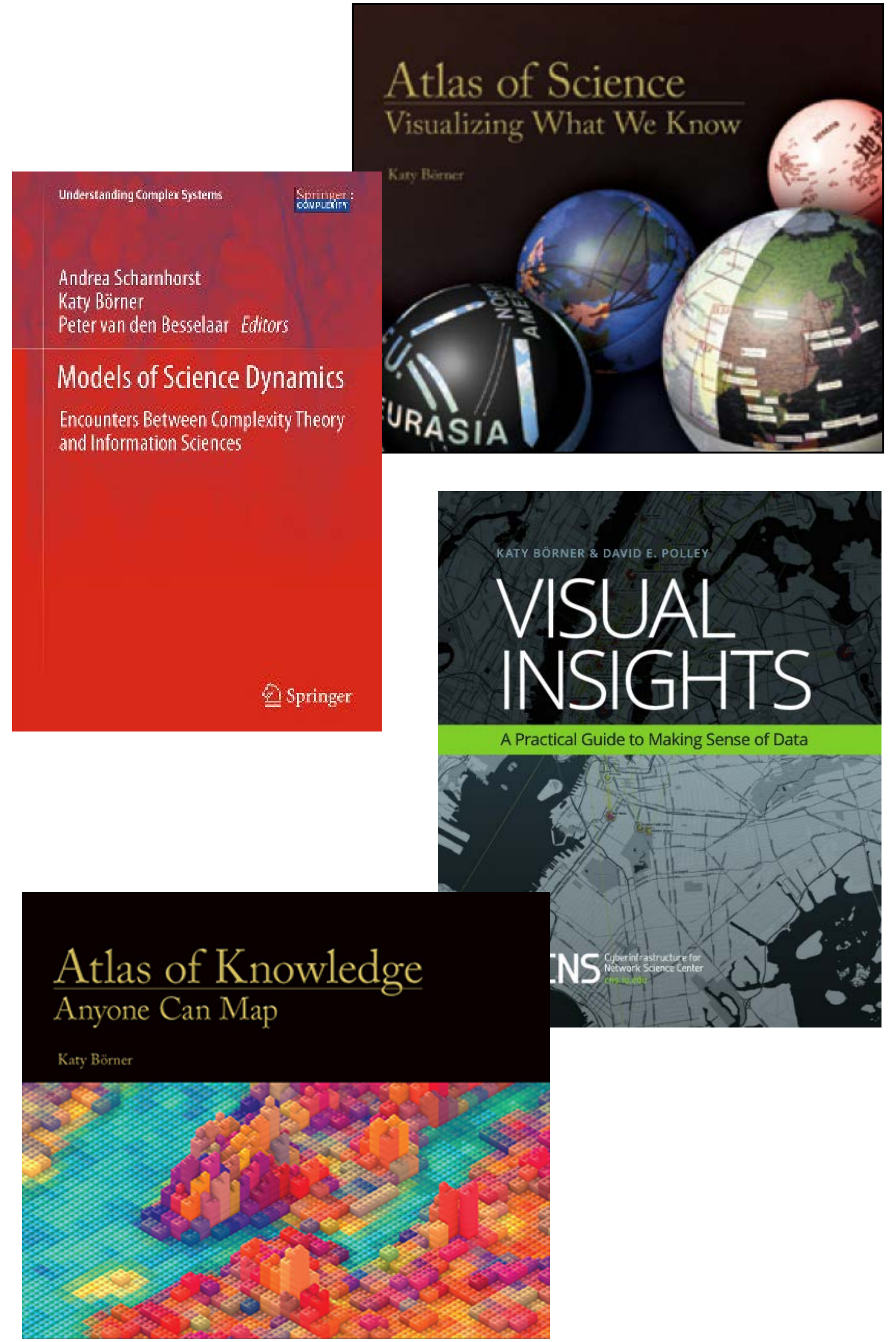

All papers, maps, tools, talks, press are linked from http://cns.iu.edu
These slides are at http://cns.iu.edu/presentations.html

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