MOOC and More

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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

The Social Sciences are the smallest and most diffuse of all the sciences. Psychology serves as the link between Medical Sciences (Psychiatry) and the Social Sciences. Statistics serves as the link with Computer Science and Mathematics.

Mathematics is our starting point, the purest of all sciences, it lies at the outer edge of the map. Computer Science, Electrical Engineering, and optics are core fields that draw upon knowledge in Mathematics and Physics. These three disciplines provide a good example of a linear progression from one pure science (Mathematics) to another (Physics) through multiple disciplines. Although applied, these disciplines are highly concentrated with distinct bands of research communities that link them. Bands indicate interdisciplinary research.

Research is highly concentrated in Physics and Chemistry. These disciplines have few, but very distinct, bands of research communities that link them. The thickness of these bands indicates an extensive amount of interdisciplinary research, which suggests that the boundaries between physics and chemistry are not as distinct as one might assume.

We are all familiar with traditional maps that show the relationships between countries, provinces, states, and cities. Similar relationships exist between the various disciplines and research topics in science. This allows us to map the structure of science.

One of the first maps of science was developed at the Institute for Scientific Information over 50 years ago. It identified 48 areas of science from the citation patterns in 17,000 scientific papers. That early map was intriguing, but it didn’t capture enough of science to accurately define its structure.

Things are different today. We have numerous computing power and advanced visualization software that make mapping the structure of science possible. This galaxy-like map of science (left) was generated at Sandia National Laboratories using an advanced graph layout routine (YEd) from the citation patterns in 800,000 scientific papers published in 2002. Each dot in the galaxy represents one of the 96,000 research communities active in science in 2002. A research community is a group of papers (from one to several hundred) that are written on the same research topic in a given year. Over time, communities can be born, continue, split, merge, or die.

The map of science can be used as a tool for science strategy. It is the terrain in which organizations and institutions locate their scientific capabilities. Additional information about the scientific and economic impact of each research community allows policy makers to decide which areas to explore, expand, shrink, or ignore.

We also envision the maps as an educational tool. For children, the traditional relationship between areas of science can be replaced with a concrete map showing how math, physics, chemistry, biology, and social sciences interact. For advanced students, areas of interest can be located and neighboring areas can be explored.

The Life Sciences, including Biology and Biochemistry, are less concentrated than Chemistry or Physics. Bands of linking research can be seen between the larger areas in the Life Sciences, for instance between Biology and Microbiology and between Biology and Environmental Science. Bioinformatics is interesting in that it is a large discipline with visible links to disciplines in many areas of the map, including Biology, Chemistry, Neuroscience, and General Medicine. It is perhaps the most interdisciplinary of the sciences.

Nanotechnology

Most research communities in nanotechnology are concentrated in Physical Chemistry and Materials Science. However, many disciplines in the Life and Medical Sciences also have nanotechnology applications.

Proteomics

Research communities in proteomics are centered in Biochemistry. In addition, there is a heavy focus in the tools section of chemistry, such as Chromatography. The balance of the proteomics community is widely dispersed among the Life and Medical Sciences.

Pharmacogenomics

Pharmacogenomics is a relatively new field within the study of activity in Medicine. It also has many communities in the Life Sciences and two communities in the Social Sciences.
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
Places & Spaces at Northwestern University
May 14 - September 23, 2015

Kristi Holmes  @kristiholmes · Apr 30
Excited for @cnscenter Places&Spaces at @galterlibrary! @katycns @NUCATSInstitute #unpackingcrates #viz
Places & Spaces Exhibit at the David J. Sencer CDC Museum, Atlanta, GA

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
10 iterations over 10 years

equal

10 \times 10 = 100 \text{ maps!}
The Power of Maps 2005
Cartographic maps of physical places have guided mankind’s explorations for centuries.

They enabled the discovery of new worlds while also marking territories inhabited by the unknown.

