



PLACES & SPACES

MAPPING SCIENCE

scimaps.org

Iteration I (2005)

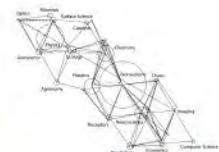
The Power of Maps



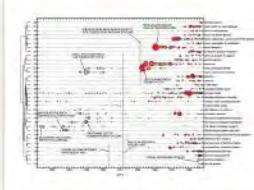
I.1



I.3



I.5



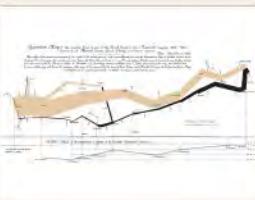
I.7



I.9



I.2



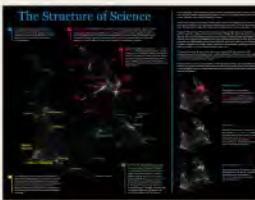
I.4



I.6



I.8



I.10

Instculptum est per Iohannem Schnitzer de Achenheim.

CAVRUS CHORVS VEL APIX SIVE ARGESTES

CIRCVS

VEL TRESIAS

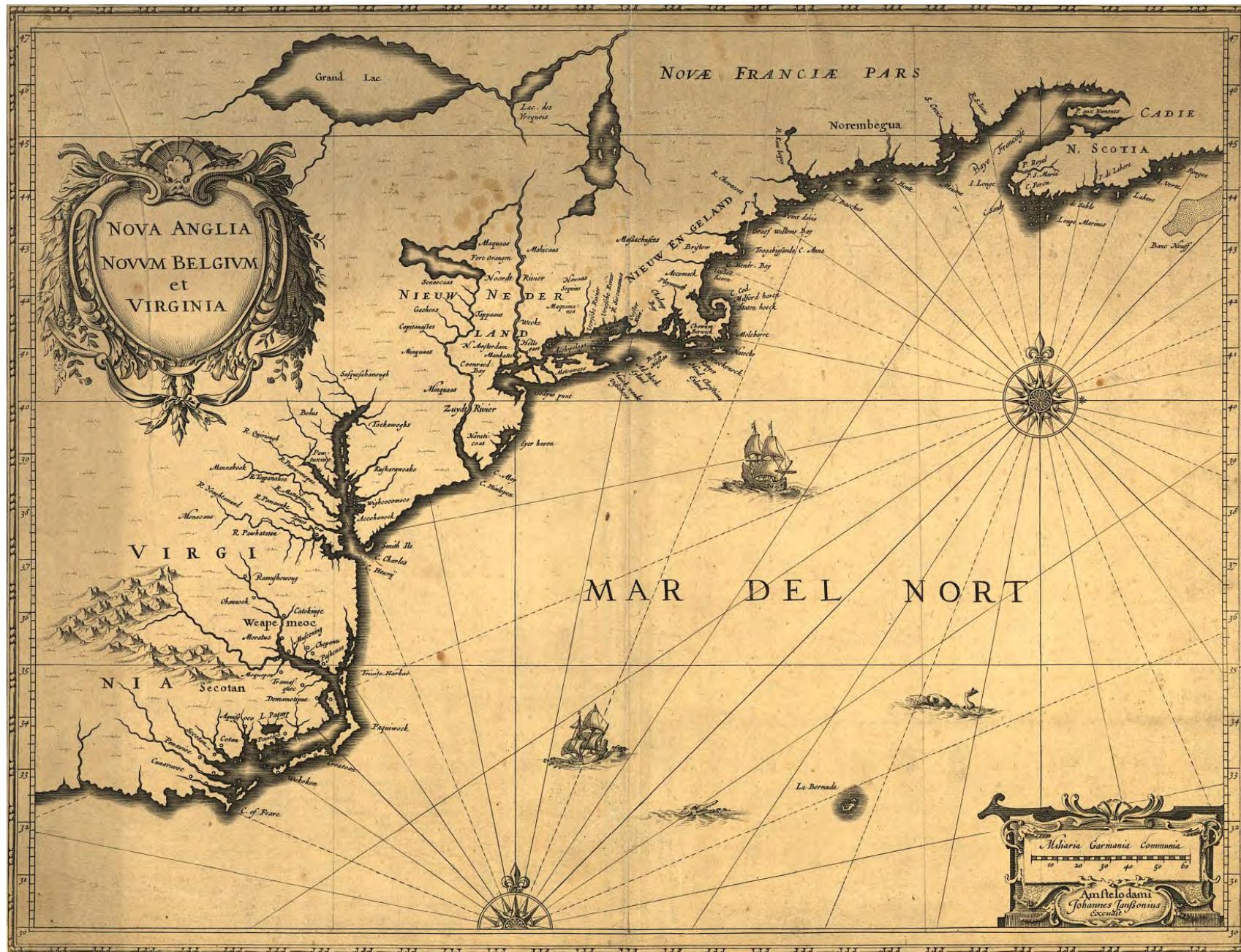
SEPTENTRIO VEL APARTIAS

AQVILO VEL BOREAS

CECIAS APELIOTES



I.1 Cosmographia World Map – Claudius Ptolemy - 1482



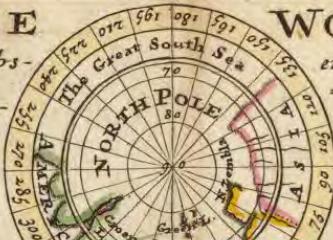
I.2 Nova Anglia, Novvm Belgivm et Virginia – Johannes Janssonius - 1642

A New Map of the WHOLE
According to the latest and most Exact Observations

WORLD with the Trade winds
Observations By H. Moll Geographer

In this Map is inserted A View of the General & Coasting Trade-Winds, Monsoons, or Shifting Trade-winds. Note that the Arrows among the Lines shew the Course of those General & Coasting Winds, and the Arrows in the void Spaces shew the Course of the Shifting Trade-winds, and the Abbreviations Sept &c.

Show the Times of the Year when such Winds Blow.



The Signs of the Zodiac. The First 6 are Northern, the others Southern Signs.
 I Aries . March XI Leo . July
 II Taurus . April XII Virgo . August
 III Gemini . May XIII Libra . September
 IV Cancer . June XIV Scorpio . October
 V Leo . July XV Sagittarius . November
 VI Virgo . August XVI Capricornus . December
 VII Libra . September XVII Aquarius . January
 VIII Scorpio . October XVIII Pisces . February

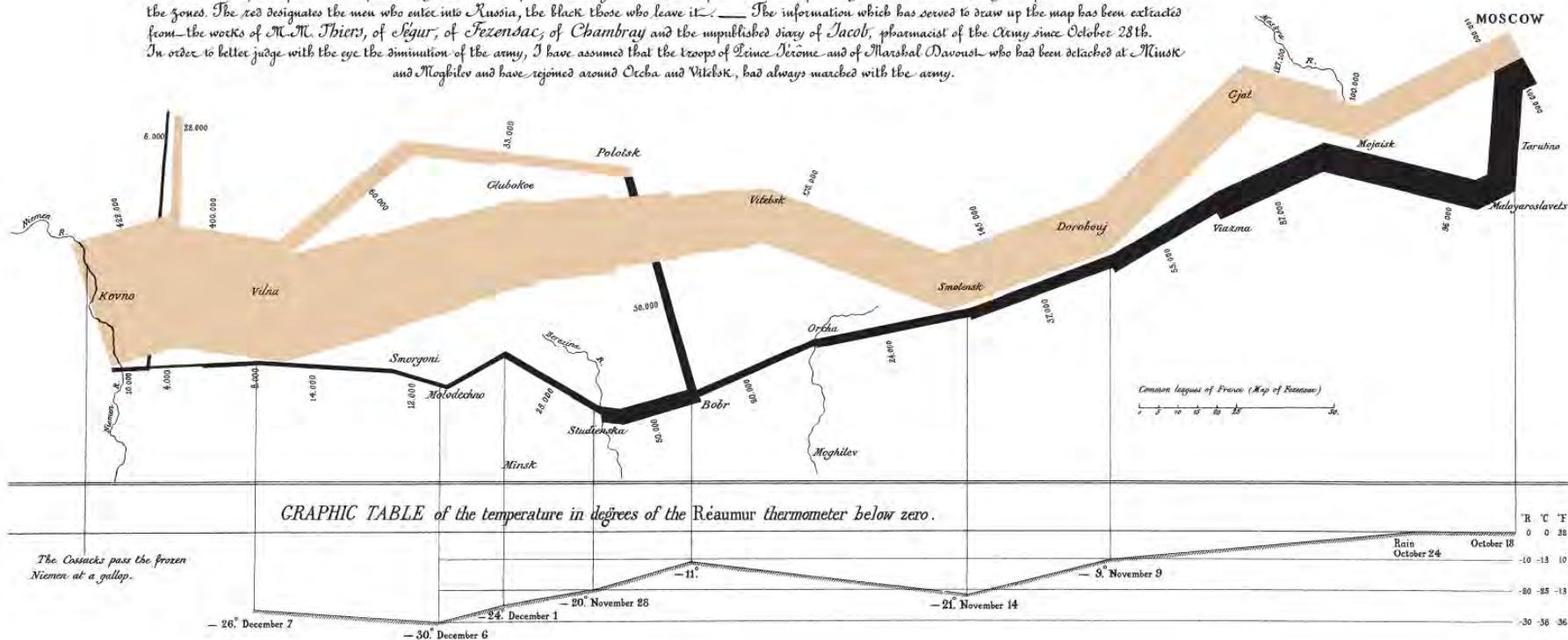


Printed for Thos Bowles Print and Map Seller next to Chapter House in St Pauls Church yard; and John Bowles Print and Map Seller at the Black Horse in Cornhill London.

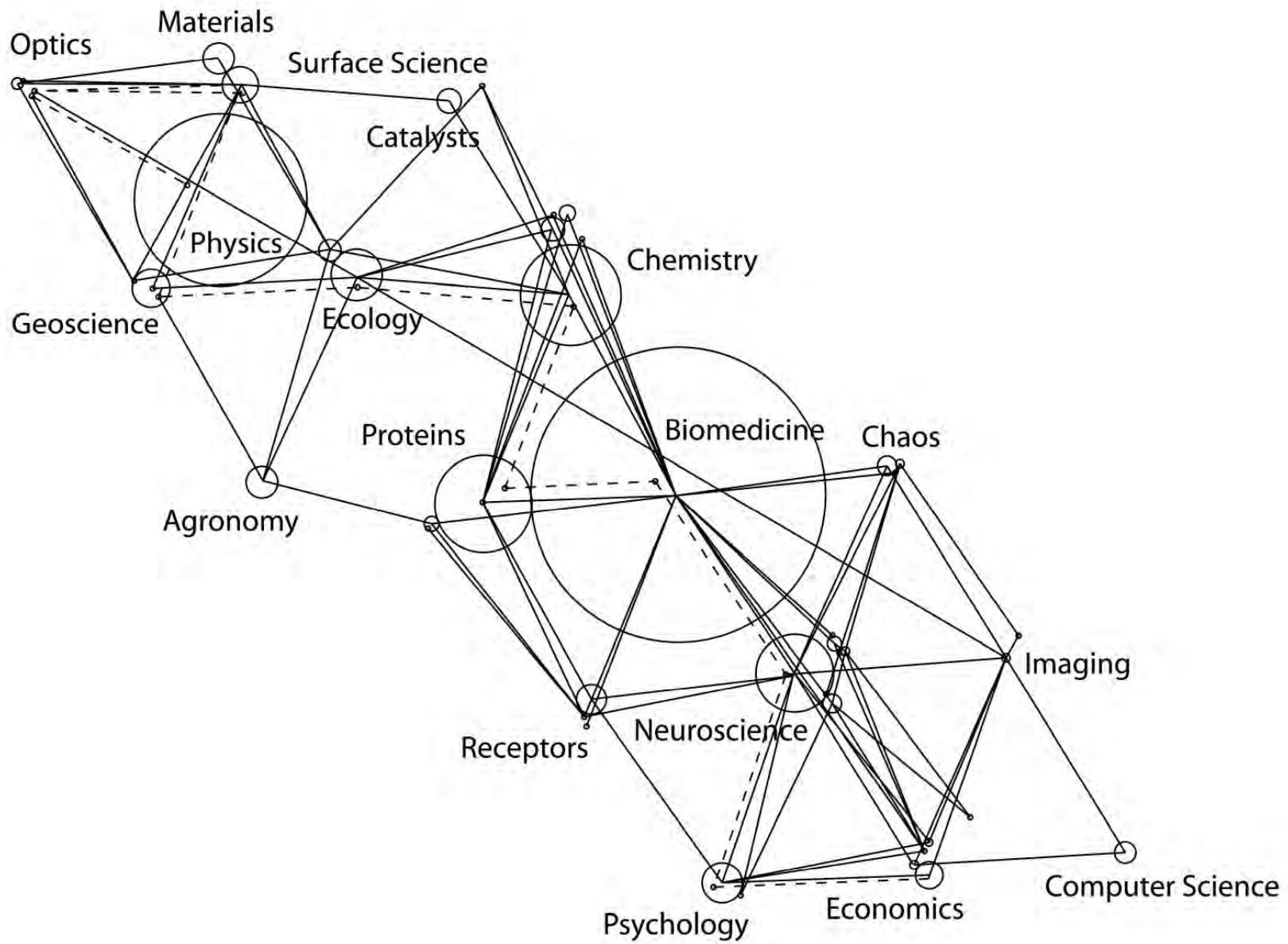
Figurative Map of the successive losses in men of the French Army in the Russian campaign 1812 ~ 1813.

