

Maps!

Todd Theriault & Katy Börner, CNS, ILS, SoIC, IU, Bloomington, IN
<http://scimaps.org> | <http://cns.iu.edu>

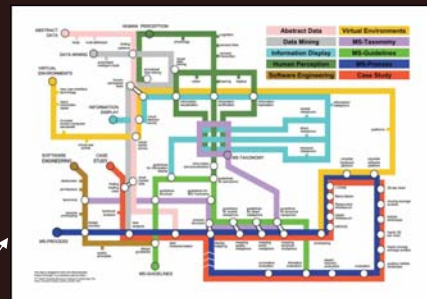
Bloomington Science Café

December 3, 2013



Terra bytes of data

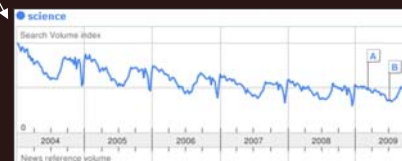
Descriptive &
Predictive
Models



Find your way



Find collaborators, friends



Identify trends

Places & Spaces: Mapping Science

scimaps.org



Places & Spaces: Mapping Science

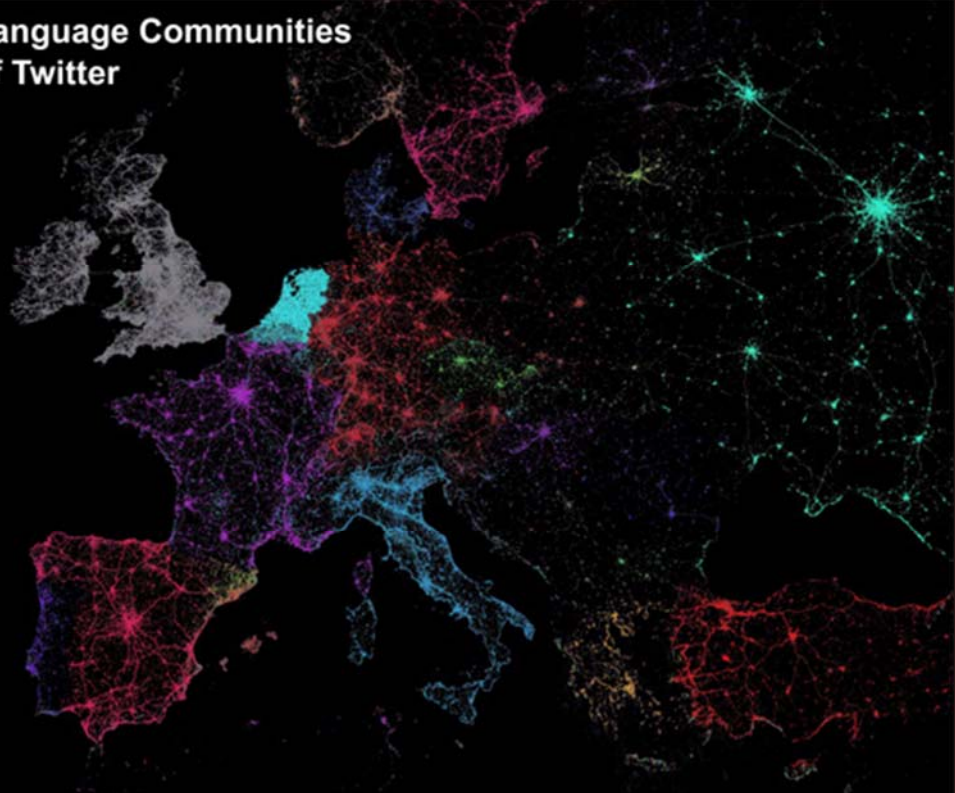
scimaps.org





Language Communities of Twitter

- English
- Portuguese
- Spanish
- Dutch
- Russian
- French
- Italian
- German
- Turkish
- Arabic
- Swedish
- Danish
- Finnish
- Catalan
- Romanian
- Norwegian
- Lithuanian
- Slovak
- Czech
- Greek
- Hungarian
- Polish
- Slovenian
- Albanian
- Latvian
- Galician
- Hebrew
- Croatian
- Bulgarian



Eric Fischer. 2012. Language Communities of Twitter.