Without maps, we would be lost.
A New Map of the Whole World with Trade Winds According to the Latest and Most Exact Observations - Herman Moll - 1736
Science maps of abstract semantic spaces aim to serve today’s explorers navigating the world of science.

They can be used to identify objectively major experts, institutions, collections. They allow us to track the emergence, evolution, and disappearance of topics and help to identify the most promising areas of research.
This map is designed to show the interconnected "tricks of thought" in a computer science thesis.


Ph.D. Thesis Map - Keith B. Nesbitt - 2004
The Power of Reference Systems 2006
This chart shows the 118 currently known and officially named elements that comprise the Periodic Table (IUPAC 2004). Each element is represented visually by an image produced for the Visual Elements project.

The Periodic Table is an arrangement of all known elements in the order of increasing atomic number. The Periodic Table fits all the elements, with their widely diverse physical and chemical properties, into a logical pattern. There are eighteen vertical columns in the table which divide the elements into groups. Elements within a group have closely related physical properties. Horizontal rows list the elements in order of their increasing mass and are called series or periods. Properties of elements change in a systematic way through a period.
How would a reference system for all of science look?

What dimensions would it have?
In their 1964 paper, Eugene Garfield and his colleagues try to answer the question: Can a computer write the history of science? To answer this question, they selected a recent scientific breakthrough – the discovery of a structure for DNA: a double helix – and used a mechanism for its self-replication, published by Watson & Crick in 1953. They used genealogical analysis to identify 14 key papers that led to the discovery of DNA's double helix, as well as their interrelationships. They also identified the citation links among these 14 key papers using the 1964 Science Citation Index.

The detailed comparison of both networks demonstrates a high degree of coincidence between Asimov's account of events and the citation links between the papers. They conclude that the use of citation links to write the history of science might provide new modeling paradigms for the study of the history of science, research administration, and the sociology of science. Today, their HistCite tool generates interactive citation graphs automatically, see <https://histcite.com>.
The Power of Forecasts 2007

III.1

III.3

III.5

III.7

III.9

III.2

III.4

III.6

III.8

III.10
Tectonic Movements and Earthquake Hazard Predictions - Martin W. Hamburger, Lou Estey, Chuck Meertens, Elisha Hardy - 2005
Impact of Air Travel on Global Spread of Infectious Diseases - Vittoria Colizza, Alessandro Vespignani - 2007

Epidemic spreading patterns changed dramatically after the development of modern transportation systems.

The SARS outbreak on the other hand was characterized by a patchwork and heterogeneous spatio-temporal pattern mainly due to the air transportation network identified as the major channel of epidemic diffusion and ability to connect far apart regions in a short time period. The SARS maps are obtained with a data-driven stochastic computational model aimed at the study of the SARS epidemic pattern and analysis of the accuracy of the model’s predictions. Simulation results describe a spatio-temporal evolution of the disease (color coded countries) in agreement with the historical data. Analysis on the robustness of the model’s forecasts leads to the emergence and identification of epidemic pathways as the most probable routes of propagation of the disease. Only a few preferential channels are selected (arrows; width indicates the probability of propagation along that path) out of the huge number of possible paths the infection could take by following the complex nature of airline connections (light gray, source: IATA).

Forecasts of the Next Pandemic Influenza

Forecasts are obtained with a stochastic computational model which explicitly incorporates data on worldwide air travel and detailed census data to simulate the spread of a pandemic influenza.

The central map represents the cumulative number of cases in the world after the first year from the start of a pandemic influenza with R0=1.9 originating in Hanoi (Vietnam) in the Spring.

The US maps focus on the situation in the US after one year, and show the effect of changes in the original scenario analyzed. Different color coding is used for the sake of visualization.

Reproductive Number (Ro)

RO = 1.7

1.3

Intervention

UNCOOPERATIVE

COOPERATIVE

Time evolution of a pandemic starting in Hanoi (Vietnam) in the Fall in the no intervention scenario. Profiles of the fraction of infectious individuals in time (prevalence) are shown for some representative countries (left) and cities (right). Two different values of the reproductive number are considered: R0=1.5, consistently with the values shown for the US map (top right), and R0=2.3, in order to provide the comparison with faster spreading.