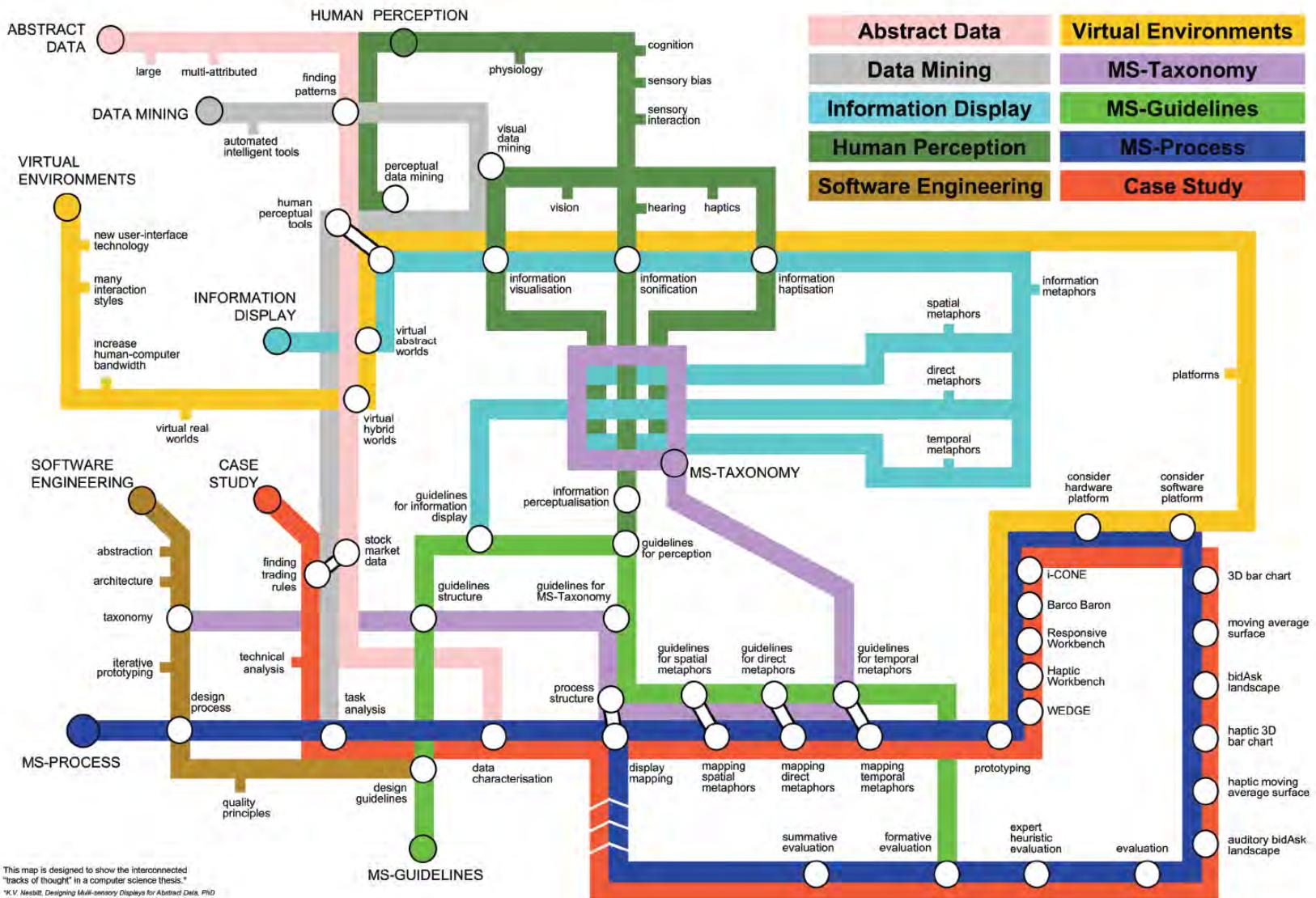
Drawn up by M. Minard, Inspector General of Bridges and Roads in retirement. Paris, November 20, 1869.

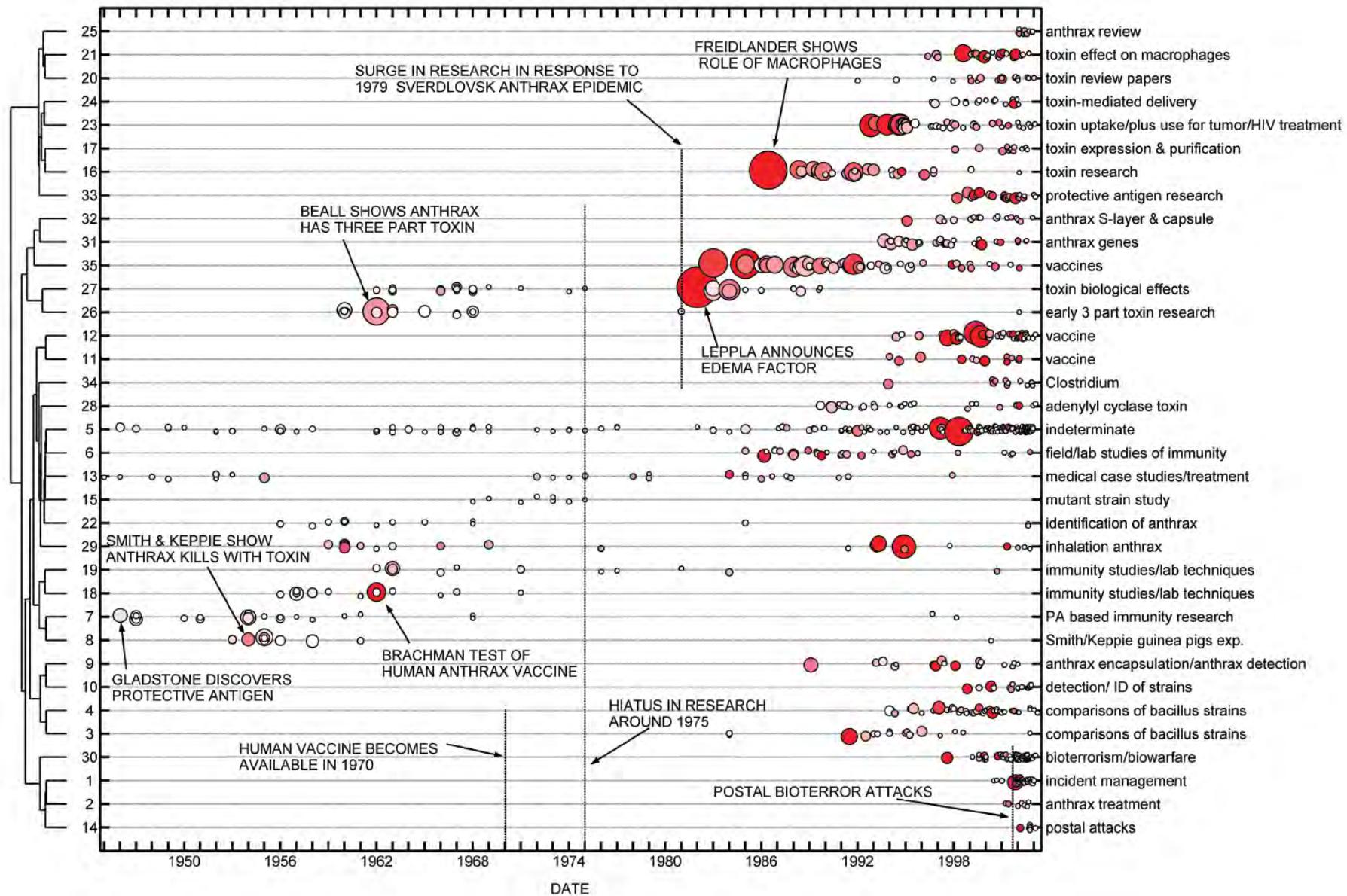
The numbers of men present are represented by the widths of the colored zones at a rate of one millimeter for every ten thousand men; they are further written across the zones. The red designates the men who enter into Russia, the black those who leave it. — The information which has served to draw up the map has been extracted from the works of M.-M. Thiers, of Séguir, of Fezenzac, of Chambray and the unpublished diary of Jacob, pharmacist of the Army since October 28th. In order to better judge with the eye the diminution of the army, I have assumed that the troops of Prince Jérôme and of Marshal Davout, who had been detached at Minsk and Mogilev and have rejoined around Orsha and Vitebsk, had always marched with the army.

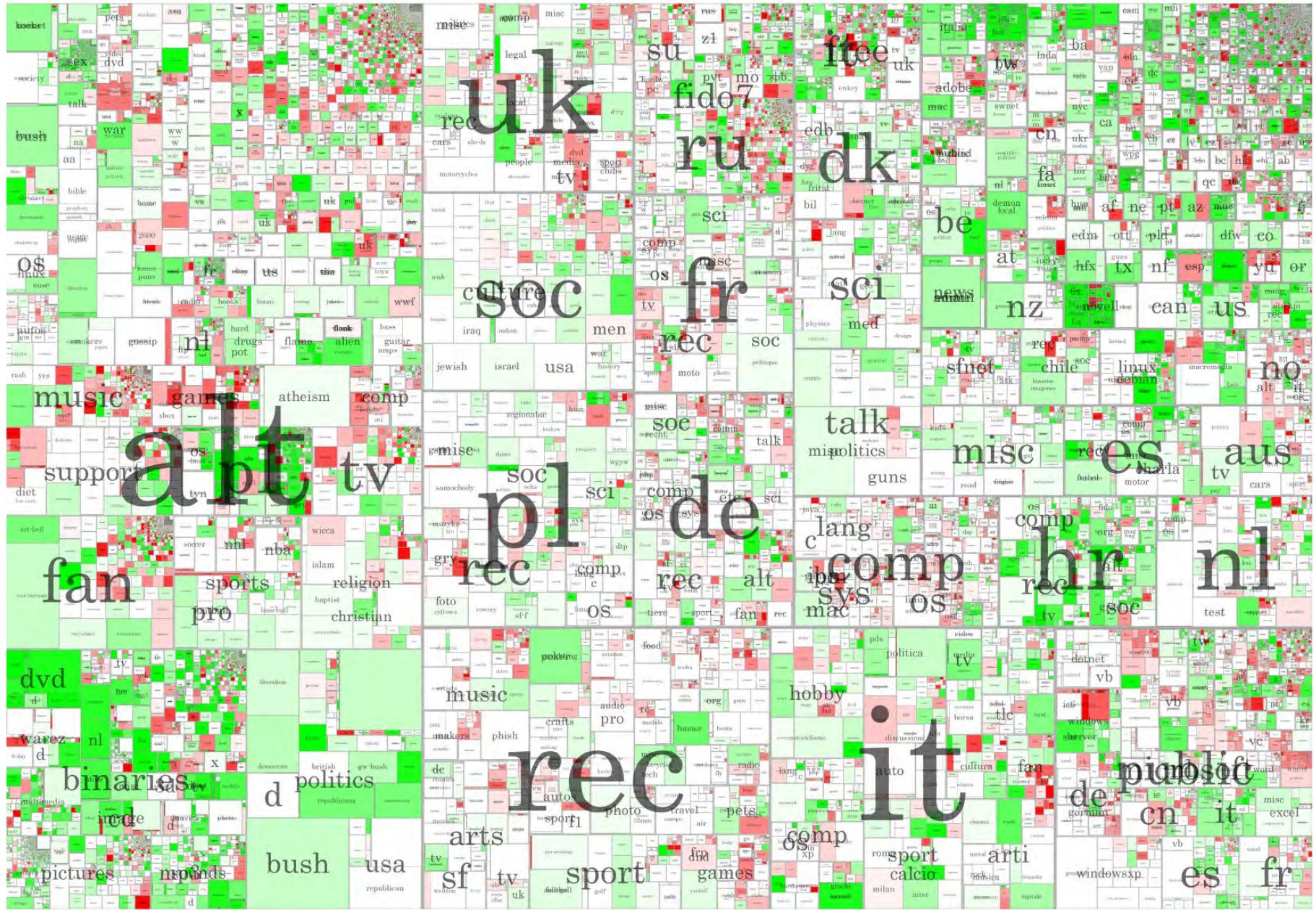


1.4 Napoleon's March to Moscow - Charles Joseph Minard - 1869









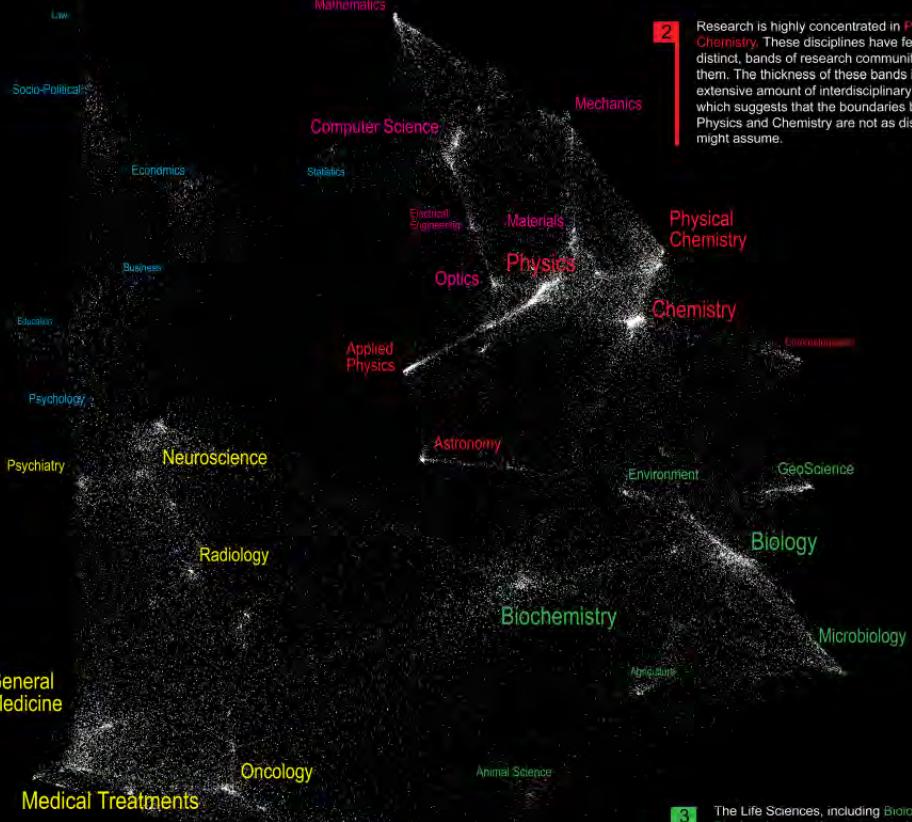
I.8 Treemap View of 2004 Usenet Returnees - Marc Smith and Danyel Fisher - 2005



1.9 In Terms of Geography – André Skupin - 2005

The Structure of Science

5 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.