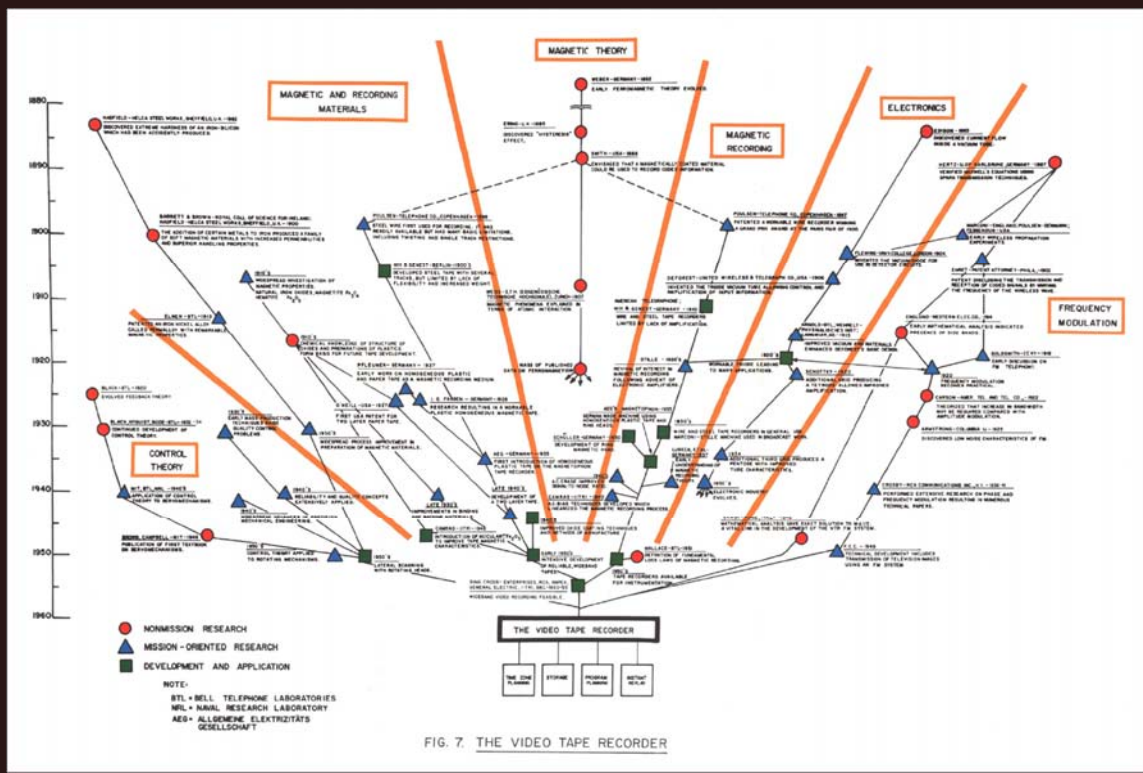
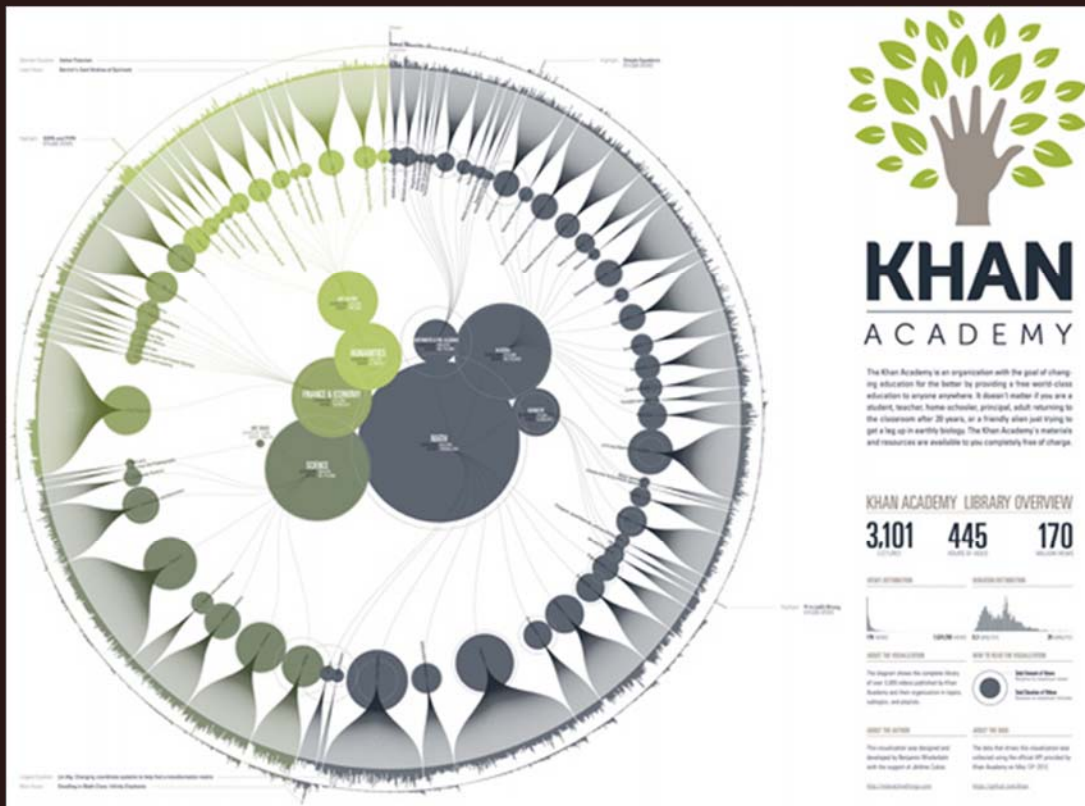
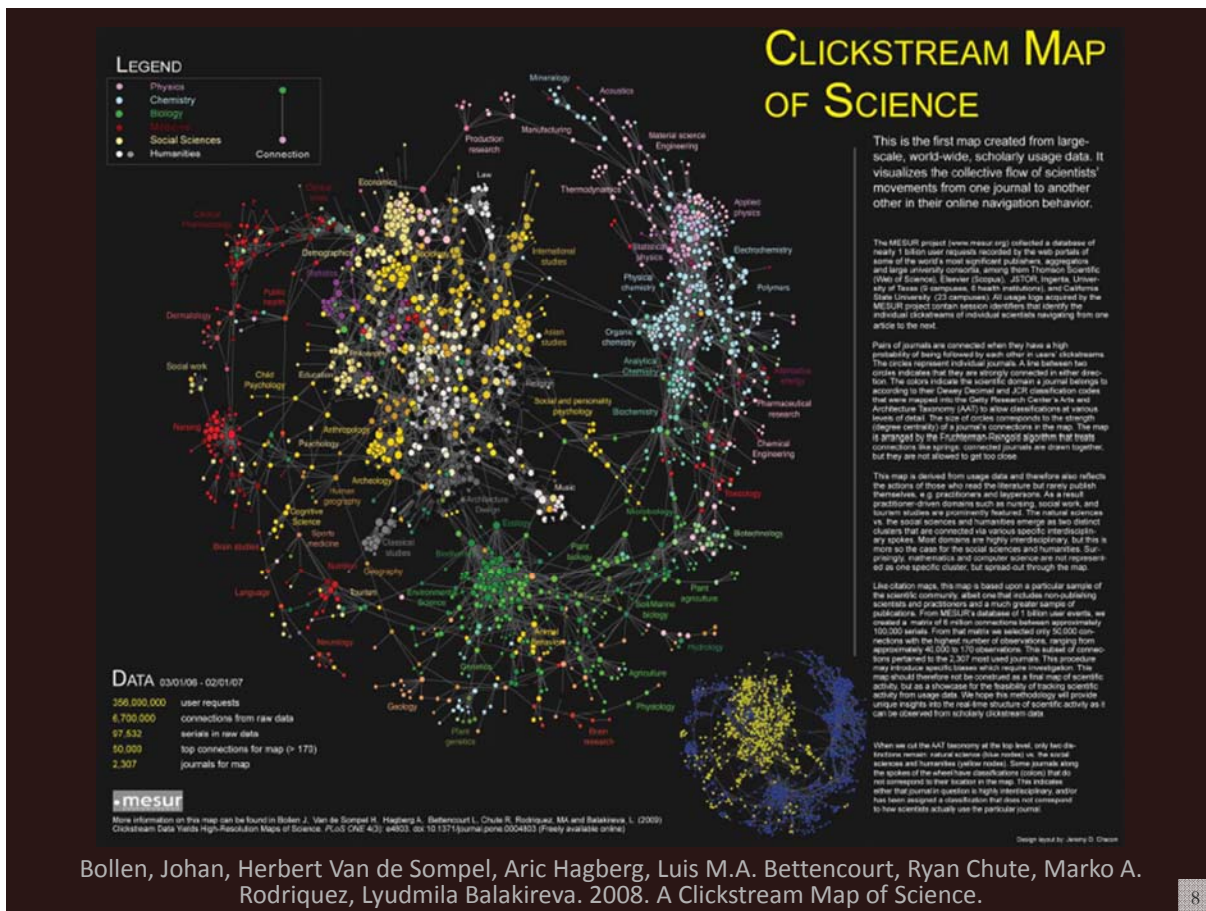


FIG. 7. THE VIDEO TAPE RECORDER

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



Benjamin Wiederkehr and Jérôme Cukier. 2012. Khan Academy Library Overview.

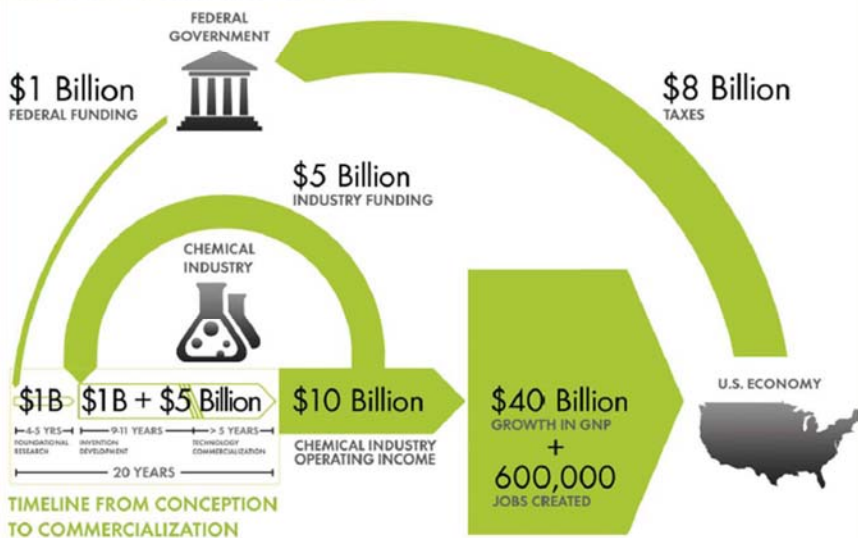


Bollen, Johan, Herbert Van de Sompel, Aric Hagberg, Luis M.A. Bettencourt, Ryan Chute, Marko A. Rodriguez, Lyudmila Balakireva. 2008. A Clickstream Map of Science.

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

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

INVESTMENT IN CHEMICAL SCIENCE R&D



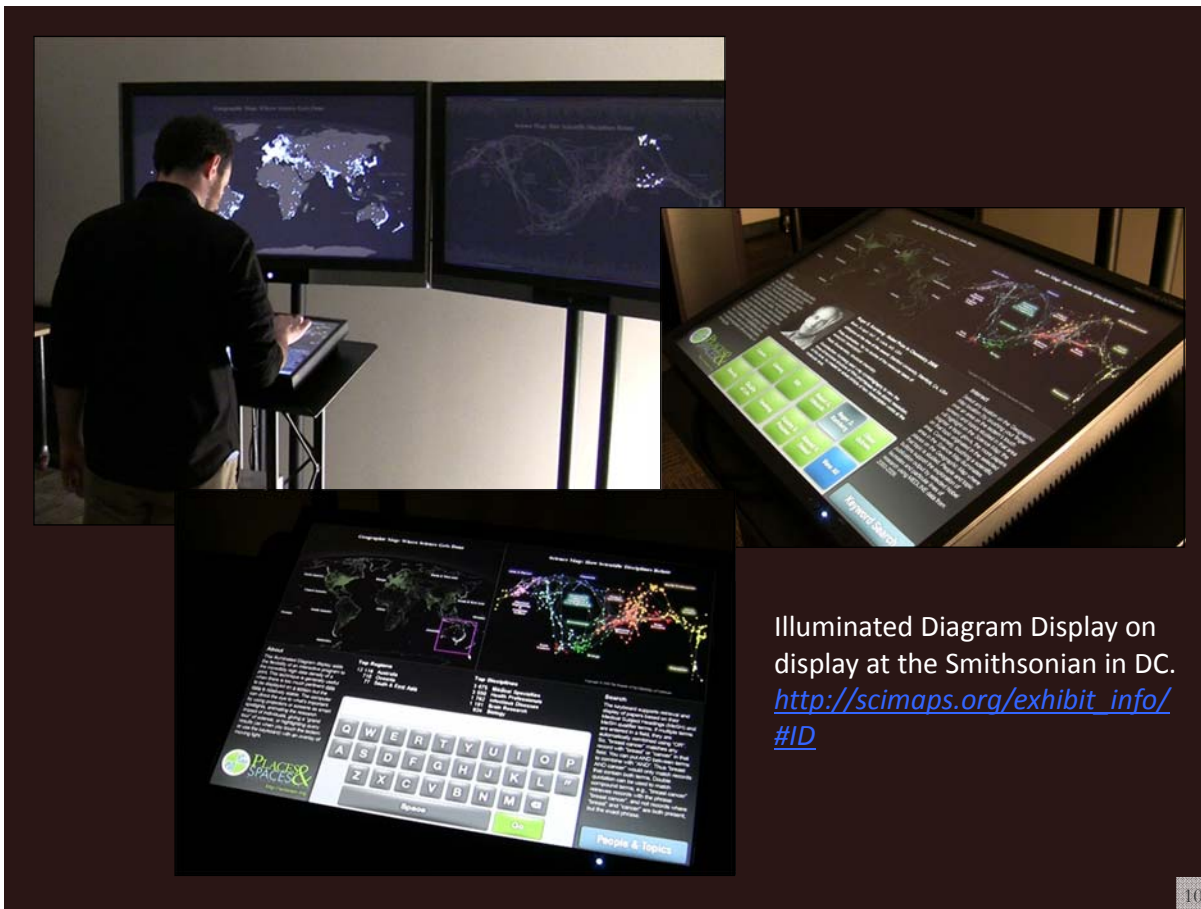
The Council for Chemical Research (CCR)