The model includes the worldwide air transportation network (source: IATA) composed of 3,100 airports in 220 countries and E=17,182 direct connections, each of them associated to the corresponding passenger flow. This dataset accounts for 99% of the worldwide traffic and is complemented by the census data of each large metropolitan area served by the corresponding airport.

Additional spreading scenarios can be obtained by modeling different levels of infectiousness of the virus, as expressed in terms of the reproductive number Ro, representing the average number of infections generated by a sick person in a fully susceptible population.

Intervention strategies modeling the use of antiviral drugs can be considered. Two scenarios are compared: an uncooperative strategy in which countries only use their own stockpiles, and a cooperative intervention which envisages a limited worldwide sharing of the resources.

Impact of Air Travel on Global Spread of Infectious Diseases - Vittoria Colizza, Alessandro Vespignani - 2007
Can one forecast science?

What ‘science forecast language’ will work to communicate results?
114 Years of Physical Review

Bruce W. Herr II, Russell Duohon, Katy Borner, Elisha Hardy, Shashikant Penumarthy

2007
Mapping the Universe: Space, Time, Discovery!
Science Maps for Economic Decision Makers 2008
What insight needs do economic decision makers have?

What data views are most useful?
Europe Raw Cotton Imports in 1858, 1864 and 1865 - Charles Joseph Minard - 1866
Tracing of Key Events in the Development of the Video Tape Recorder - Mr. G. Benn, Francis Narin - 1968
Science Maps for Science Policy Makers 2009
The Council for Chemical Research (CCR) has examined the US Congress and government policy makers' role in important decisions regarding the funding of Federal R&D investments in US Innovation and global competitiveness. Through its 2010 report, "Science, the Innovation Engine," CCR highlighted the critical role of Federal funding in driving innovation and economic growth. The diagram below illustrates the impact of R&D funding on various sectors, including Federal Government, Chemical Industry, and the U.S. Economy. The diagram presents a model where $1 Billion in Federal Funding leads to $5 Billion in Corporate Funding, which in turn generates $10 Billion in operating income, creating 600,000 jobs and contributing to $40 Billion in GNP. This cycle highlights the importance of sustained investment in R&D for long-term economic growth and national competitiveness.
The EMERGENCE of NANOTECHNOLOGY

MAPPING THE NANO REVOLUTION
The emergence of nanotechnology has been one of the major scientific-technological revolutions in the last decade and it led to a structural reorganization of major fields of science. Price (1965) showed that fields of science and their development can be mapped using aggregated citations among the journals in the fields and their relevant environments. The frames to the right show the evolving journal citation network for the years 1998-2003. Distances are proportional to cosine values between the citation patterns of the respective journals. Textual descriptions of key events during the development of Nanotechnology are given below each frame. Most notably, leading papers in Science and Nature catalyzed the breakthrough around 2000.

CHANGING ROLES OF DIFFERENT JOURNALS
The interdisciplinarity of a journal can be measured using betweenness centrality (BC): journals that occupy many shortest paths between other journals in a network have higher BC value than those that do not. In the map, sizes of nodes are proportional to the betweenness centrality of the respective journal in the citation network.
From being a specialist journal in applied physics, the journal Nanotechnology obtains a high BC value in the years of the transition, ca. 2001. This is preceded by the "intervention" of Science. After the transition, the new field of nanotechnology is established, new journals such as Nano Letters published by the influential American Chemical Society join the lead, and a new specialty structure with low BC value journals results.

LEGEND
- Science
- Nature
- Nanotechnology
- Nano Letters

An animated sequence of this evolution is at: http://www.leydesdorff.net/journals/nanotech.