4 The Medical Sciences include broad therapeutic studies and targeted areas of Treatment (e.g. central nervous system, cardiology, gastroenterology, etc.) Unlike Physics and Chemistry, the medical disciplines are more spread out, suggesting a more multi-disciplinary approach to research. The transition into Life Sciences (via Animal Science and Biochemistry) is gradual.

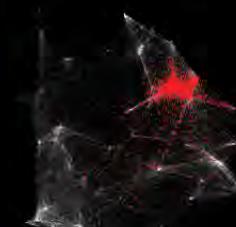
We are all familiar with traditional maps that show the relationships between countries, provinces, states, and cities. Similar relationships exist between the various disciplines and research topics in science. This allows us to map the structure of science.

One of the first maps of science was developed at the Institute for Scientific Information over 30 years ago. It identified 41 areas of science from the citation patterns in 17,000 scientific papers. That early map was intriguing, but it didn't cover enough of science to accurately define its structure.

Things are different today. We have enormous computing power and advanced visualization software that make mapping of the structure of science possible. This galaxy-like map of science (left) was generated at Sandia National Laboratories using an advanced graph layout routine (VxOrd) 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 (9 on average) 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. This 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, exploit, abandon, or ignore.

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



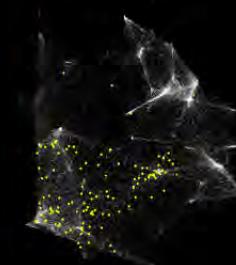
Nanotechnology

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



Proteomics

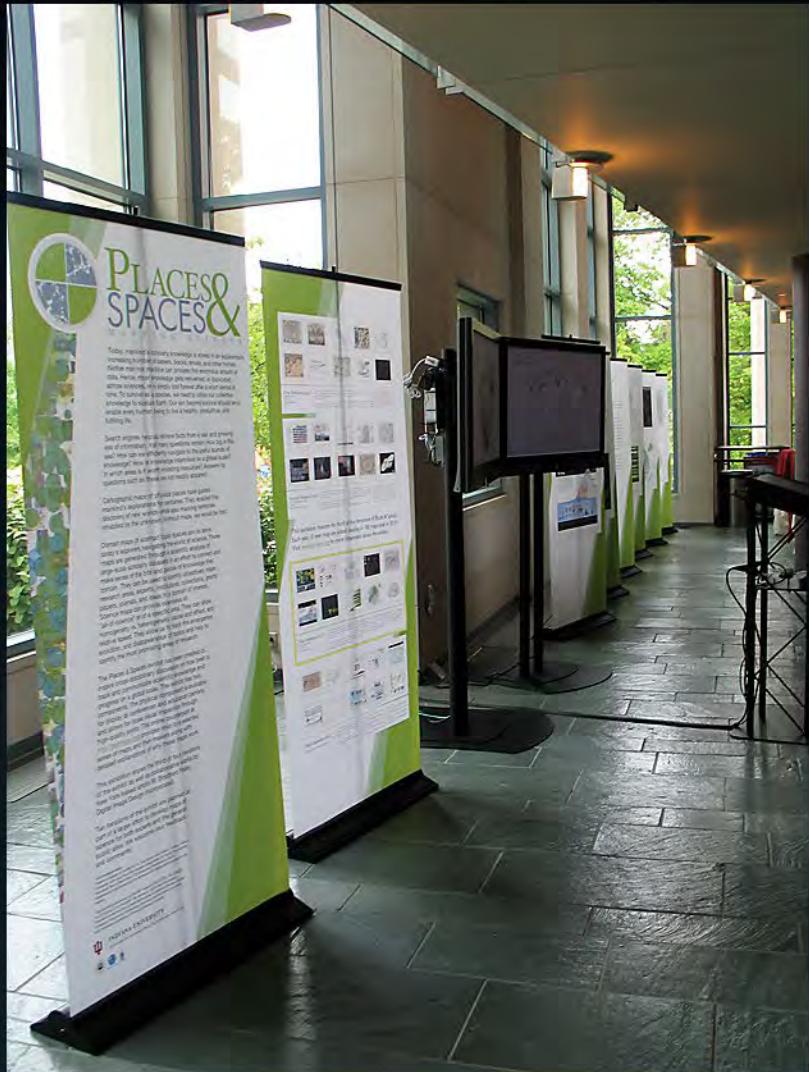
Research communities in proteomics are centered in Biochemistry. In addition, there is a heavy focus in the tools section of chemistry, such as Chromatography. The balance of the proteomics communities are widely dispersed among the Life and Medical Sciences.



Pharmacogenomics

Pharmacogenomics is a relatively new field with most of its activity in Medicine. It also has many communities in Biochemistry and two communities in the Social Sciences.

Want to host the **Places & Spaces** Exhibit?



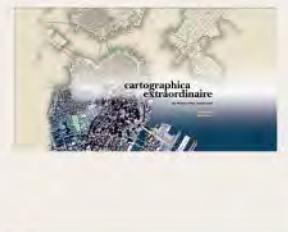
Visit scimaps.org/host
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this unique collection to
your venue!

Iteration II (2006)

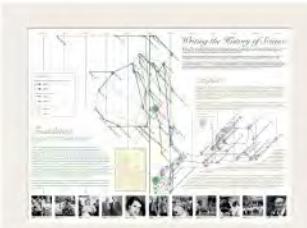
The Power of Reference Systems



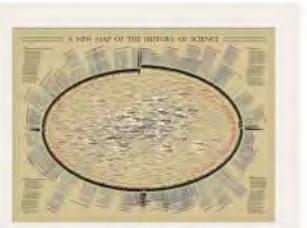
II.1



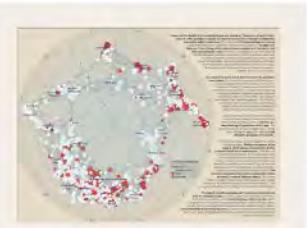
II.3



II.5



II.7



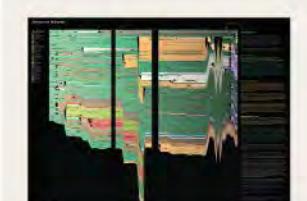
II.9



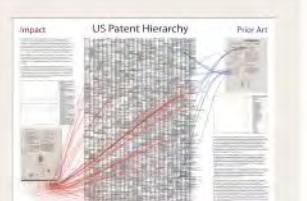
II.2



II.4



II.6



II.8



II.10

UNITED STATES FREQUENCY ALLOCATIONS

THE RADIO SPECTRUM

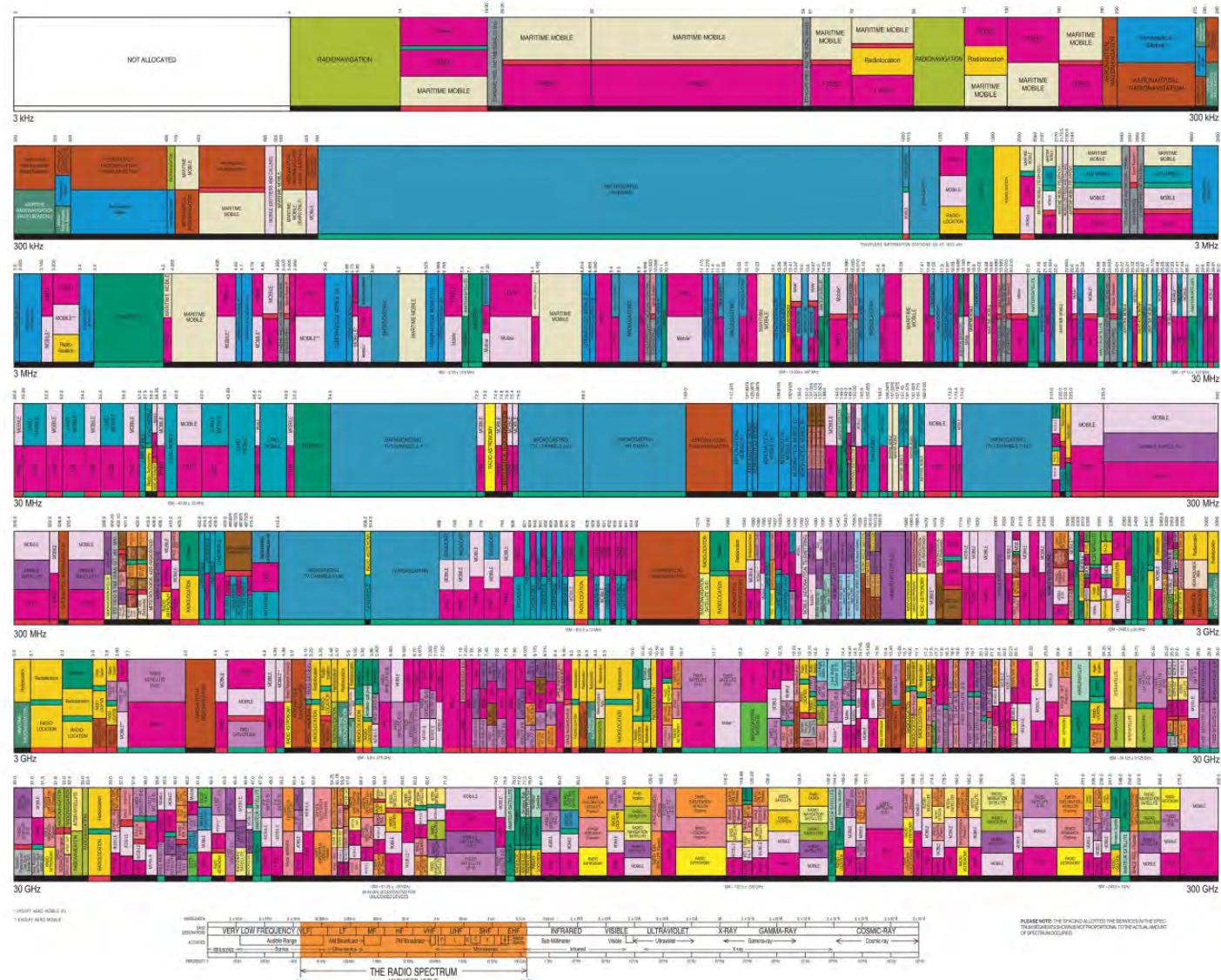


ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital Letters
Secondary	Mobile	1st Capital with lower case letters

You find in a graphic design portion-line picture of the Table of Frequency Allocations cited by the FCC in its "Allocation of Radio Frequencies." This chart is not a complete listing of all frequencies allocated in the United States. Therefore, for complete information, users should consult the Table of Frequency Allocations. Together, for complete information, users should consult the Table of Frequency Allocations and the U.S. Government's

U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Office of Spectrum Management
October 2003



II.1 U.S. Frequency Allocations Chart - National Telecommunications and Information Administration - 2003

The Visual Elements Periodic Table



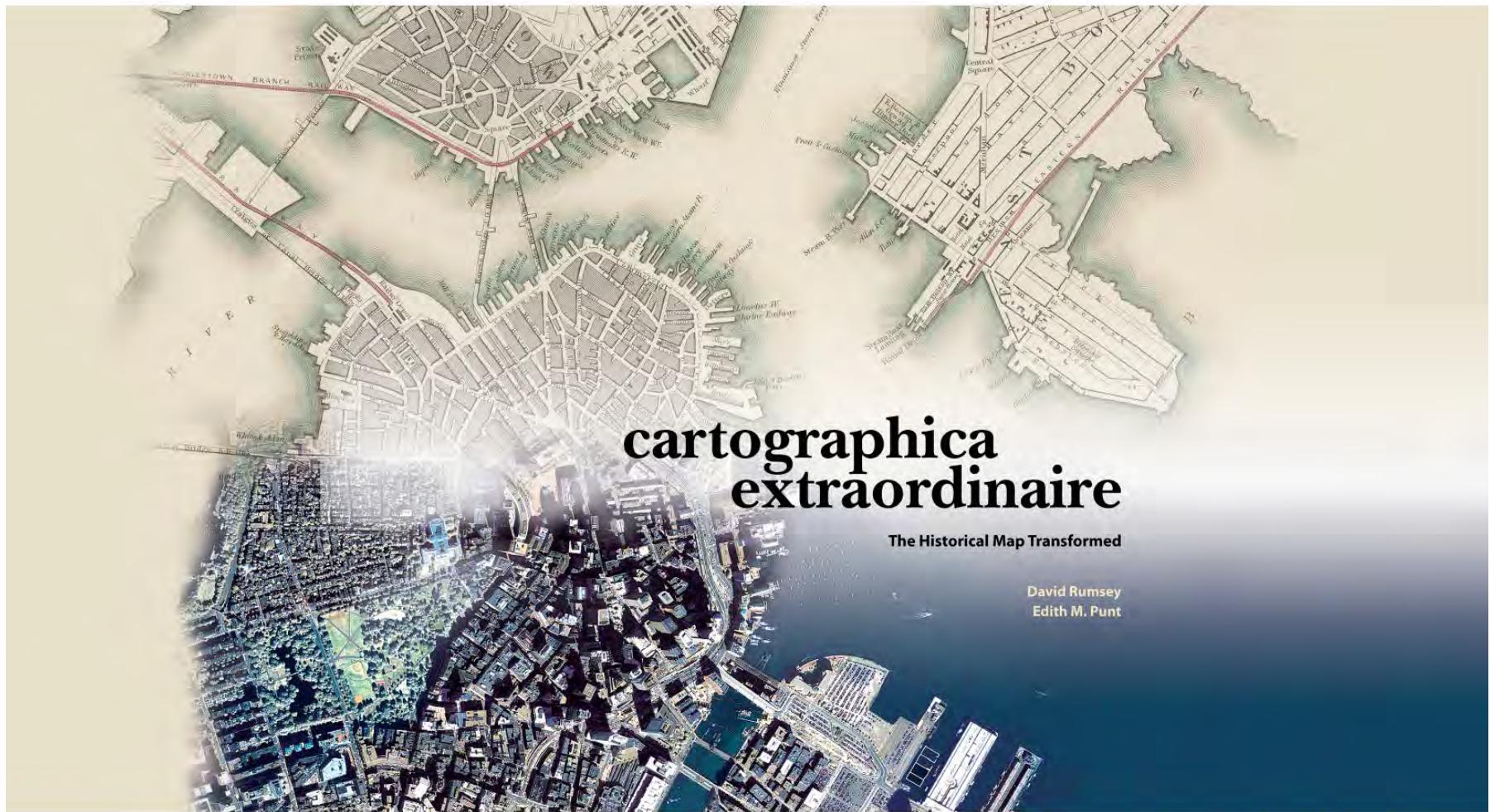
This chart shows the 111 currently known and officially named elements that comprise the Periodic Table (IUPAC 2004). Each element is represented visually by an image produced for the Visual Elements project.