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 cycle 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.

Council for Chemical Research. 2009. Chemical R&D Powers the U.S. Innovation Engine. Washington, DC. Courtesy of the Council for Chemical Research.



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.

Top Five Continents

- North America - 4,000 records
- South & East Asia - 3,589
- Australia - 2,431
- Africa - 2,208
- South America - 1,562

Top Five Scientific Disciplines

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

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.

Q	W	E	R	T	Y	U	I	O	P
A	S	D	F	G	H	J	K	L	"
Z	X	C	V	B	N	M			
Space									Go

<http://scimaps.org>

People & Topics

11

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.

Interact

Select any location on the Geographic Map location (by brushing your finger over an area on the lectern's touch screen) and topics studied in that area will highlight on the Science Map; the brighter a topic glows, the more papers on that topic originated in the selected area. Conversely, touching a scientific area in the Science Map illuminates places on the Geographic Map where that topic is studied. People and topic buttons support the exploration of publication output by selected Noble laureates and particular lines of research using MEDLINE data from 2000-2009.

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

<http://scimaps.org>

Keyword Search

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Ingo Gunther's Worldprocessor globe design on display at the Giant Geo Cosmos OLED Display at the Museum of Emerging Science and Innovation in Tokyo, Japan



Science Maps in "Expedition Zukunft" science train visiting 62 cities in 7 months 12 coaches, 300 m long Opening was on April 23rd, 2009 by German Chancellor Merkel <http://www.expedition-zukunft.de>



Debut of 5th Iteration of Mapping Science Exhibit at MEDIA X was on May 18, 2009 at Wallenberg Hall, Stanford University, <http://mediax.stanford.edu>, <http://scaleindependentthought.typepad.com/photos/scimaps>