References

The Emergence of Nanoscience & Technology - Loet Leydesdorff - 2010
Science Maps as Visual Interfaces to Digital Libraries 2011
Map of Scientific Collaborations from 2005-2009

Stream of Scientific Collaborations Between World Cities - Olivier H. Beauchesne - 2012
Check out our **Zoom Maps** online!

Visit [scimaps.org](http://scimaps.org) and check out all our maps in stunning detail!
The Khan Academy is an organization with the goal of changing education for the better by providing a free world-class education to anyone anywhere. It doesn’t matter if you are a student, teacher, home-schooler, principal, adult returning to the classroom after 30 years, or a friendly alien just trying to get a leg up in earthly biology. The Khan Academy’s materials and resources are available to you completely free of charge.

Khan Academy Library Overview

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<tr>
<td>Humanities</td>
<td>170</td>
<td>295:45</td>
<td>25:10</td>
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VIEWS DISTRIBUTION

- 100 views
- 1,000+ views

HOW TO READ THE VISUALIZATION

- The diagram shows the complete library of over 3,000 videos published by Khan Academy and their organization in topics, subtopics, and playlists.

ABOUT THE AUTHOR

This visual library was designed and developed by Benjamin Wiederkehr with the support of Jerome Cukier.

https://www.khanacademy.org

ABOUT THE DATA

The data that drives the visualization was collected using the official API provided by Khan Academy on May 17, 2012.

https://api.khanacademy.org

Khan Academy Library Overview - Benjamin Wiederkehr and Jérôme Cukier - 2012
Science Maps Showing Trends and Dynamics 2013
Pulse of the Nation: U.S. Mood Variations Inferred From Twitter

Mood Variations
A number of interesting trends can be observed in the data from overall daily variations can be seen from graphs, with the early morning and late evening having the highest level of happiness. Second, geographic variations can be observed, with a region's daily pattern being more consistent in the west coast.

Weekly Variations
Weekly trends can be observed as well, with weekdays being much happier than weekend days.

About the Data and Visualization
The posts were captured using over 300 million tweets (Sep 2009 - Aug 2009) collected by MIR Eval researchers, represented as density-observing cartograms. The mood of each tweet was inferred using SMMR and graph-tool. The U.S. map was taken from the U.S. Census Bureau at https://www.census.gov, and the basic U.S. map was taken from Free Public Domain. Location information was inferred using the Google Maps API and mapped into counties using PostGIS and U.S. County map from the U.S. National Atlas. Mood colors were selected using Color Brewer 2.

Northeastern University
College of Computer and Information Science
Center for Complex Network Research
http://www.cs.northeastern.edu/home/amislove/twittermood

© 2010 Alan Mislove, Sune Lehmann, Yong-Yeol Ahn, Jukka-Pekka Onnela, and James Niels Rosenquist - 2010
Who Really Matters in the World—Leadership Networks in Different-Language Wikipedias

Peter A. Gloor, Keiichi Nemoto, Samuel T. Mills, and David E. Polley - 2013
Visit us on Facebook!

Become a fan and see many great photos of the exhibit—plus find out when it’s coming to a venue near you!

facebook.com/mappingscience
The Future of Science Mapping 2014

Use the original online tool at [healthmap.org/predict](http://healthmap.org/predict)
Exploring the Relationships Between a Map of Altruism and a Map of Science

How is altruism related to science? Altruism is about individual selfless intentions. Science is about discovery and problem solving. On the surface these two facets of society may seem unrelated. In reality they may be strongly linked. Altruistic missions explain historical (and may predict future) patterns of scientific investments. The map of altruism (left) represents altruistic missions, and displays the relative positions of nearly 100,000 non-profit organizations (NPOs) in the United States based on mission-related text from their websites. This map of altruism reveals the issues that we care most about as a society: Culture, Sports, Education, Religion, Community, Citizenship, and Caring. The map of science (right) represents decades of funded research in the natural and medical sciences, engineering, technology, social sciences and humanities. It displays over 43,000,000 documents that are grouped together using a combination of citation and textual similarity.