The Periodic Table is an arrangement of all known elements in 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.

Visual Elements is an arts and science collaborative project supported by the Royal Society of Chemistry which aims to explore and reflect upon the diversity of elements that comprise matter in as unique and innovative manner as possible. All the images displayed here, together with screensavers, postcards and chemical data for each element can be viewed on the Visual Elements web site, hosted by the RSC.

Visit the periodic table on the web at:
www.chemsoc.org/viselements

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II.3 *Cartographica Extraordinaire: The Historical Map Transformed* - David Rumsey and Edith M. Punt - 2004

Evening Stars

The Big Dipper floats high in the northeast these early spring evenings, while Orion sinks low in the southwest. These are just a few of the celestial sights you can find on any clear evening in April using a sky map like the one shown here.



How to Use a Sky Map

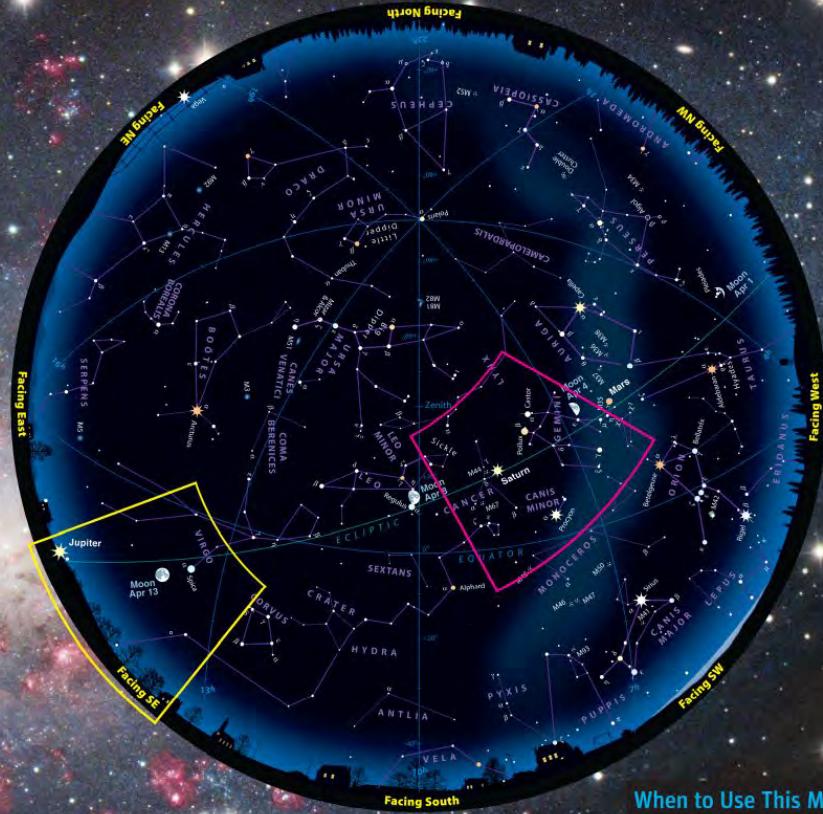
1. Check the dates and times at right. Take your map out under the night sky around the right time, and bring along a flashlight to read it by. It helps to attach a piece of red paper over the front or to use a flashlight with red LEDs; the dim red light won't spoil your night vision.

2. Outside, you need to know which direction you're facing. (If you're unsure, just note where the Sun sets; that's west.) Whichever way you're facing, make sure the corresponding yellow label along the curved edge of the map is at the bottom, right-side up.

This curved edge represents the horizon. The stars above it on the map match the stars in front of you. The farther up from the map's edge they appear, the higher they'll be in the sky.

The center of the map is the zenith (straight overhead). So a star halfway from the edge of the map to the center will appear halfway from straight ahead to straight up. Ignore all the parts of the map above horizons you're not facing.

3. Let's give it a try! Pretend you're facing the southwest horizon (labeled "Facing SW"). Just a little way up (that is, a little way in from the edge of the map) is Sirius, the brightest star in the night sky, in the constellation Canis Major. Farther up, nearly halfway overhead, is the star Procyon in Canis Minor. Still farther up is the ringed planet Saturn. Go out at the right time, face southwest, and look up into the sky — there they are!



When to Use This Map

Early April: 10 pm (daylight-saving time)
Late April: Dusk

Tips

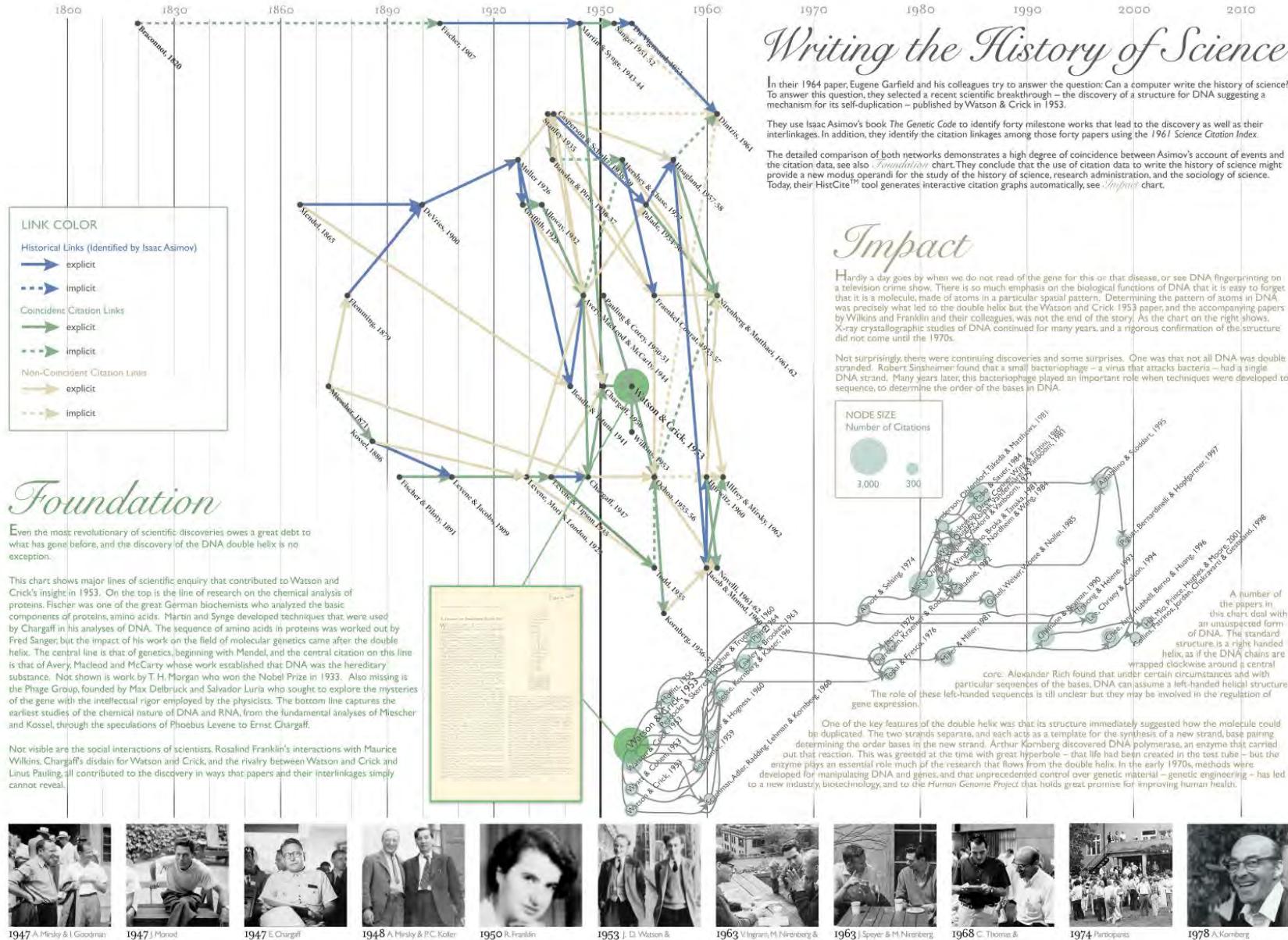
A couple of tips: Look for the brightest stars and constellations first; light pollution or moonlight may wash out the fainter ones. And remember that star patterns in the sky will look a lot bigger than they do here on paper.

With a map like this, you can identify celestial sights all over the sky. Go out the next clear night and make some starry friends!

You can customize a night-sky map for any time and place at SkyandTelescope.com.

PHOTO COURTESY OF ROBERT GENDLER

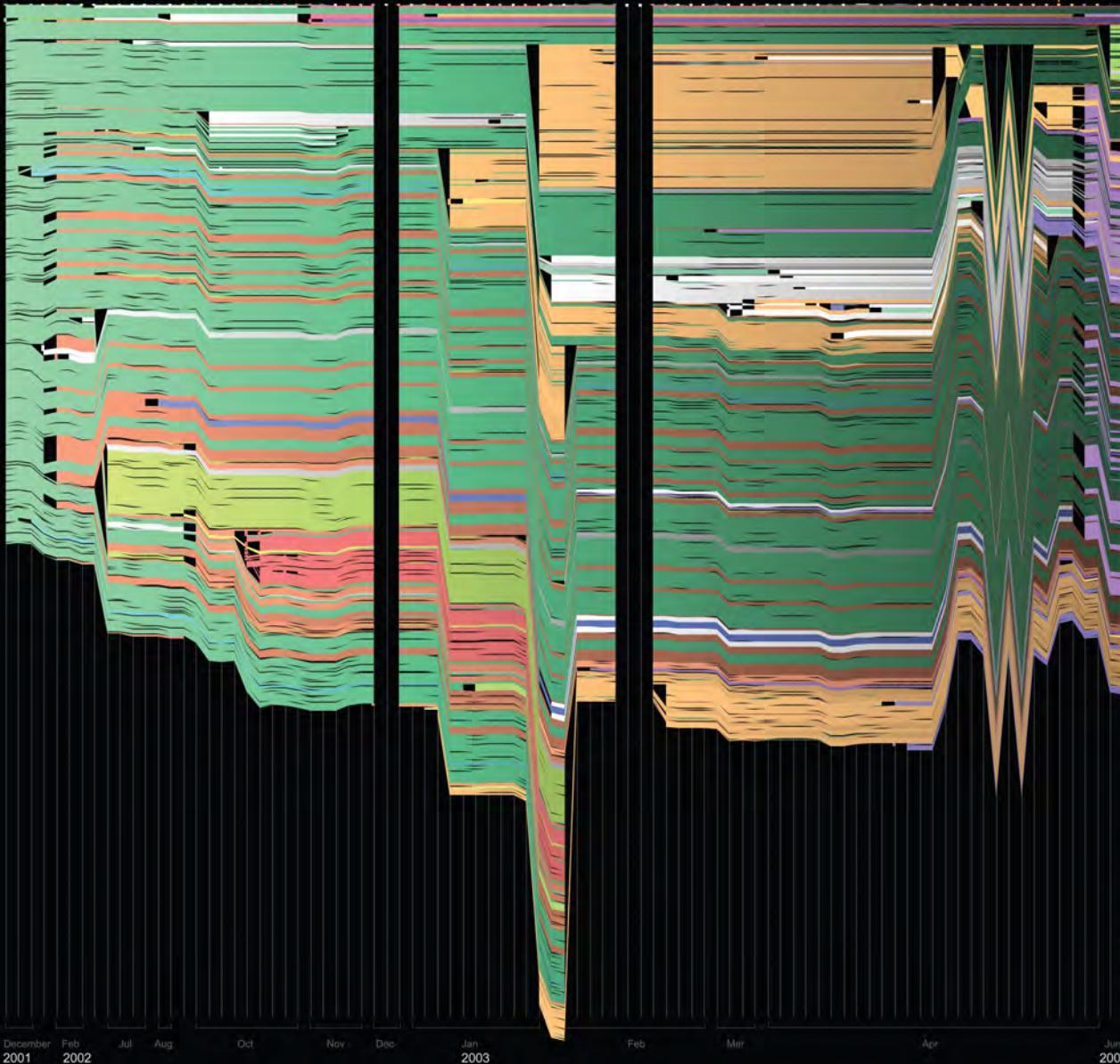
SKY
& TELESCOPE



Abortion on Wikipedia

Authors

Zundark
The Cunctator
The Eptopt
Conversion script
Rk
Fredb
B4hand
KamikazeArchon
Dwight Gilbert
Shrubender
Mkmccorm
Iata
Derek Ross
Derek Ross
Afghan
Maveric149
Jizzbug
Jdtarl
Thianthropo
Tibetan
Dreamward
Stevengtgo
Camerbert
Hephaestos
Hephaestos
MyRedDice
G-Man
Kingurtse
Montrealais
212