Science Maps for Kids 2012



VIII.1



VIII.3



VIII.5



VIII.7



VIII.9



VIII.2



VIII.4



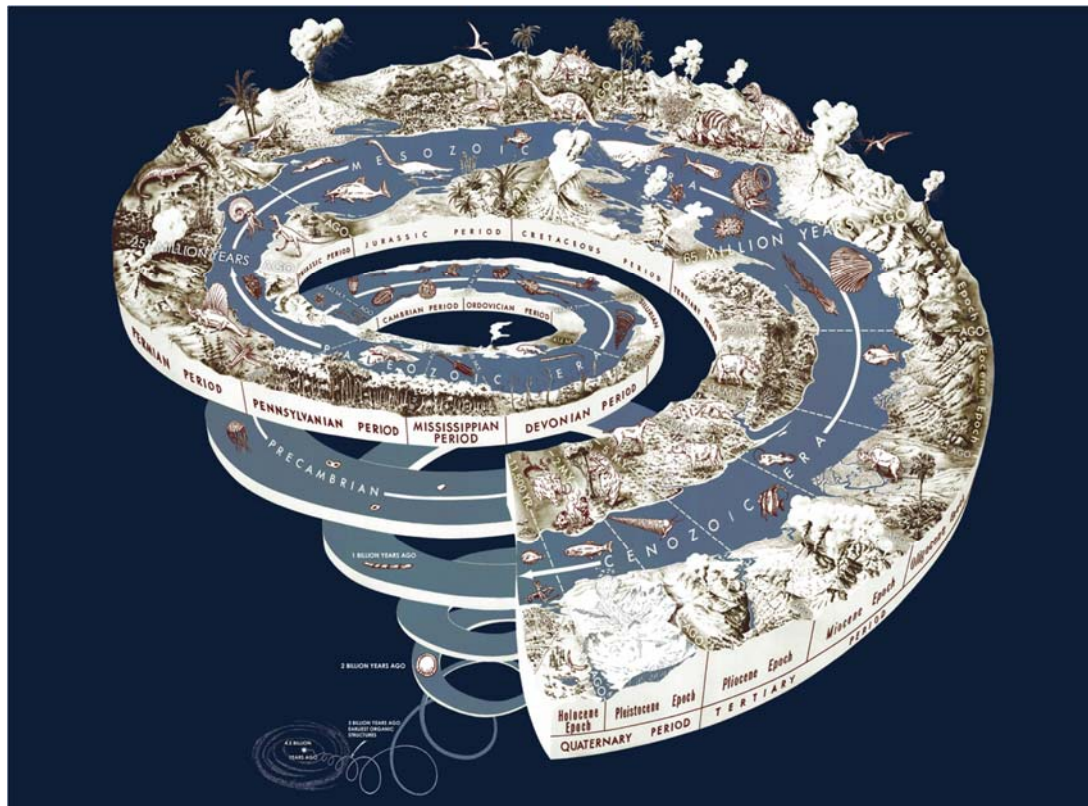
VIII.6



VIII.8

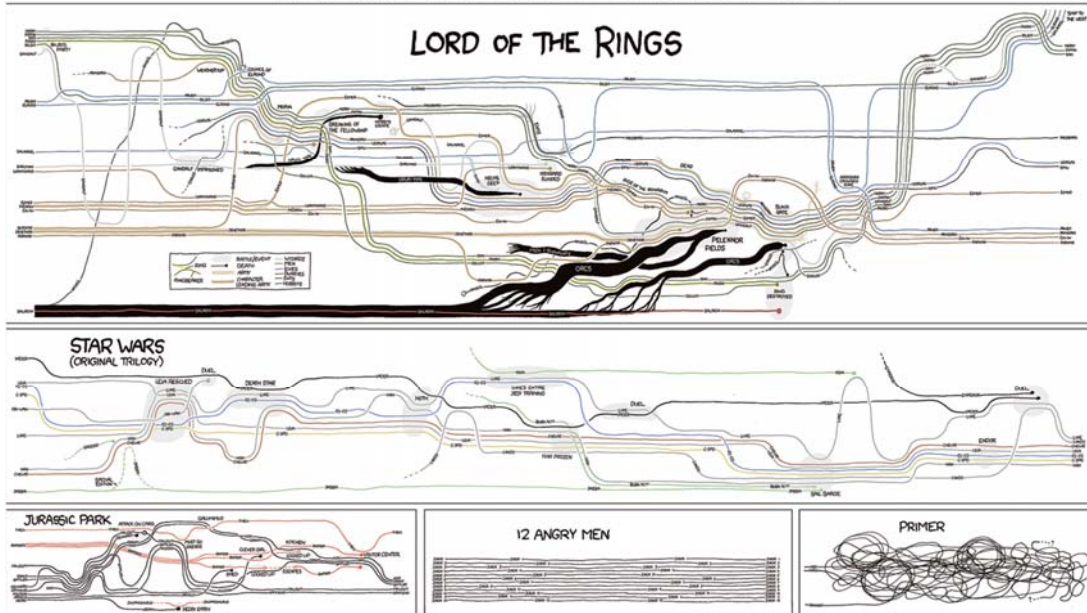


VIII.10

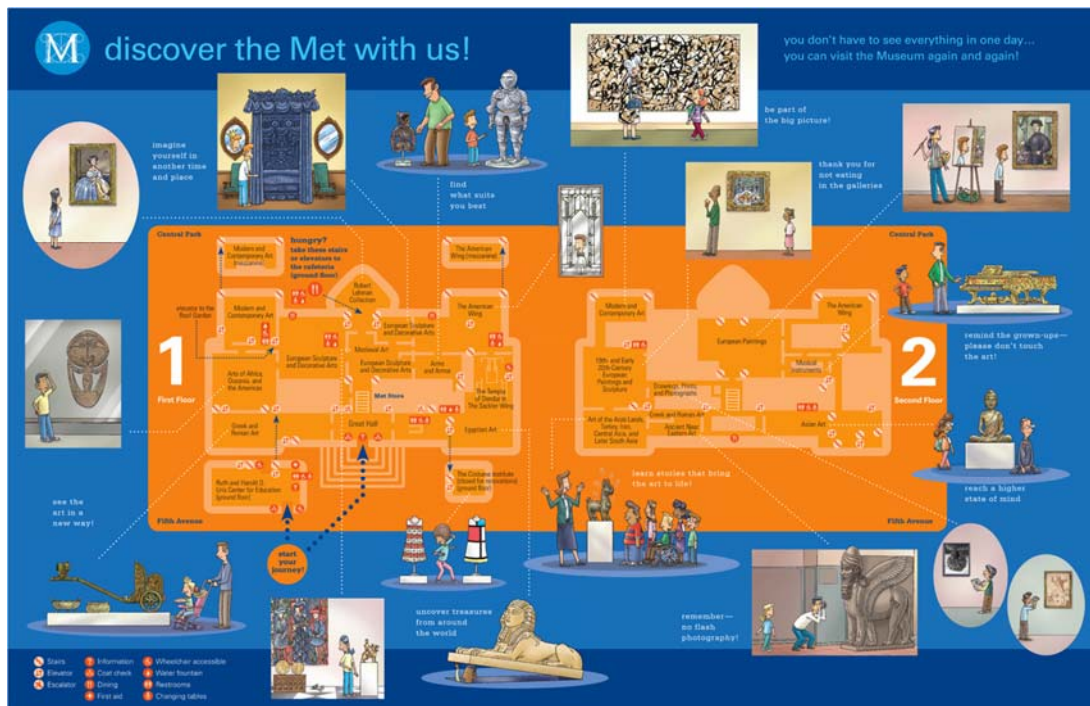


Geologic Time Spiral: A Path to the Past - Joseph Graham, William Newman, and John Stacy - 2008

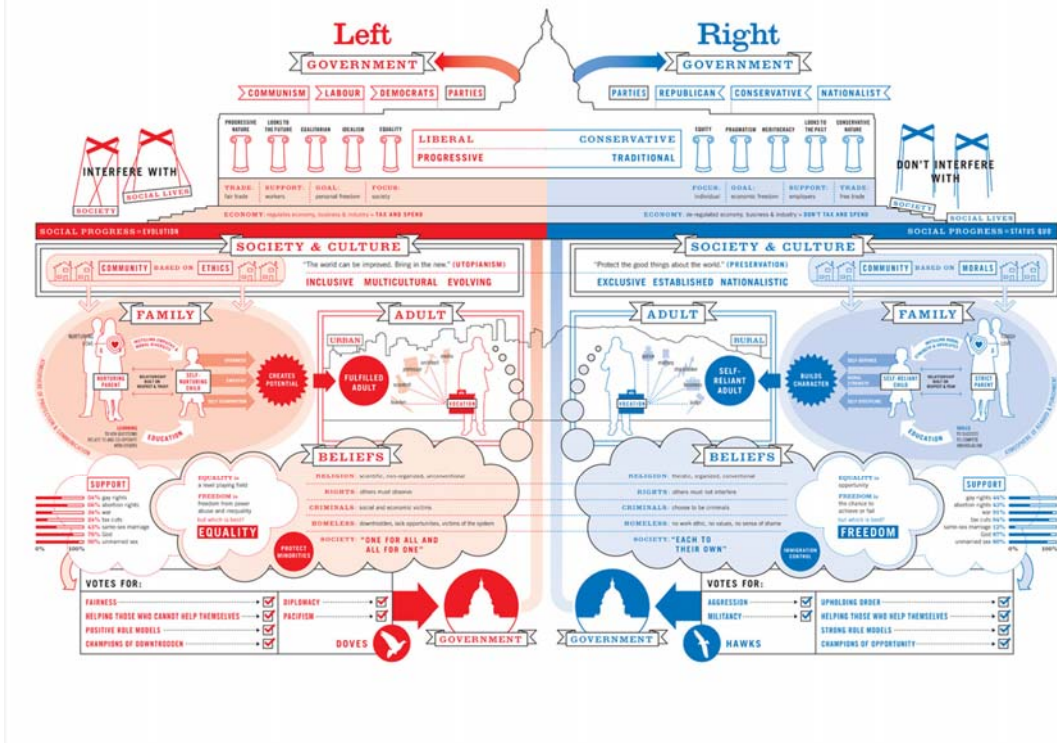
THESE CHARTS SHOW MOVIE CHARACTER INTERACTIONS.
THE HORIZONTAL AXIS IS TIME. THE VERTICAL GROUPING OF THE
LINES INDICATES WHICH CHARACTERS ARE TOGETHER AT A GIVEN TIME.



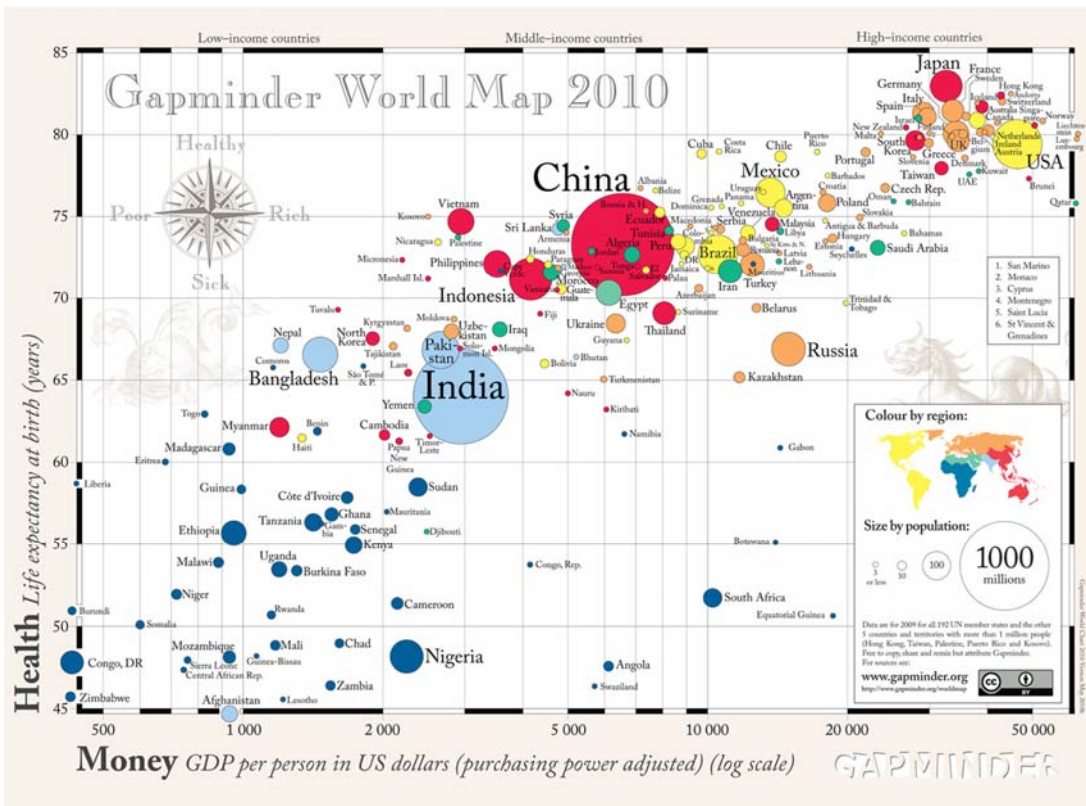
Movie Narrative Charts (Comic #657) - Randall Munroe - 2009



Metropolitan Museum of Art Family Map - Masha Turchinsky and John Kerschbaum - 2008



Left vs. Right Political Spectrum - David McCandless and Stefanie Posavec - 2009



Gapminder World Map - Mattias Lindgren - 2010

Knowledge Web
A project of the James Burke Institute
Visit the Knowledge Web at: k-web.org

With the Knowledge Web, you can fly through time and space, following your interests anywhere they lead you, even from Napoleon to the computer. With more than 2000 people and inventions, there are tens of thousands of different possibilities, so you never know what surprising connections you'll find. The globe display will tell you where you are, and the timeline will tell what else is going on at the same time. Along the way you can visit historic places like Marie Curie's lab, talk to her and do experiments—with no danger from radiation!