These two maps are shown side-by-side to illustrate how the altruistic intentions of a society correlate with where we focus our discovery and problem solving efforts. The map of science has been divided into four major areas, shown in four different colors. NPOs whose National Taxonomy of Exempt Entities (NTEE) codes indicate that they explicitly fund scientific activities in these four areas are correspondingly colored in the map of altruism. Altruistic missions associated with these four areas are considered in more detail below, along with projections of how altruistic missions not currently associated with funding of scientific research might benefit from such funding in the future.

**Citizenship** is linked to Physics, Chemistry, Engineering, and Computer Science. The specific aspect of Citizenship active here is the belief that funding should be provided for entrepreneurship and innovation so that the economy can flourish. The funding of science-based innovation from governments and NPOs is reasonably mature and is expected to remain high.

**Caring** is the basis for funding medical research. The aspects of Caring vary, and include caring of disease, providing opportunities for the disabled, and the treatment of mental health issues. A scientific understanding of these issues has been well funded by individuals, e.g., through donations to NPOs and through government funding, e.g., the National Institutes of Health.

**All Seven Aspects of Altruism** are potentially important for childhood development. Scientific research related to this topic is currently focused on social issues, e.g., risk factors, and Education. The altruism map raises an interesting question: Is this the right balance, or should more scientific attention be paid to childhood development in other areas, such as Culture, Community, Sports, and Citizenship? Time will tell.

**Historical**

**Culture and Citizenship** contribute to the funding of environmental research. Culture supports that aspect of environmental research that is more concerned with the preservation of our planet for the future enjoyment of our children. Citizenship supports the aspect focusing on innovative solutions and political tradeoffs which arise from the toxic consequences of current practices.

**Future**

**Community** is an important altruistic mission that represents a potential funding opportunity. We know very little about how different communities (e.g., professional, social, etc.) have evolved in terms of providing altruistic services to their members. There are lessons to be learned from how communities variously emphasize Culture, Sports, Education, Religion, Care, or Civic responsibility.

Exploring the Relationships between a Map of Altruism and a Map of Science - Richard Klavans and Kevin W. Boyack - 2014
Explore the maps and background information at http://scimaps.org
Macrosopes

PlACES & SPACES
MAPPING SCIENCE

scimaps.org
MAPS

vs.

MACROSCOPES
Microscopes & Telescopes vs. MACROSCOPES
Iteration XI (2015): Macrosopes for Interacting with Science

http://scimaps.org/iteration/11
Earth – Cameron Beccario
The News Co-occurrence Globe
An interactive visualization of how countries are mentioned together in the world's news media.

2,922
COOCCUR%

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

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

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 power of maps to reveal and enrich our relationships to the natural world and to our fellow human beings.
Join the map makers & exhibit ambassadors.
Data Visualization Literacy: Teaching
The Information Visualization MOOC
ivmooc.cns.iu.edu

Students from more than 100 countries
350+ faculty members
#ivmooc
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?

• Or?
Different Question Types

Find your way

Descriptive & Predictive Models

Find collaborators, friends

Terabytes of data

Identify trends
Different Levels of Abstraction/Analysis

Macro/Global
Population Level

Meso/Local
Group Level

Micro
Individual Level
Needs-Driven Workflow Design

**Stakeholders**

- **Types and levels of analysis** determine data, algorithms & parameters, and deployment

**Data**

1. **READ**
2. **ANALYZE**

**DEPLOY**

- Visually encode data
- Overlay data
- Select visualiz. type
Needs-Driven Workflow Design

Stakeholders

Data

Types and levels of analysis determine data, algorithms & parameters, and deployment

READ

ANALYZE

VISUALIZE

DEPLOY

Validation

Interpretation

Visually encode data

Overlay data

Select visualiz. type

READ ANALYZE VISUALIZE DEPLOY
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
- categorize/cluster
- order/rank/sort
- distributions (also outliers, gaps)
- comparisons
- trends (process and time)
- geospatial
- compositions (also of text)
- correlations/relationships