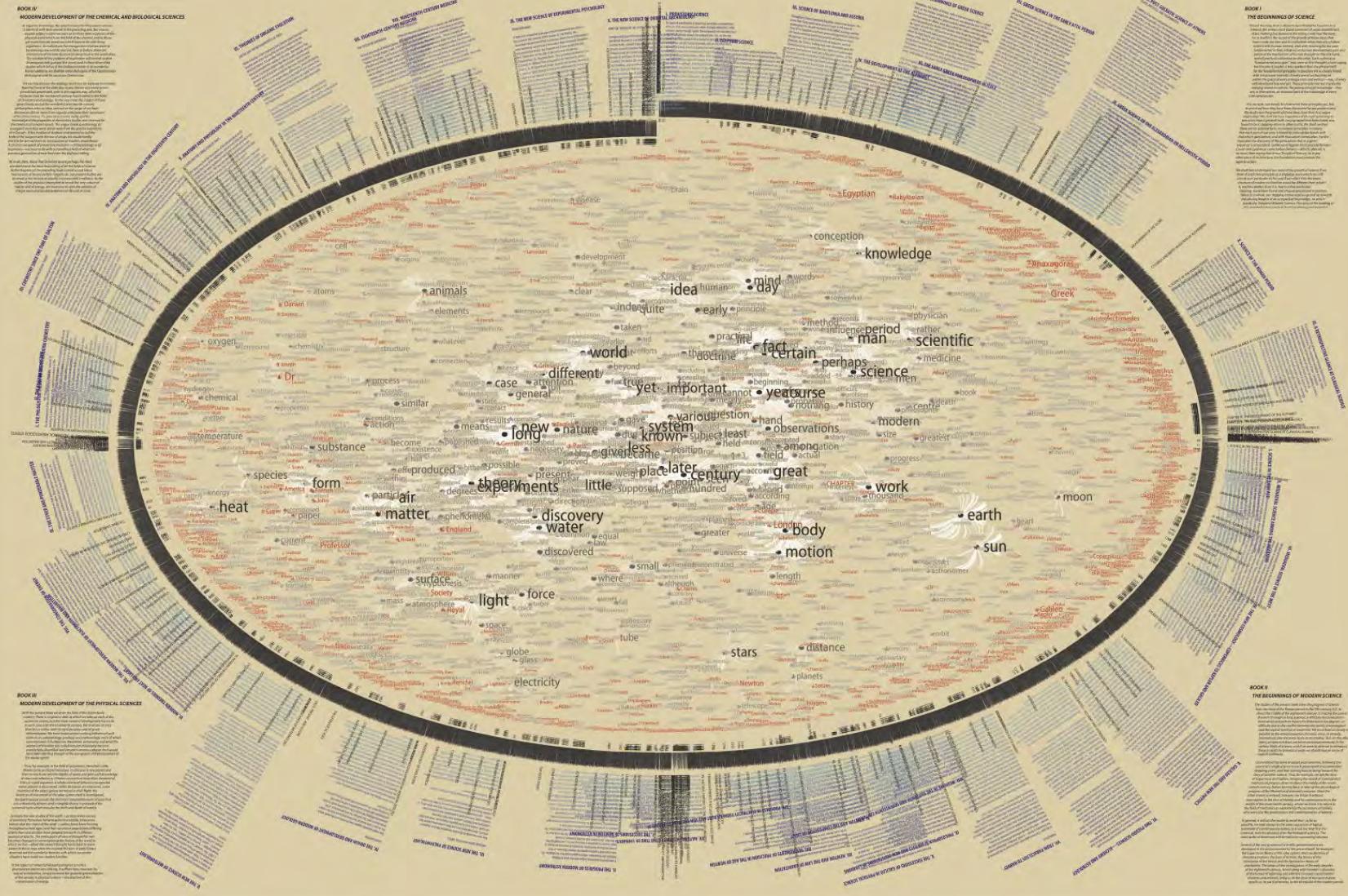


II.6 History Flow Visualization of the Wikipedia Entry on "Abortion" - Martin Wattenberg and Fernanda B. Viégas - 2006

Bring a friend or relatives to see it! *A History of Science* by Henry Smith Williams, MD, LL.D., revised by Edward A. Williams, M.D.
Friends always an online as in the form of a book showing how easily they placing word and their own terms (or capitals)
at their average position - as if rubber bands pulled toward every stage. A dark star rises to a words when that word is used.

A NEW MAP OF THE HISTORY OF SCIENCE

white signs toward lines in which a word is mentioned. Words get large and darker the more they are used. This particular book
has been enhanced to extract and analyze historical medical names (medieval names) appear inside the arc; chapter leaders & introductory
paragraphs available; book annotations in the corners. Typeset and drawn in November, 2005 by W. Bradford Paley. All rights reserved.



Impact

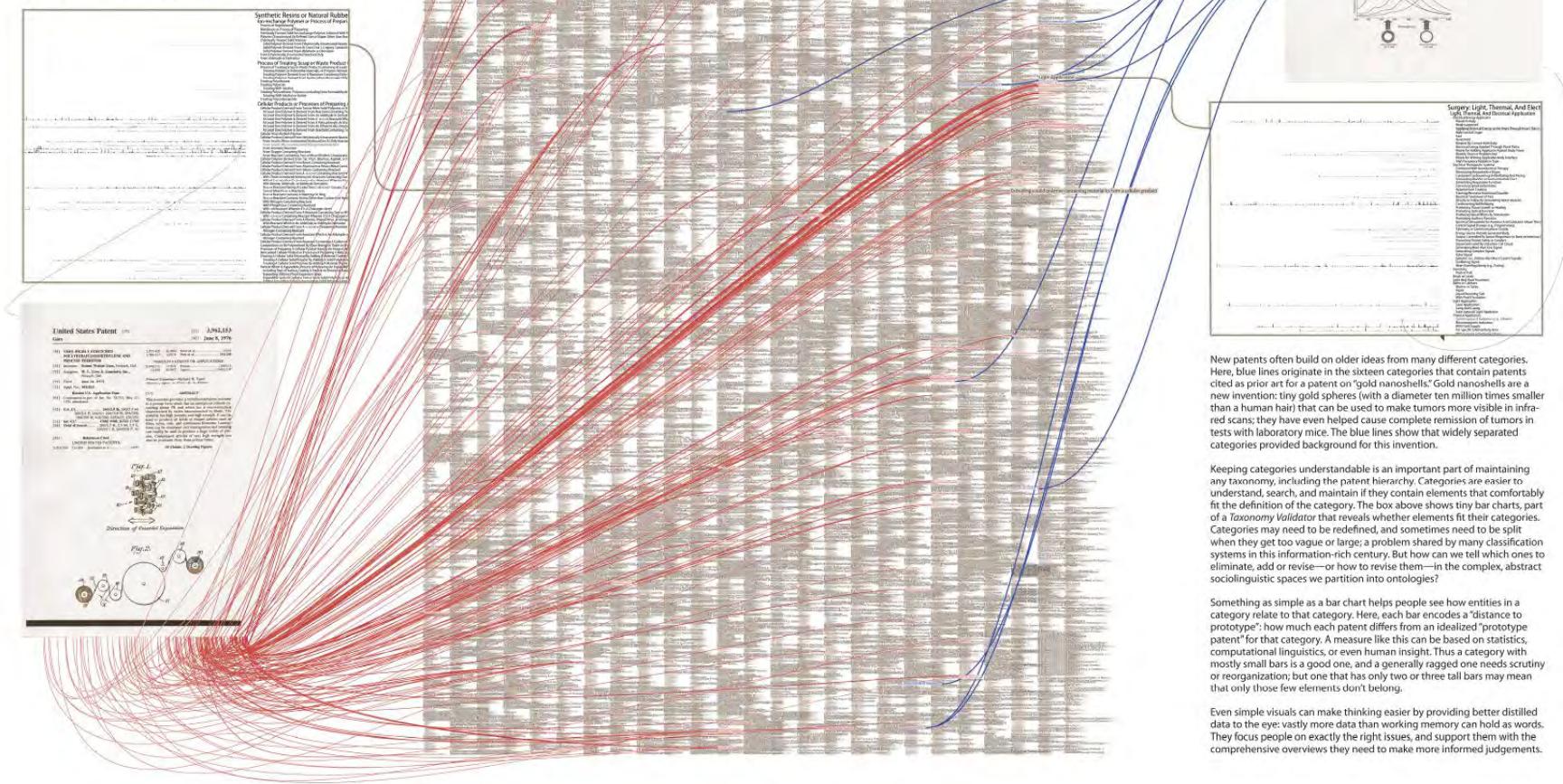
The US Patent Hierarchy

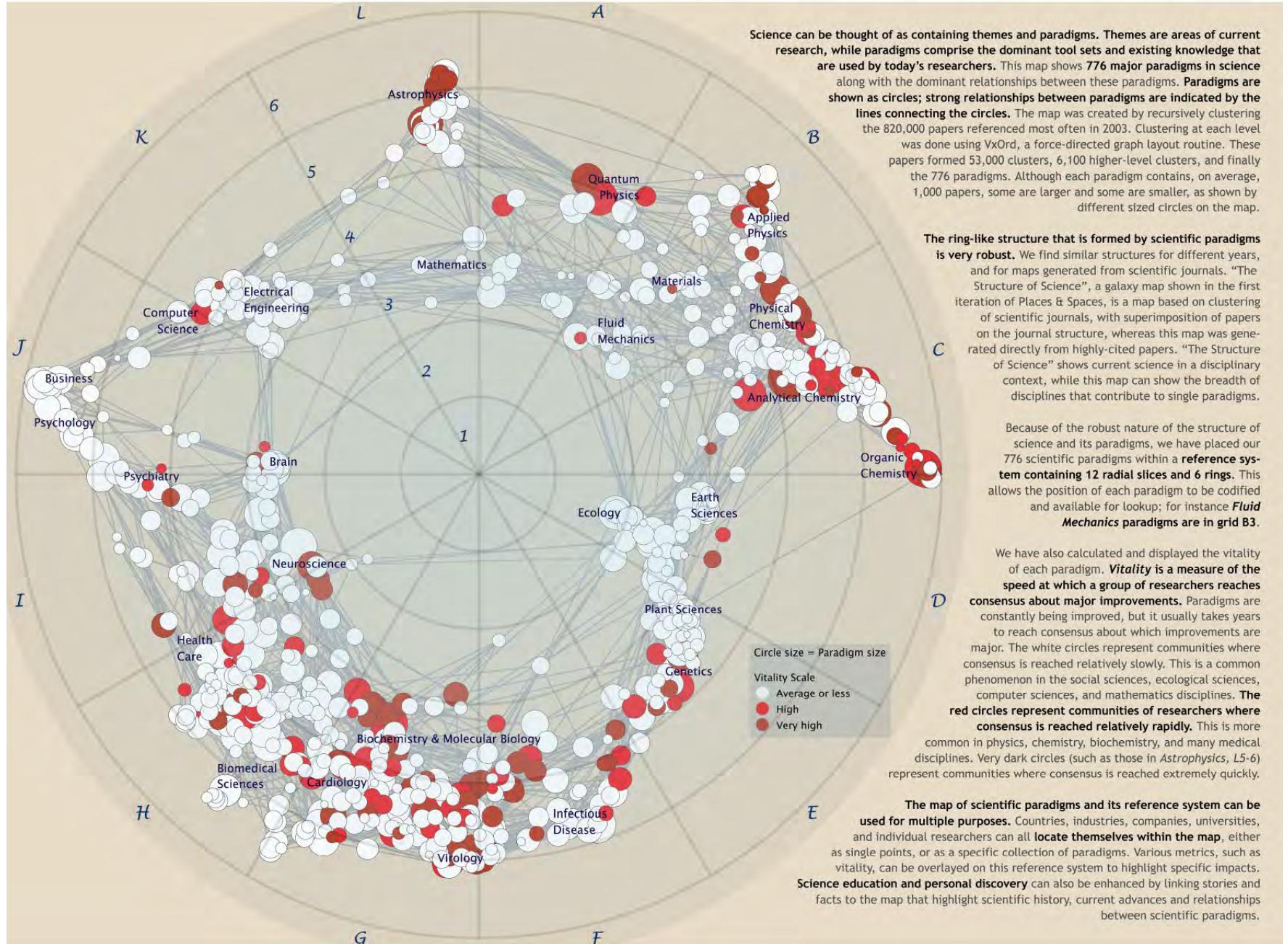
Prior Art

The United States Patent and Trademark Office does scientists and industry a great service by granting patents to protect inventions. Inventions are categorized in a taxonomy that groups patents by industry or use, proximate function, effect or product, and structure. At the time of this writing there are 160,523 categories in a hierarchy that goes 15 levels deep. We display the first three levels (13,529 categories) at right in what might be considered a textual map of inventions.

Patent applications are required to be unique and non-obvious, partially by revealing any previous patents that might be similar in nature or provide a foundation for the current invention. In this way we can trace the impact of a single patent, seeing how many patents and categories it affects.

The patent on Goretex—a lightweight, durable synthetic fiber—is an example of one that has had significant impact. The box below enlarges the section of the hierarchy where it is filed, and the red lines (arranged to start along a time line from 1981 to 2006) point to the 130 categories that contain 182 patents, from waterproof clothing to surgical cosmetic implants, that mention Goretex as “prior art.”







II.10 Zones of Invention—Patterns of Patents - Ingo Günther - 2006

Exhibit Venues



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.