Lyons Playfair
Lyons Playfair came up with the gravity-powered steam, which is all built but he got it wrong, and presented a paper called "World War" in the 1850s. He was a friend of Benjamin Franklin.

David Livingstone
David Livingstone was a missionary and explorer who was the first to see the Victoria Falls. He was a friend of Benjamin Franklin.

Lord William Thomson Kelvin
Lord Kelvin discovered the law of conservation of energy and discovered the law of absolute zero. He was a friend of Benjamin Franklin.

Cyrus West Field
Cyrus West Field was the first to see the Victoria Falls. He was a friend of Benjamin Franklin.

Samuel Finley Breese Morse
Samuel Finley Breese Morse was the first to see the Victoria Falls. He was a friend of Benjamin Franklin.

Soak Webster
Soak Webster was the first to see the Victoria Falls. He was a friend of Benjamin Franklin.

Apple strudel
The apple strudel is a traditional Austrian dessert. It was first made in the 18th century.

Postcard
Postcards were the first way for people to share images, ideas of distant travel. The first postcard was sent in 1840. It was a friend of Benjamin Franklin.

Sir Rowland Hill
Sir Rowland Hill was the first to see the Victoria Falls. He was a friend of Benjamin Franklin.

Ada Lovelace
Ada Lovelace was the first to see the Victoria Falls. He was a friend of Benjamin Franklin.

William Whewell
William Whewell was the first to see the Victoria Falls. He was a friend of Benjamin Franklin.

Sir James Clark Ross
Sir James Clark Ross was the first to see the Victoria Falls. He was a friend of Benjamin Franklin.

Charles Macintosh
Charles Macintosh was the first to see the Victoria Falls. He was a friend of Benjamin Franklin.

Raincoat
The raincoat was first made in the 18th century. It was a friend of Benjamin Franklin.

Knowledge Web - James Burke, Patrick McKeher, and Michael J. Stamper - 2012

MANGA UNIVERSE
883 Series
62,172 Chapters
1,074,790 Pages

The digitization of cultural artifacts and the use of novel methods made possible the creation of this project. But there can be no doubt that the most important contribution to the project was the work of the artists and writers who created the original works. The project is a testament to their creativity and the power of the digital age.

The pages in the lower left of the map consist of a small number of the pages, with the most common pages on the left and the least common on the right. The pages in the lower right of the map consist of a small number of the pages, with the most common pages on the left and the least common on the right.

- 1
- 2
- 3
- 4

Manga Universe - Lev Manovich and Jay Chow - 2012

Can we teach ourselves to react in a certain way?

To show that reflexes can be learned, Ivan Pavlov (also known as Pavlov) rang a bell and then fed his dog. He found that the dog salivated when it saw the bell. He repeated this, and then when he rang the bell without food, the dog salivated automatically. This means that Pavlov had taught his dog new reflex. Maybe this means that people can learn new reflexes too, and the stimulus could be anything that can be sensed in the dark argument.

Is there any reflex that you would like to teach yourself?

Can we make a copy of ourselves?

In 1906, Ian Wilmut managed to make a copy of an adult sheep, which is called cloning. The sheep was called Dolly. Cloning can help to mass produce organisms with desired qualities, like a prize-winning cow or a genetically engineered animal – for instance, sheep have been engineered to produce human insulin. Someone might want to replace lost or diseased family pets, or appropriate endangered (or extinct) species.

Cloning is a controversial topic. Not all people think this should be allowed. What do you think?

Can we go into space?

Alan, a thing, was the first animal to travel into space, but he was the first with a mission. He had received training before going on board on how to push a button as quickly as possible. (If he did not, he would eat his banana.) Alan managed to do this on his trip, January 31, 1961, showing that it was possible to travel into space and perform a task. He was only a little slower than an earth. He returned to earth safely after 16 minutes and 39 seconds in space.

There is another famous animal space traveler. Do you know who it is?

How old can we grow?

Charles Darwin, the famous scientist, collected Harriet the Turkie around 1811 from the Falkland Islands and brought her with him to England. For 100 years or so, Harriet was thought to be a male turkey and was called Henry. At the time of Darwin's visit, Harriet would have been as big as a dinner plate. He was 175 years old when she died, and the size of a dinner table. Her keepers believe she survived for so long because she had a stress-free life, had a walk every morning, and was on a vegetarian entry-based diet.

What do you think is the longest-lived animal species?

Can our feet stick to the walls?

Geckos may not have Happy Feet, but they do have Sticky Feet! They have millions of tiny hairs on their feet, and that gives them the ability to stick to surfaces.

Andrew Giner observed this extraordinary ability of geckos and is currently developing gecko tape very strong tape based on this principle.

What do you think will it be possible to walk on the ceiling with such tape?

Can we see with our ears?

How does a dolphin see in the dark sea? The dolphin makes a clicking sound and sends it into the water. When the sound hits an object in the water, it bounces back to the dolphin as an echo. The dolphin absorbs the returning echo through its jaw. The sound is conducted to the dolphin's inner ear, and the dolphin's brain then knows how big the object is, what it looks like, and what it could be.

Did you know that dolphins sleep with one eye closed? Only half their brain sleeps at any time!

Can we communicate only by singing?

Did you know that whales sing to communicate with each other? This is called whale song. The word "song" is used because it is very similar to our human singing, but it is not the same. Whales make use of groans, moans, wails, riffs, and high-pitched squeals that may last up to 10 minutes or longer.

If you had to communicate through a song, what would you choose?

What can we learn from animals?

People can teach animals things, such as teaching a dog how to fetch. Did you know that it can also be the other way around? In fact, there are many things that animals have taught us: things we would not know without them! There are also many things that people cannot do, but animals can!

Welcome to our map of science!

The map shows how different subjects relate to one another, from medicine to chemistry, mathematics to psychology. Which of these subjects do you recognize? Do you know what they all are?

Accidents can lead to discoveries.

Imagine a lab with different chemicals stored next to each other. If one container leaks into another, a new substance can be created. The new substance could be very useful, maybe it's a new form of super strong glue. If a scientist works out how the glue was created, and can repeat the process, the accident will lead to a scientific discovery. This means that there can be luck in science, but scientists need to be ready to seize it. If nobody pays attention or is able to work out what happened, then there will be no discovery.

To explore different subjects, read the stories along the top and bottom of the map.

Above are seven stories from the animal kingdom, while the stories below tell of accidental discoveries. Each story comes from a location on the map of science: the mini-maps will show you where.

Why do things fall down?

In Isaac Newton was a 17th century English scientist. One day, in a garden, he saw an apple fall from a tree. This made him wonder why things fall down and not up or sideways. He concluded that there is a force coming from the centre of the Earth that attracts things (and people when they fall over) to the ground. He called this force universal gravitation (also called gravity). Gravity explains why things fall to the ground.

If you drop a feather and a stone, which will reach the ground first?

How does a microwave oven work?

Percy Lawrence Spencer was an engineer. At his work, there was a magnetron, a machine that produces microwaves. Microwaves are invisible electromagnetic waves that make TVs and phones work. One day in 1945, Spencer passed the magnetron, and noticed that a chocolate bar in his pocket melted. He placed popcorn by the machine and it popped. He placed an egg in front of the machine and it exploded! Spencer had discovered that microwaves can cook food.

What should you not put into a microwave oven?

Being messy is not always a bad thing.

Alexander Fleming was a Scottish microbiologist. He was not very good at cleaning up his laboratory one quiet morning one day in 1928, so he returned from holiday. He saw that one of the dishes he used for his experiments had grown mould. The mould was killing off bacteria that can make people very sick. Fleming grew the mould and found that it could kill many bacteria, and therefore cure several diseases. From the mould Fleming created the first antibiotic: penicillin.

Being messy is not always bad. Which is your favourite?

What are ice lollies made of?

In 1905, a popular drink was a soda prepared by mixing powder into water. One day, an 11 year old boy called Frank Epperson prepared a drink with a mixer but left it outside overnight. It was a cold night, cold enough for water to freeze into ice. Over night, the drink turned to ice, trapping the powder mixture: the popsicle was created. Ice lollies are made of frozen liquid often water and fruit juice.

Today there are more than 30 flavours of popsticks. Which is your favourite?

How were sticky notes invented?

In the late 1930s, Spencer Silver was trying to develop strong glue. By accident, he actually invented an adhesive that stuck weakly, but then easily washed. This special material could be used several times before the glue wore off or dried. At first no one was interested, but 4 years later a colleague had the idea of using this weak glue on postmarks to mark pages in a book. They stuck, and peeled off without damaging the paper. The Post-it note was born!