### Data Scale Types
- nominal
- ordinal
- interval
- ratio

### Visualization Types
- table
- chart
- graph
- map
- network layout

### Graphic Symbol Types
- geometric symbols
  - point
  - line
  - area
  - surface
  - volume
- linguistic symbols
  - text
  - numerals
  - punctuation marks
- pictorial symbols
  - images
  - icons
  - statistical glyphs

### Graphic Variable Types
- spatial position
- retinal form
- color
- optics
- motion

### Interaction Types
- overview
- zoom
- search and locate
- filter
- details-on-demand
- history
- extract
- link and brush
- projection
- distortion
## Visualization Framework

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# Visualization Framework

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### Geometric Symbols

- **Point**

- **Line**

- **Area**

Legend:

- BLACK
- GRAY
- COLOR

Note: NA (Not Applicable)
## Graphic Variable Types Versus Graphic Symbol Types

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<thead>
<tr>
<th>Graphic Variable Types</th>
<th>Graphic Symbol Types</th>
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<tr>
<td><strong>Statistical Graphs</strong></td>
<td><img src="image" alt="Statistical Graphs" /></td>
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Some table cells are left blank to encourage future exploration of combinations.

### Graphic Variables
- **Spacing**
- **Consistency**
- **Pattern**
- **Orientation**
- **Density**
- **Size**
- **Transparency**
- **Visibility**
- **Coxesoptical Depth**
- **Speed**
- **Velocity**
- **Rhythm**

### Graphic Symbols
- **Point**
- **Line**
- **Axis**
- **Surface**
- **Volume**
- **Text**
- **Numerals**
- **Punctuation Marks**
- **Text**
- **Images**
- **Icons**
- **Statistical Graphs**

94
Load **One** File and Run **Many** Analyses and Visualizations

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**Statistical Analysis—p. 44**

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**Temporal Burst Analysis—p. 48**

**Geospatial Analysis—p. 52**
Load **One** File and Run **Many** Analyses and Visualizations

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Co-author and many other bi-modal networks.
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/ivmoocbook14.html
Data Visualization Literacy: Outlook
Network Visualization in the Humanities

November 25 – 30, 2018, Schloss Dagstuhl, Wadern, Germany

Organizers:
Katy Börner (Indiana University – Bloomington, US)
Dan Edelstein (Stanford University, US)
Tamara Mchedlidze (KIT – Karlsruher Institut für Technologie, DE)
Gerik Scheuermann (Universität Leipzig, DE)
Raymond G. Siemens (University of Victoria, CA)

Digital humanities have seen fast growth in the last ten years. Digital humanities scholars of all fields extract data from their object of study and apply computational methods to answer research questions and to gain new insights. Much of the data collected from, e.g., books, historical texts, publications, dialogs, speeches, archaeological databases, and art pieces can be modeled as networks. Existing network analysis and visualization techniques have already proven themselves useful in analyzing these data and providing new discoveries.

The central goal of the network visualization field is the development of techniques and algorithms for effective network visualization. While network visualization strongly impacts a variety of different major research areas (incl. social science, bioinformatics, neuroscience, electronics, software engineering, business informatics, etc.), the humanities fields use only a tiny portion of the existing network visualization methods. On the other hand, network visualization scholars have not made an extensive attempt to develop and adapt techniques to be used by humanities researchers. Besides the general force-directed algorithm, there is a very limited number of other types of network visualization techniques that have been
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
CSWS Session: Visualizing STEAM Data in Support of Smart Decision Making
November 15-17, 2017, Tokyo, Japan.
References


All papers, maps, tools, talks, press are linked from http://cns.iu.edu
These slides are at http://cns.iu.edu/presentations.html
CNS Facebook: http://www.facebook.com/cnscenter
Mapping Science Exhibit Facebook: http://www.facebook.com/mappingscience