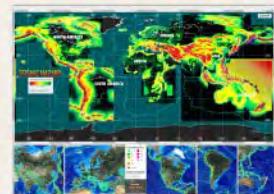
Duke University, Durham, NC.
January 12 - April 10, 2015



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

Iteration III (2007)

The Power of Forecasts



III.1



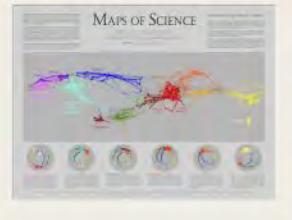
III.3



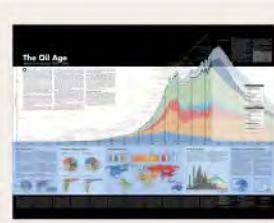
III.5



III.7



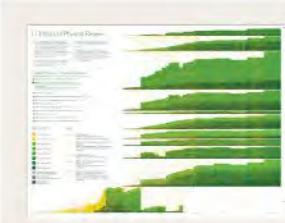
III.9



III.2



III.4



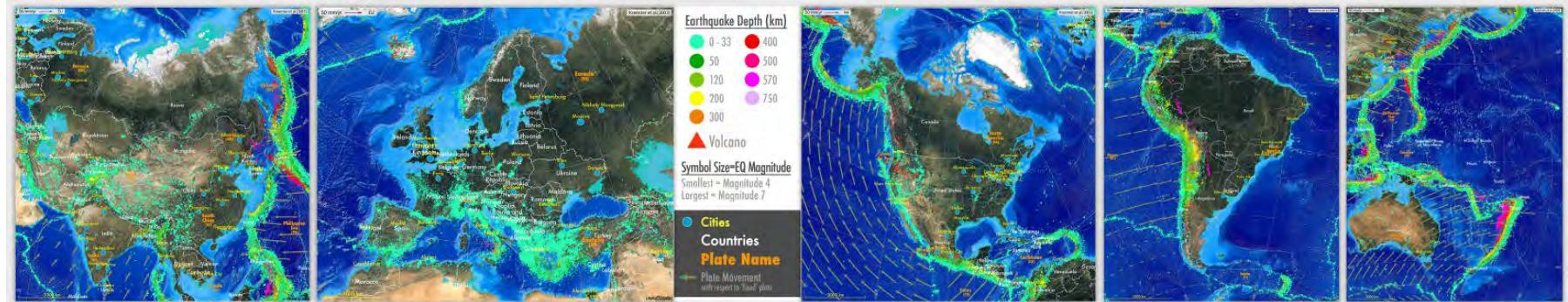
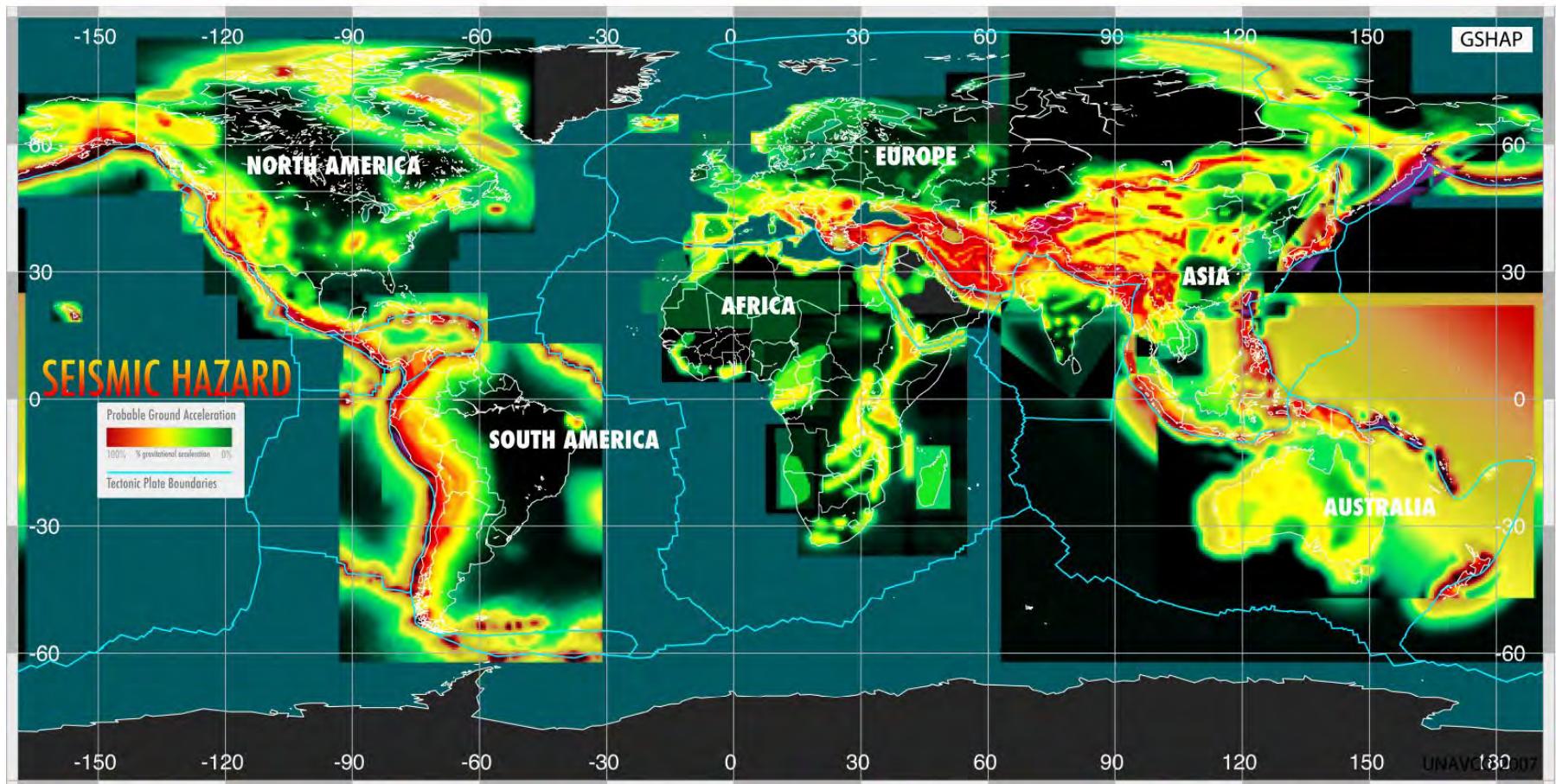
III.6



III.8

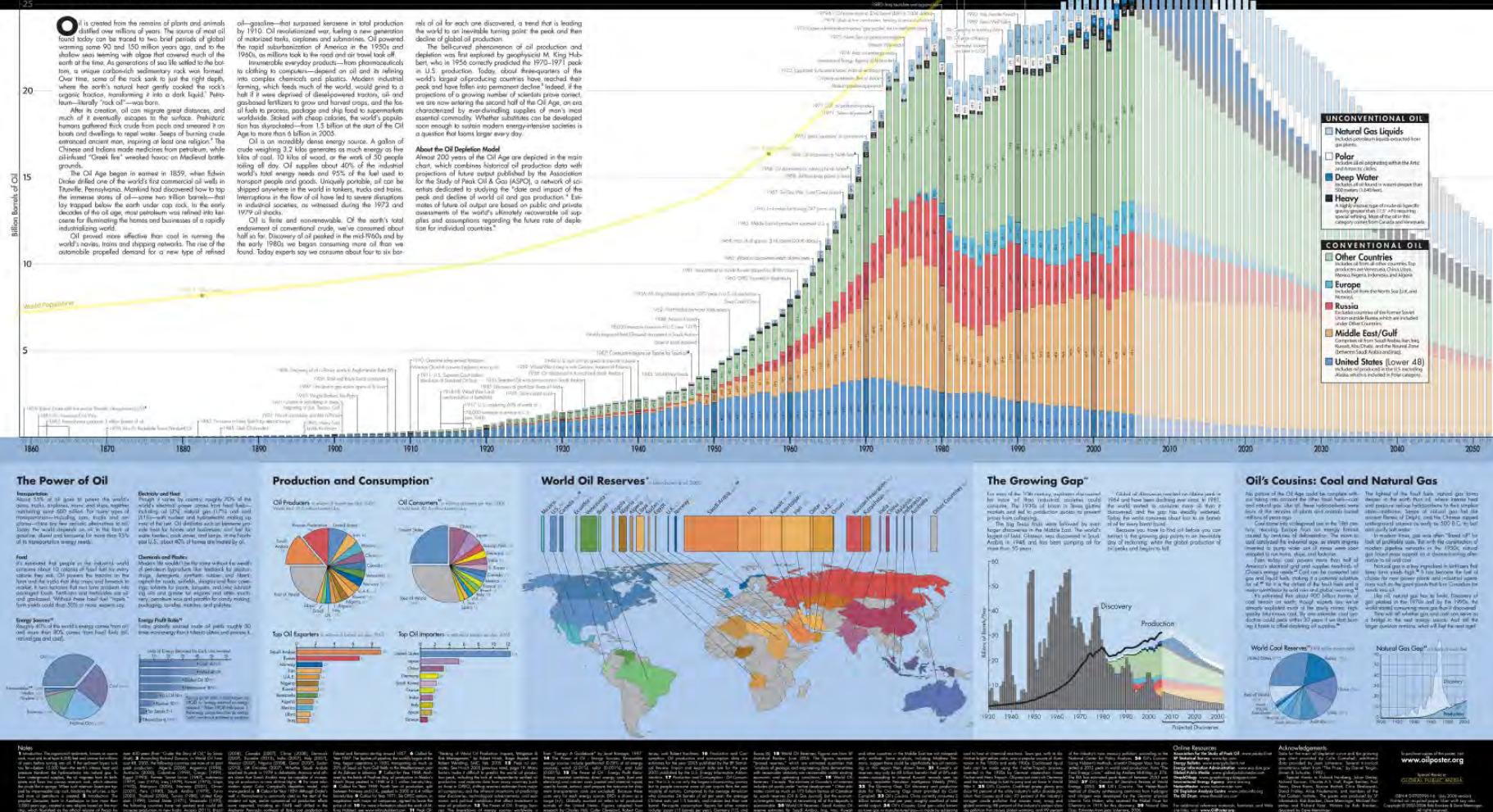


III.10



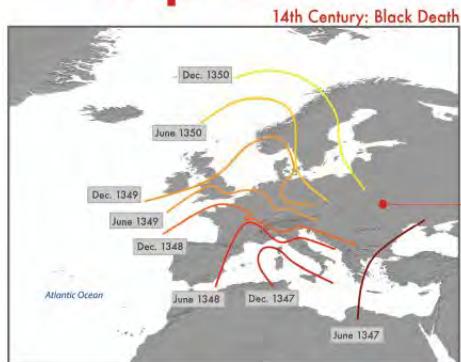
The Oil Age

World Oil Production 1859 - 2050



III.2 The Oil Age: World Oil Production 1859-2050 - Rob Bracken, Dave Menninger, Michael Poremba, and Richard Katz - 2006

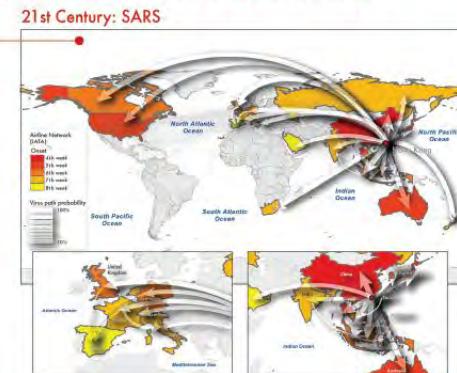
•Impact OF Air Travel ON Global Spread OF Infectious Diseases•



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

In pre-industrial times disease spread was mainly a spatial diffusion phenomenon. During the spread of Black Death in the 14th century Europe, only few traveling means were available and typical trips were limited to relatively short distances on the time scale of one day. Historical studies confirm that the disease diffused smoothly generating an epidemic front traveling as a continuous wave through the continent at an approximate velocity of 200-400 miles per year.

The SARS outbreak on the other hand was characterized by a patched 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 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 grey, source: IATA).



•Forecasts OF THE Next Pandemic Influenza•

Seasonal



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



The modeling approach considers infection dynamics (i.e., virus transmission, onset of symptoms, infectiousness, recovery, etc.) among individuals living in urban areas around the world, and assumes that individuals are allowed to travel from one city to another by means of the airline transportation network.

Geographical



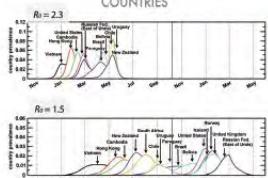
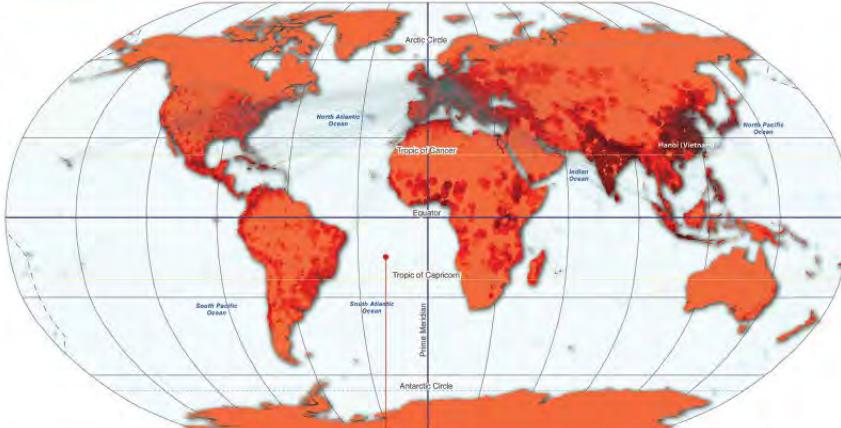
Numerical simulations provide results for the temporal and geographic evolution of the pandemic influenza in 3,100 urban areas located in 220 different countries. The model allows to study different spreading scenarios, characterized by different initial outbreak conditions, both geographical and seasonal.



The central map represents the cumulative number of cases in the world after the first year from the start of a pandemic influenza with $R_0=1.9$ 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.