Apart from sticky notes, can you name other sticky things?

Why do Slinkys keep moving?

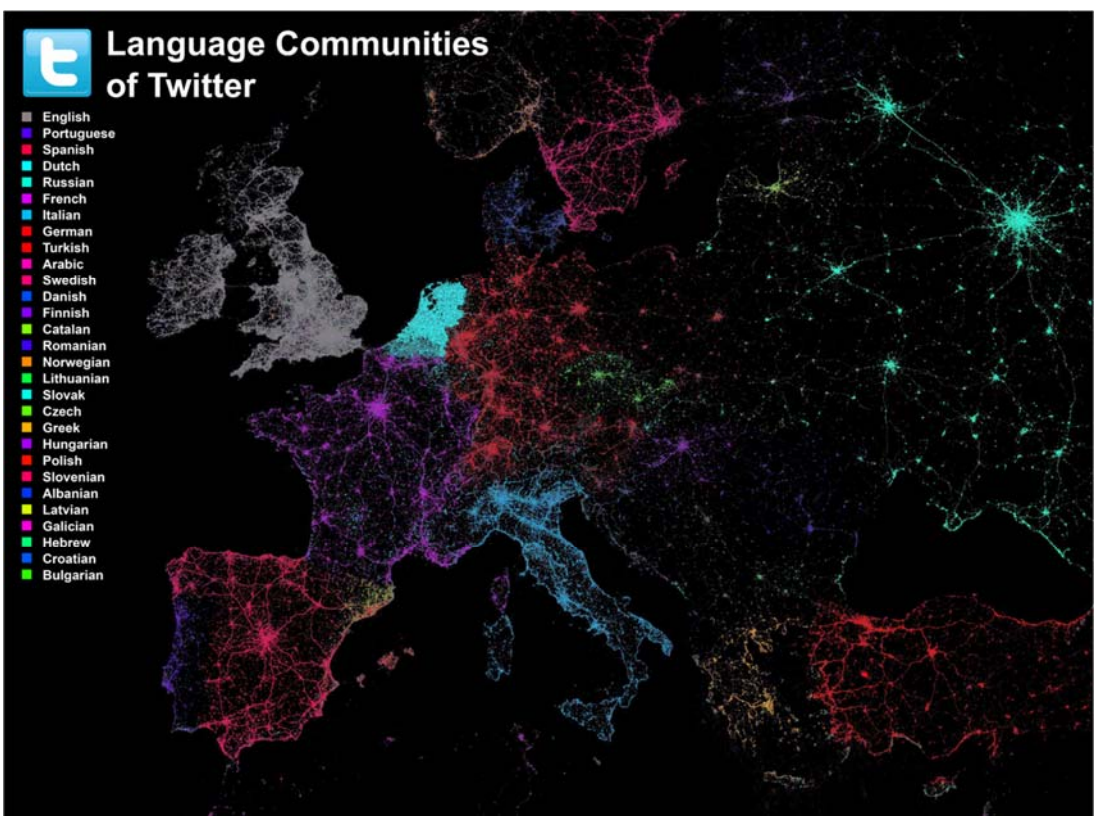
Richard James was a naval engineer, a scientist building equipment for boats. When ships are on the sea, the waves create a lot of movement inside them. This can damage fragile equipment, so in 1943 James was trying to develop a spring to protect the fragile objects from the shaking of the waves. One of the springs he was working on fell off a shelf, but then continued moving due to gravity! James thought this would make a fun toy, and invented the Slinky.

Do you have a Slinky? What other toys are fun because of their movement?

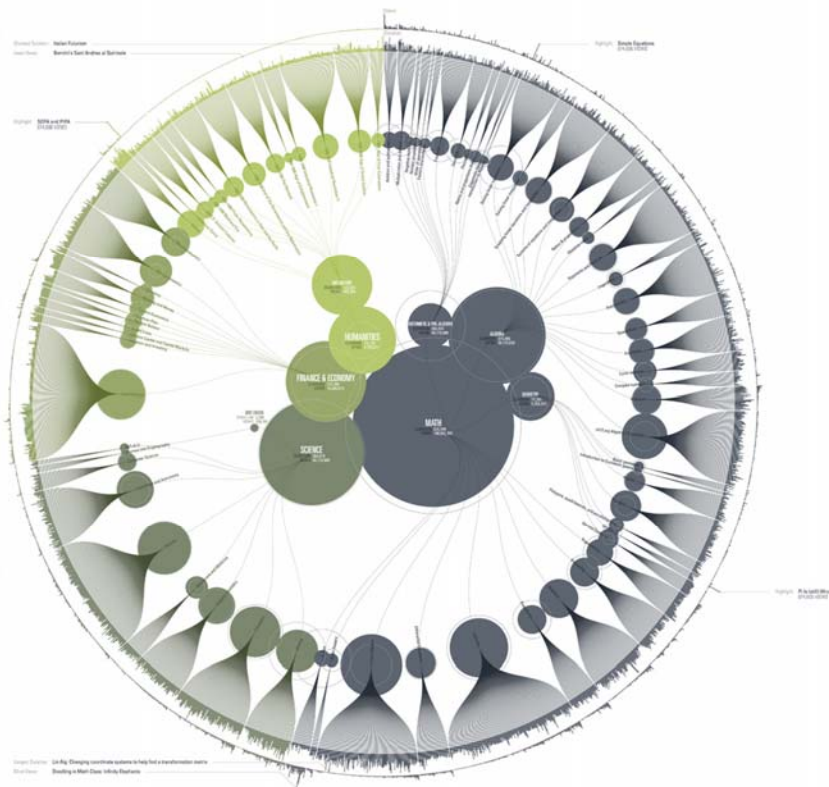
How do vaccines work?

Edward Jenner was an 18th century English doctor who noticed that people who got cowpox never caught smallpox, a much more dangerous disease. Jenner injected a small amount of cowpox into a boy. A few weeks later, he injected cowpox into the boy, but the boy did not get ill. He had been vaccinated. Nowadays, vaccination protects people from many diseases. It is usually done with a syringe containing a small amount of substance similar to the disease: our bodies learn from this how to recognize and fight the disease. Have you had any vaccinations?

The Fundamental Interconnectedness of All Things - Matthew Richardson, Judith Kamalski, Sarah Huggett, and Andrew Plume - 2012



Language Communities of Twitter - Eric Fischer - 2012



KHAN
ACADEMY

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, former scholar, principal, adult returning to the classroom after 20 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