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: $R_0=1.5$, consistently with the values shown for the US map (top right), and $R_0=2.3$, 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 R_0 , representing the average number of infections generated by a sick person in a fully susceptible population.

Reproductive Number (R_0)



Intervention



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 envisions a limited worldwide sharing of the resources.





./ logicaland

PARTICIPATIVE GLOBAL SIMULATION WWW.LOGICALAND.NET

[LOGICALAND] IS A PROJECT STUDY FOR VISUALIZING OUR WORLD'S COMPLEX ECONOMICAL, POLITICAL AND SOCIAL SYSTEMS.

[LOGICALAND] V0.1 IS THE FIRST ATTEMPT TO REALIZE A PROTOTYPE OF A GLOBAL SIMULATION THAT IS BASED ON THE COLLECTIVE DECISIONS OF UNLINKED PARTICIPANTS. IT IS BASED ON A GLOBAL WORLD MODEL DEVELOPED IN THE 1970s THAT HAS BEEN TAKEN OUT OF ITS ORIGINAL CONTEXT AND ADAPTED INTO A PARTICIPATIVE COMPUTER GAME. IN ROUNDS OF PLAY LASTING UP TO 22 HOURS, FINANCIAL AND NATURAL RESOURCE ENDOWMENTS OF 185 STATES CAN BE MANIPULATED IN AN INTERDEPENDENT WORLD SYSTEM. THE SIMULATION STARTS WITH A NEAR VERSION FROM THE YEAR 2001 TAKEN FROM THE STATISTICS CONTAINED IN THE CIA WORLD FACT BOOK.

THE PARAMETER CHANGES MADE BY PARTICIPANTS BECOME "VOTES" THAT ARE POLED BY THE SERVER AND FED BACK INTO THE SIMULATION.

GLOBAL WORLD MODELS CAN BE UNDERSTOOD AS "COMPUTER PROGRAMS THAT SIMULATE THE WORLD IN VERY BROAD, COMPREHENSIVE MANNER. GEOGRAPHICALLY, THEY ENCOMPASS THE WHOLE WORLD OR AT LEAST A MAJOR PORTION OF IT. MORE IMPORTANTLY, THEY EXPLICITLY LINK TOGETHER A NUMBER OF DIFFERENT ASPECTS OF THE WORLD SUCH AS ECONOMIC, DEMOGRAPHIC, POLITICAL, AND THE ENVIRONMENT. BECAUSE OF THESE TRAITS, INTEGRATED GLOBAL MODELS CAN BE AND ARE USED AS TOOLS TO HELP US UNDERSTAND PROCESSES WHOSE EFFECTS CROSS NATIONAL BORDERS AND WHOSE STUDY CROSSES DISCIPLINARY BOUNDARIES." (PETER BREIDER)

[LOGICALAND] IS A PARTICIPATIVE WORLD SYSTEM IDEA / CONCEPT / REALIZATION:
RE-P-DR = VIENNA, AUSTRIA
MICHAEL ASHAUER, MAIA GUSBERTI, NIK THOENEN,
IN COLLABORATION WITH SEPP DEINHOFER AND THE SUPPORT OF SILVERSERVER



QUICK INFO
 [LOGICALAND] may be seen as a "massive strategic simulation game", one round lasts for 22 hours. one round starts one year: any user from anywhere can start/propose changes to the world model. these changes are then voted on by all other users. additionally, each user can propose changes to their own country. the calculated average of all user's propositions are accounted for the simulation.

FORUM
 [LOGICALAND] is a communication tool: free users to users post, read, discuss etc.

HOME TO
 the online version of this website.

STATS
 [LOGICALAND] graphical statistics: how many users of the world, via Internet access distribution and where [LOGICALAND]'s users come from - visualized in the same line as the globe.

EXIT
 logout and exit here ...

ACTUAL YEAR
TIME PROGRESS BAR
 indicates time left until year changes (next round starts)

INFO PANEL
 prints absolute values of some parameters for currently selected region (or the world) if no region is selected

PARAMETER PICK
 choose the parameter you want to be displayed on the map and the graph.

MAP MODE
 choose your preferred type of visualization between:
 WORLD MAP (zoomed geographic world map currently selected parameter is mapped to country size).
 "classical" BAR CHART
 NORTH/SOUTH (zoomed geographic world map resources and draw distinctions between regions via north/south divide).

TIMELINE
 click or drag the slider to appropriate the year you want to be displayed.

SUBMIT BUTTON
 sends your proposed values to the server; only one submission per round and user is allowed.

GRAPH
 displays selected value of current region (or world) as a function of time
 1. past
 2. actual year
 3. future (proposal)

CONTROL PANEL
 edit and change parameters of currently selected region (actual year).

TARGET INVESTMENT DISTRIBUTION
 intended distribution of investment on the sectors industry, agriculture, logistics and others.

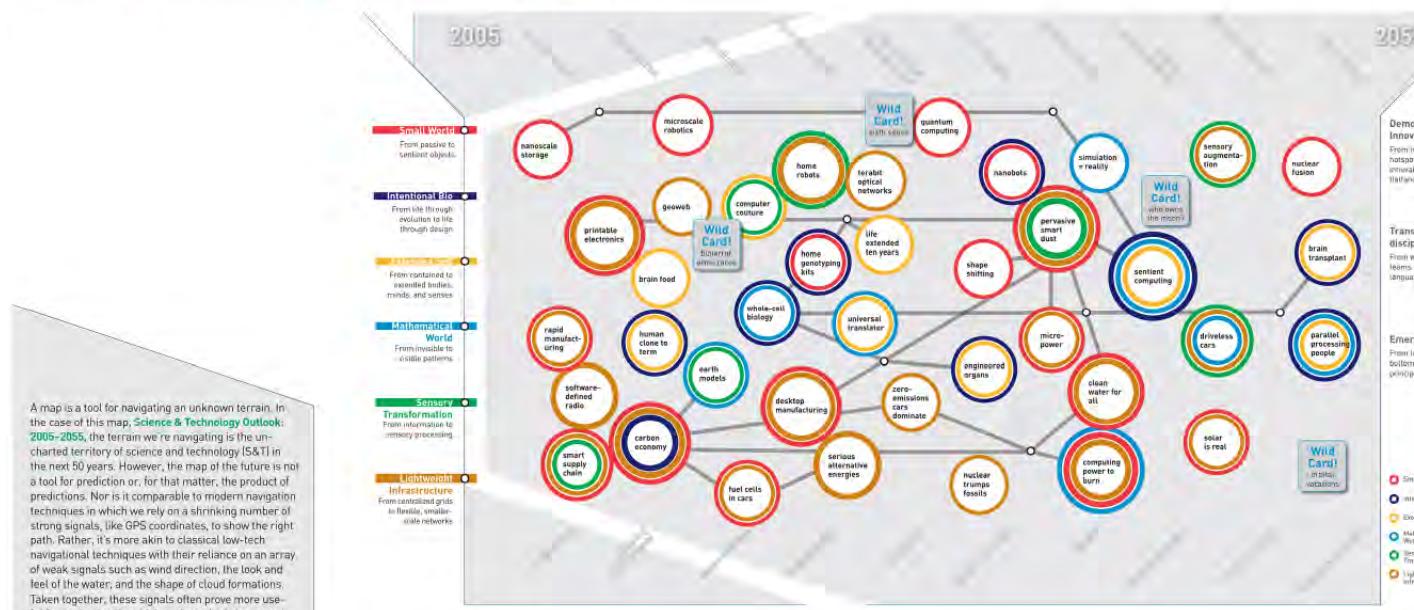
FOOD AD
 percentage of food surplus that will be provided as (development) aid.

FINANCIAL AD
 percentage of utilities surplus that will be provided as (development) aid.

green bar indicates your proposed value.
grey bar indicates present value calculated by all user's contributions.

all values are immediately recalculated after release of a new round. to see the massive effects on one of the world maps (or bar chart), your display year must be set within the prognosis period (see timeline).





A map is a tool for navigating an unknown terrain. In the case of this map, *Science & Technology Outlook: 2005–2055*, the terrain we're navigating is the uncharted territory of science and technology (S&T) in the next 50 years. However, the map of the future is not a tool for prediction or, for that matter, the product of predictions. Nor is it comparable to modern navigation techniques in which we rely on a shrinking number of strong signals, like GPS coordinates, to show the right path. Rather, it's more akin to classical long-distance navigational techniques with their reliance on an array of weak signals such as wind direction, the look and feel of the water, and the shape of cloud formations. Taken together, these signals often prove more useful for navigation than high-tech methods because, in addition to aiding travelers in selecting the "right" path, the signals contextualize information and reveal interdependencies and connections between seemingly unrelated events, thus enriching our understanding of the landscape. That's precisely the intention of this map of the future of S&T—to give the reader a deeper contextual understanding of the landscape and to point to the intricacies and interdependences between trends.

While developing the map, the **Institute for the Future (IFTF)** team listened for and connected a variety of weak signals, including those generated during interviews and workshop conversations involving more than 100 eminent U.S. and U.K. experts in S&T—academics, policymakers, journalists, and corporate researchers. The IFTF team also compiled a database of outlooks on developments that are likely to impact the full range of S&T disciplines and practice areas over the next 50 years. We also relied on IFTF's 40 years of experience in forecasting S&T developments to create the map and an accompanying set of **S&T Perspectives** that discuss issues emerging on the S&T horizon and are important for organizations, policymakers, and society-at-large to understand.

On this map, six themes are woven together across the 50-year horizon, often resulting in important breakthroughs. These are supported by key technologies, innovations, and discoveries. In addition to the six themes, three meta-themes—democratized innovation, transdisciplinarity, and emergence—will overlay the future S&T landscape influencing how we think about, learn about, and practice science. Finally, S&T trends won't operate in a vacuum. Wider social, demographic, political, economic, and environmental trends will both profoundly influence S&T trends and will be influenced by them. Some of these wider trends surround the map to remind us of the larger picture.

MAP THEMES

Small World

After 20 years of basic research and development at the 100-nanometer scale, the importance of nanotechnology as a source of innovations and new capabilities in everything from materials science to medicine is already well-understood. Three trends, however, will define how nanotechnology will unfold, and what impacts it will have. First, nanotechnology is not a single field with a coherent intellectual program; it's an opportunistic hybrid, shaped by a combination of fundamental research questions, promising technical applications, and venture and state capital. Second, nanotechnology is moving away from the original vision of small-scale mechanical engineering—in which assemblers build mechanical systems from individual atoms—toward one in which molecular biology and biochemistry contribute essential tools (such as proteins that build nanowires). Finally, nanotechnology will also serve as a model for transdisciplinary science. It will support both fundamental research and commercially oriented innovation; and it will be conducted not within the boundaries of conventional academic or corporate research departments, but in institutional and social milieus that emphasize heterogeneity.

Intentional Biology

For 3.5 billion years, evolution has governed biology on this planet. But today, Mother Nature has a collaborator: Inexpensive tools to read and rewrite the genetic code of life will bootstrap our ability to manipulate biology from the bottom up. We'll not only genetically re-engineer existing life but actually create new life forms with purpose. Still, we will not be blind to what nature has to teach us. Evolution's elegant engineering at the nano-scales will be a rich source of inspiration as we build the bio-nanotechnology of the next 50 years.

Extended Self

In the next 50 years, we will be faced with broad opportunities to remake our minds and bodies in profoundly different ways. Advances in biotechnology, brain science, information technology, and robotics

will result in an array of methods to dramatically alter, enhance, and extend the mental and physical hand that nature has dealt us. Welding these tools on ourselves, humans will begin to define a variety of different "transhumanist" paths—that is, ways of being and living that extend beyond what we today consider natural for our species. In the very long term, following these paths could someday lead to an evolutionary leap for humanity.

Mathematical World

The ability to process, manipulate, and ultimately understand patterns in enormous amounts of data will allow decoding of previously mysterious processes in everything from biological to social systems. Scientists are learning that at the core of many biological phenomena—reproduction, growth, repair, and others—are computational processes that can be decoded and simulated. Using techniques of combinatorial science to uncover such patterns—whether these are physical, biological, or social—will likely occupy an increasing share of computing cycles in the next 50 years. Such massive computation will also make simulation widespread. Computer simulation will be used not only to help make decisions about large complex scientific and social problems but also to help individuals make better choices in their daily lives.

Sensory Transformation

In the next ten years, physical objects, places, and even human beings themselves will increasingly become embedded with computational devices that can sense, understand, and act upon their environment. They will be able to react to contextual clues about the physical, social, and even emotional state of people and things in their surroundings. As a result, increasing demands will be placed on our visual, auditory, and other sensory abilities. Information previously encoded as text and numbers will be displayed in richer sensory formats—as graphics, pictures, patterns, sounds, smells, and tactile experiences. This enriched sensory environment will coincide with major breakthroughs in our understanding of the brain—in how we process sensory information and connect various sensory functions.

Humans will become much more sophisticated in their ability to understand, create, and manage sensory information and ability to perform such tasks will become keys to success.

Lightweight Infrastructure

A confluence of new materials and distributed intelligence is pointing the way toward a new kind of infrastructure that will dramatically reshape the economics of moving people, goods, energy, and information. From the molecular level to the macroeconomic level, these new infrastructure designs will emphasize smaller, smarter, more independent components. These components will be organized into more efficient, more flexible, and more secure ways than the capital-intensive networks of the 20th century. These lightweight infrastructures have the potential to boost emerging economies, improve social connectivity, mitigate the environmental impacts of rapid global urbanization, and offer new future paths in energy.

META-THEMES

Democratized Innovation

Before the 20th century, many of the greatest scientific discoveries and technical inventions were made by amateur scientists and independent inventors. In the last 100 years, a professional class of scientists and engineers, supported by universities, industry, and the state, pushed amateurs aside as a creative force. At the national scale, the capital-intensive character of scientific research made world-class research the property of prosperous advanced nations. In the new century, a number of trends and technologies will lower the barriers to participation in science and technology again, both for individuals and for emerging countries. The result will be a renaissance of the serious amateurs, the growth of new scientific and technical centers of excellence in developing countries, and a more global distribution of world-class scientists and technologists.