3,101 445 170
LECTURES HOURS OF VIDEO VIDEOS UPLOADED



Khan Academy Library Overview - Benjamin Wiederkehr and Jérôme Cukier - 2012

Science Maps Showing Trends and Dynamics 2013



IX.1



IX.3



IX.5



IX.7



IX.9



IX.2



IX.4



IX.8



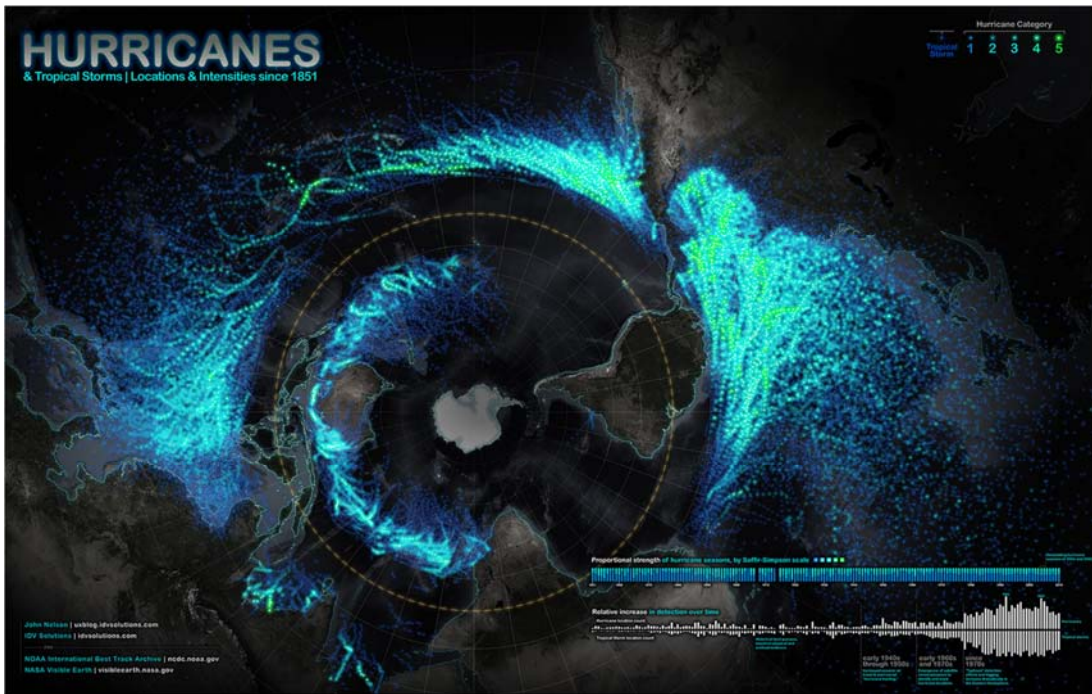
IX.8



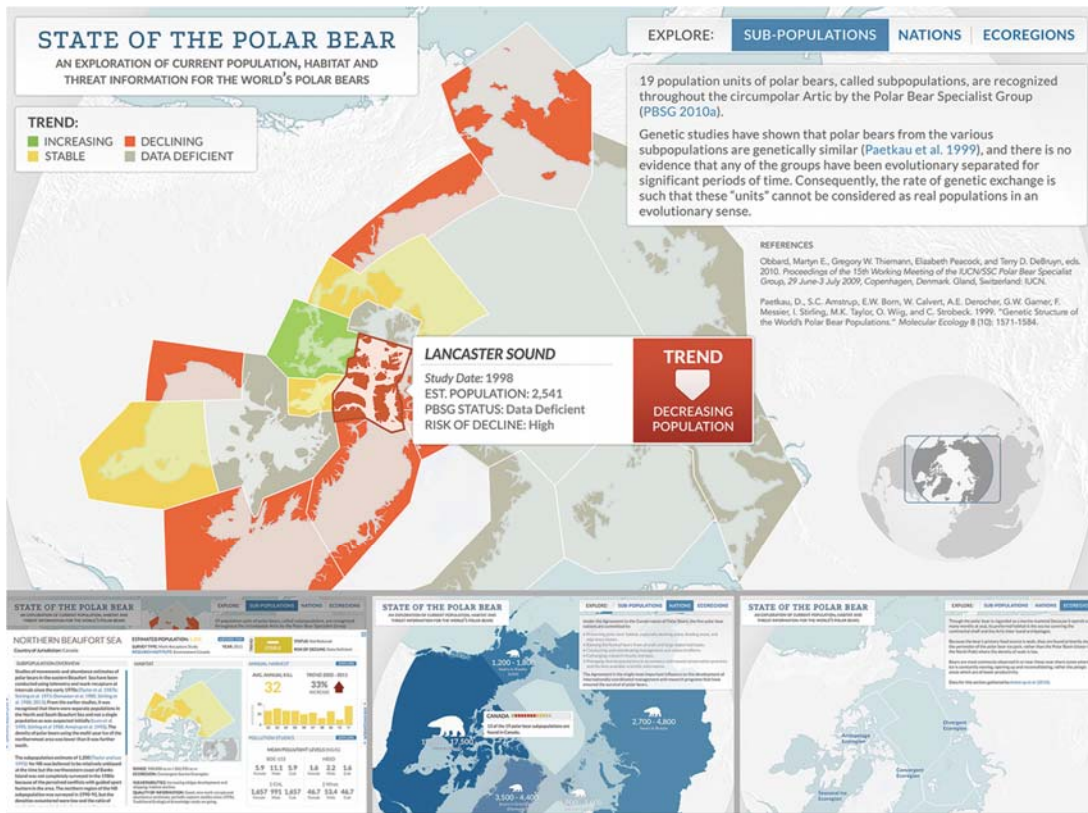
IX.10



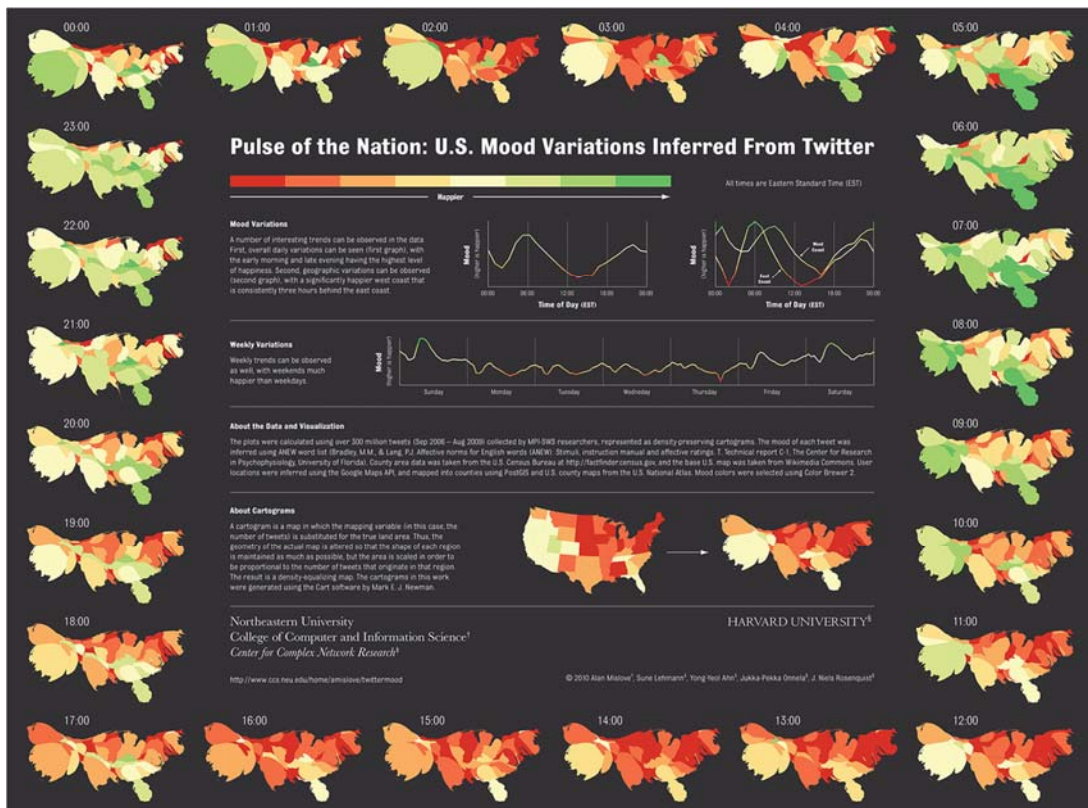
NASA Views Our Perpetually Moving Ocean - Dimitris Menemenlis, Horace G. Mitchell, Christopher N. Hill, and Gregory W. Shirah - 2011



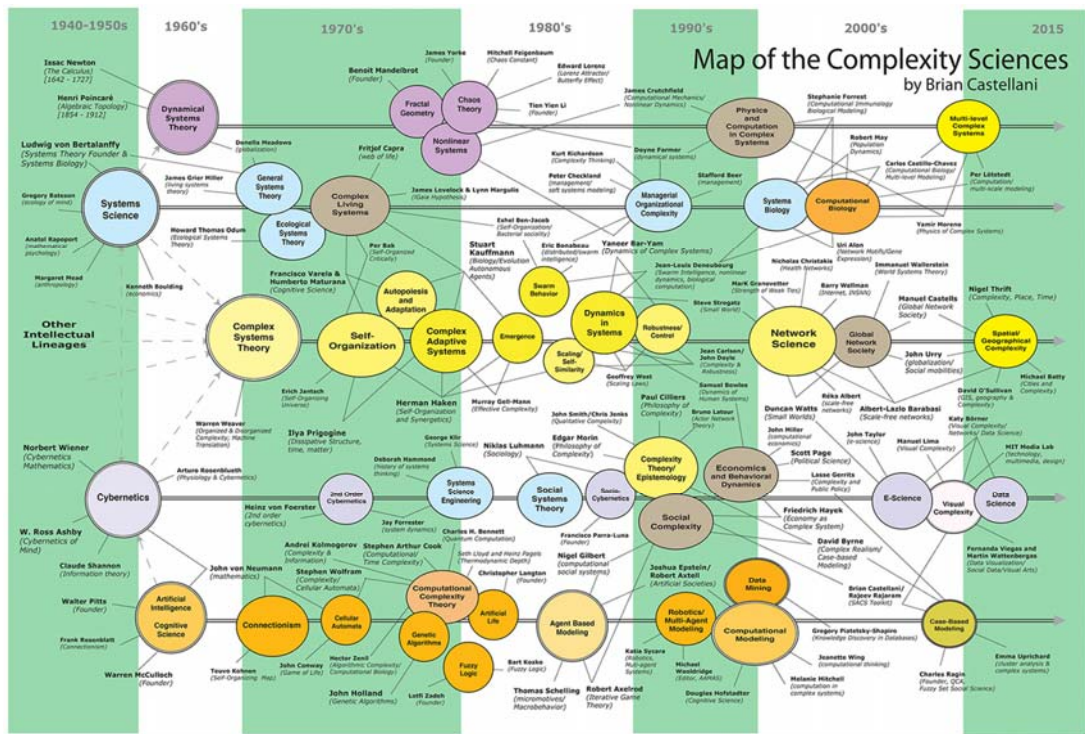
Hurricanes & Tropical Storms—Locations and Intensities Since 1851 - John Nelson - 2012



State of the Polar Bear - Dino Citraro, Kim Rees, Jacob O'Brien, Brett Johnson, Domanique Alicia, and Andrew Winterman - 2013



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



Map of Complexity Science - Brian Castellani - 2013

VISUALIZING TRENDS AND DYNAMICS 30 YEARS OF SCIENTIFIC DEVELOPMENT



Social sciences

Health & medical sciences

Biomedical sciences

Life & earth sciences

Chemistry

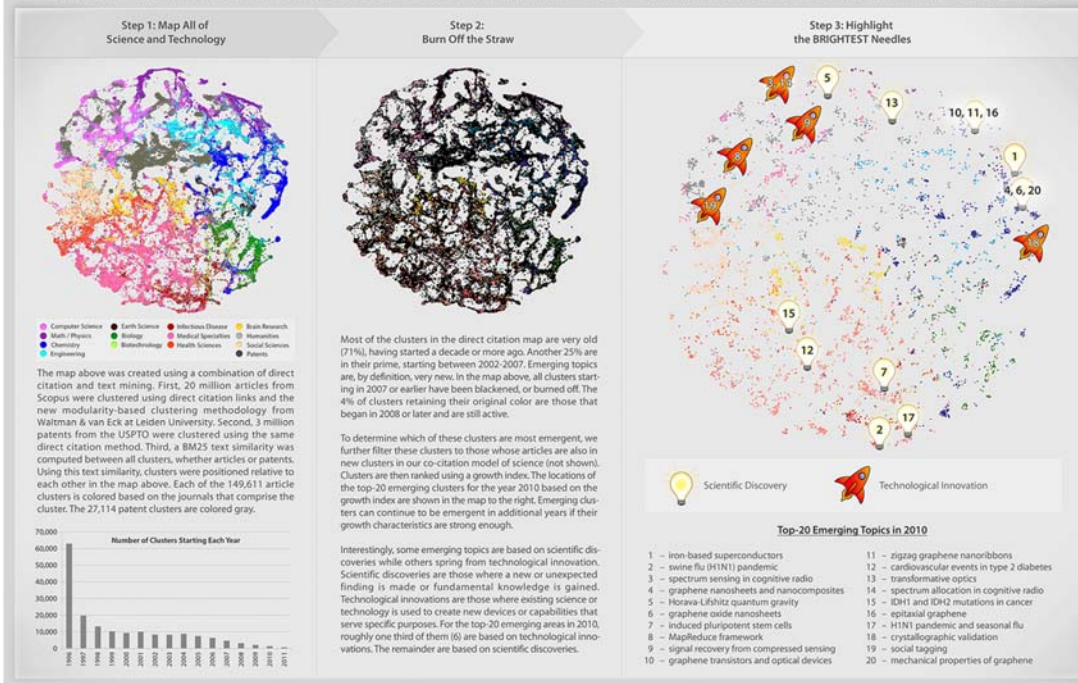
Physics & engineering

Mathematics & computer sciences

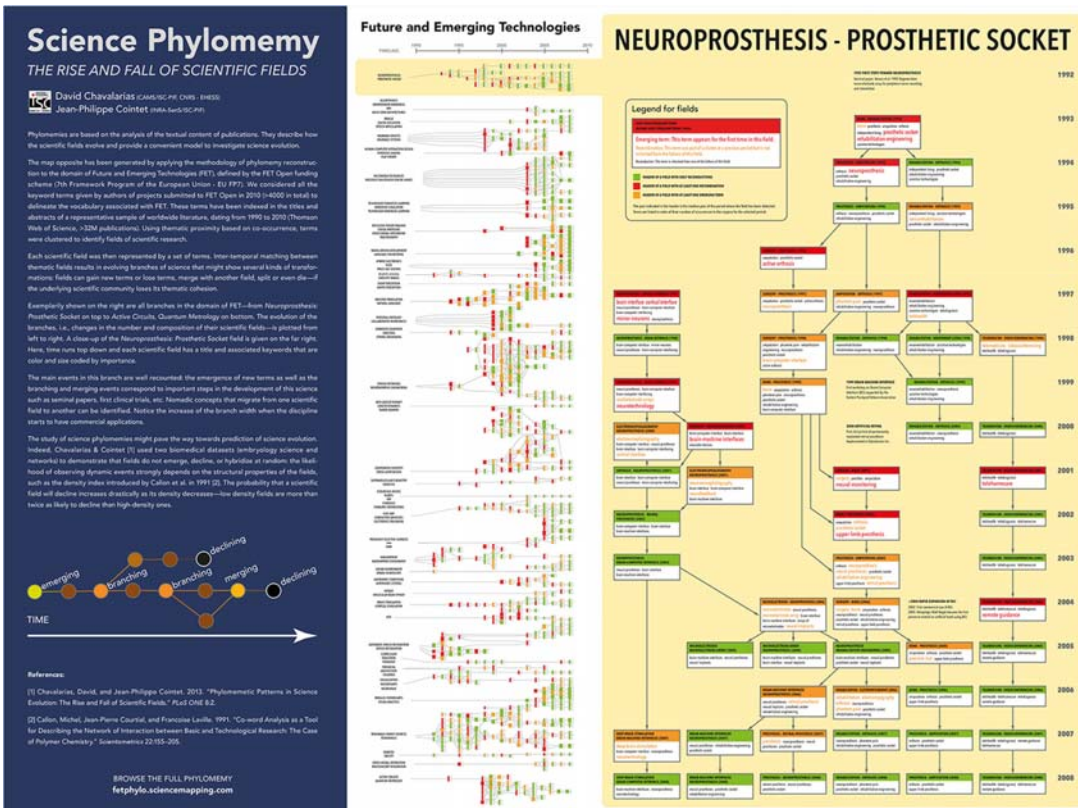
IDENTIFYING EMERGING TOPICS IN SCIENCE AND TECHNOLOGY

(finding the needles in the haystack)

A novel approach to identifying emerging topics in science and technology has been developed. Two models of science and technology have been created using 16 years (1996-2011) of Scopus (20 million articles) and USPTO (3 million patents) data. These two models—one based on direct citation, and one based on co-citation—are used together to nominate the most emergent topics in S&T at a particular point in time.



Identifying Emerging Topics in Science and Technology - Kevin W. Boyack, Richard Klavans, and Henry G. Small - 2013



Science Phylomemy - David Chavalarias and Jean-Philippe Cointet - 2013

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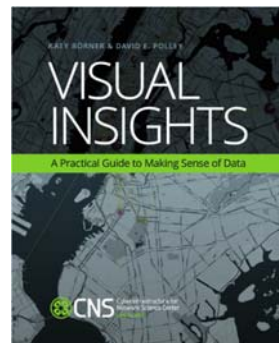
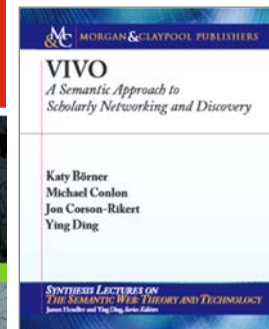
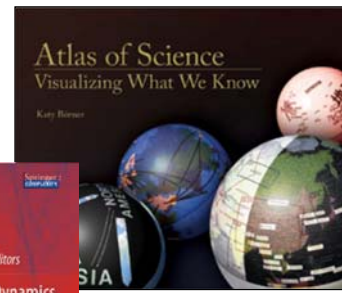
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Katy Börner, Michael Conlon, Jon Corson-Rikert, Cornell, Ying Ding (2012) **VIVO: A Semantic Approach to Scholarly Networking and Discovery**. Morgan & Claypool.

Katy Börner and David E Polley (2014) **Visual Insights: A Practical Guide to Making Sense of Data**. MIT Press.



39

Information Visualization MOOC

INDIANA UNIVERSITY
CNS

Overview

This course provides an overview about the state of the art in information visualization. It teaches the process of producing effective visualizations that take the needs of users into account.

Among other topics, the course covers:

- Data analysis algorithms that enable extraction of relationships in data
- Major visualization and interaction techniques
- Discussions of systems that drive research and development.

A certificate will be issued upon successful completion. Please watch the introduction video to get better acquainted with the course.

Katy Börner, Ph.D.
Indiana University

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