Transdisciplinarity

In the last two centuries, natural philosophy and natural history fractured into the now-familiar disciplines of physics, chemistry, biology, and so on. The sciences evolved into their current form in response to intellectual and professional opportunities, philanthropic priorities, and economic and state needs. Through most of the 20th century, the growth of the sciences, and academic and career pressures, encouraged ever-greater specialization. In the coming decades, transdisciplinary research will become an imperative. According to Howard Rheingold, a prominent forecaster and author, "transdisciplinarity goes beyond bringing together researchers from different disciplines to work in multidisciplinary teams. It means educating researchers who can speak languages of multiple disciplines—biologists who have understanding of mathematics, mathematicians who understand biology."

Emergence

The phenomenon of self-organizing swarms that generate complex behavior by following simple rules—will likely become an important research area, and an important model for understanding how the natural world works and how artificial worlds can be designed. Emergent phenomena have been observed across a variety of natural phenomena, from physics to biology to sociology. The concept has broad appeal due to the diversity of fields and problems to which it can be applied. It is proving useful for making sense of a very wide range of phenomena. Meanwhile, emergence can be modeled using relatively simple computational tools, although those models often require substantial processing power. More generally, it is a richly suggestive as a way of thinking about designing complex, robust technological systems. Finally, emergence is an accessible and vivid metaphor for understanding nature. Just as classical physics profited from popular treatments of Newtonian mechanics, so too will scientific study and technical reproductions of emergent phenomena likely draw benefits from the popularization of its underlying concepts.

113 Years of Physical Review

This visualization aggregates 389,899 articles published in 720 years of Physical Review and 26 Nobel Prizes from 1893 to 2005. The 91,762 articles published from 1893 to 1976 are shown in the base map. In 1977, the Physical Review introduced the Physics and Astronomy Classification Scheme (PACS) codes, and the visualization subdivides into the top-level PACS codes. The 212,503 articles from 1977 to 2000, for which good citation data is available, occupy the middle third on the map. The 80,634 articles from 2001 to 2005, for which good citation data is available, fill the last third of the map.

Each vertical bar is subdivided vertically into the journals that appear it with height proportional to the number of papers, and each journal is subdivided horizontally into the volumes of the journal appearing in the column.

On top of this base map, all citations from the papers in every top-level PACS code in 2005 are overlaid and then drawn from the source area to the individual volumes containing papers cited.

The small Nobel Prize medals indicate the 24 volumes containing the 26 papers appearing in Physical Review for 11 Nobel prizes between 1990 and 2005. Each year, Thomson ISI presents the Nobel laureates in physics based on citation counts, high impact papers, and discoveries or themes worthy of special recognition. Correct predictions by Thomson ISI are highlighted.

Nobel Prizes in Physical Review

Year of Nobel Prize Winners Publication Year(s) (indicated by Nobel Prize medals on the right)

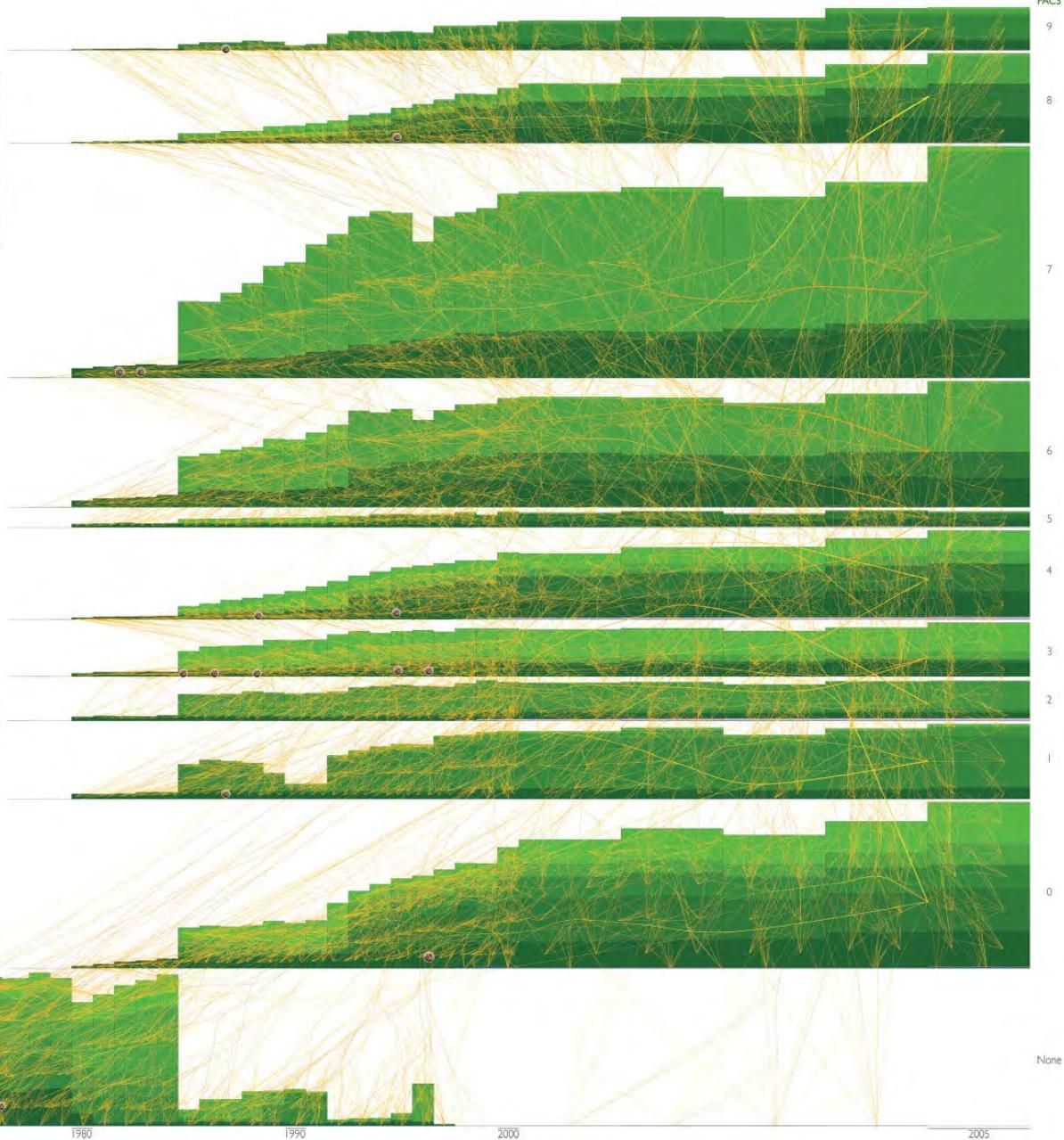
- 2005 Roy J. Glauber; John L. Hall, and Theodor W. Hänsch | 1963, 1971
- 2004 David J. Gross, H. David Politzer, and Frank Wilczek | 1973
Thomson ISI successfully predicted a winner in this year, with the following paper:
Gross, D., Wilczek, F. Ultraviolet Behavior of Non-Abelian Gauge Theories. *Physical Review Letters* 30, 1343 & 1973
- 2003 Anthony J. Leggett | 1970
- 2002 Raymond Davis Jr., Masatoshi Koshiba, and Riccardo Giacconi | 1962, 1968, 1987
- 2001 Eric A. Cornell, Wolfgang Ketterle, and Carl E. Wieman | 1995, 1996
- 1998 Robert B. Laughlin | 1982, 1983
- 1997 Steven Chu and William D. Phillips | 1985, 1986, 1988
- 1996 David M. Lee, Douglas D. Osheroff, and Robert C. Richardson | 1972
- 1995 Martin L. Perl | 1959, 1975
- 1994 Bertram N. Brockhouse and Clifford G. Shull | 1955, 1958
- 1990 Jerome I. Friedman, Henry W. Kendall, and Richard E. Taylor | 1969

Bar Graph



Lines

- PACS 0 General
PACS 8 Interdisciplinary Physics and Related Areas of Science and Technology
- PACS 1 The Physics of Elementary Particles and Fields
PACS 4 Electromagnetism, Optics, Acoustics, Heat Transfer, Classical Mechanics, and Fluid Dynamics
- PACS 2 Nuclear Physics
PACS 3 Atomic and Molecular Physics
- PACS 5 Physics of Gases, Plasmas, and Electric Discharges
PACS 9 Geophysics, Astronomy, and Astrophysics
- PACS 6 Condensed Matter: Structure, Mechanical and Thermal Properties
PACS 7 Condensed Matter: Electronic Structure, Electrical, Magnetic, and Optical Properties

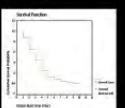


Mapping the Universe

Space, Time, Discovery!

Burst rate = 10.56

Fan et al. (2005) Sources of $z > 5.7$ quasars in the Sloan Digital Sky Survey II. Discovery of three additional quasars at $z > 6$. The Astronomical Journal [25, 1645-1659]



The above curve shows the cumulative probability of survival of a citation burst. The X-axis is the time span of a citation burst, and Y-axis is the probability of the end of a citation burst. Based on our data, the average citation burst at the SJSS literature lasts 3.5 years.

Network of Scientific Literature

The SBDS literature network gives an example of a collective and dynamic intellectual structure of scientific domains. The network consists of 1,362 nodes and 8,241 links. It contains two types of nodes. SBDS papers (that have received at least one citation) and other documents (including primary papers, books, and reviews). Nodes are represented by rectangles and edges by lines. Nodes are colored according to their domain. Domains are represented by schemes terms shown as triangles. These are labeled if their frequencies exceed user-defined threshold. Three types of links between nodes are distinguished: citations between nodes, connections between terms, and connections between nodes and cited nodes. Edges are colored according to their weight in light green, and the most recent ones in red. Edge color represents values received by a corresponding paper over time. The distribution of colors reveals the dominance of each intellectual structure.



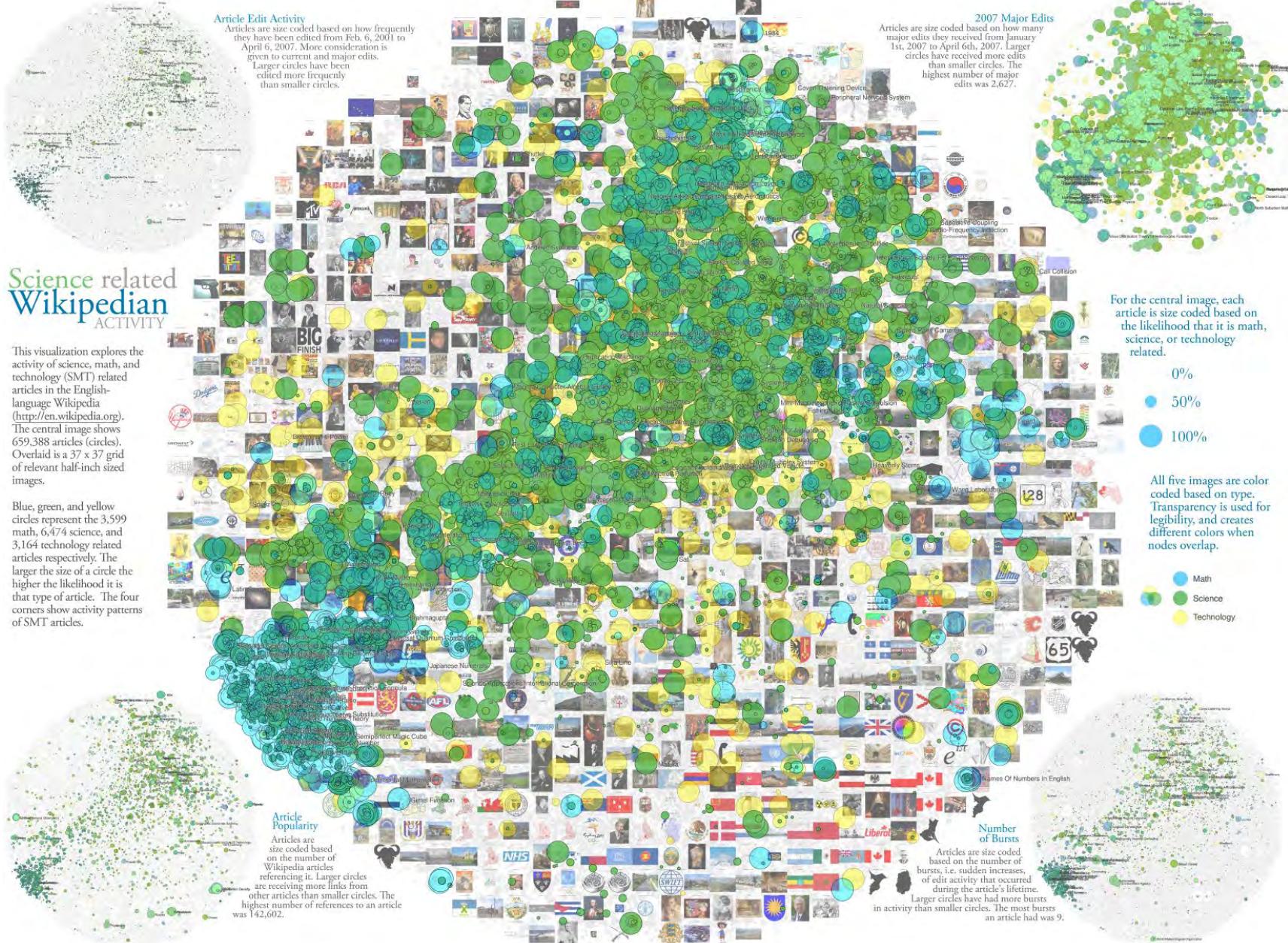
Time Spiral

The nine spiral degrees new topics that emerged *only* or *in* the SDSS literature. These topics are selected based on statistical tests of association between terms found in SDSS papers. Terms are included in the nine spiral *only* if they appear for the first time. Subsequent appearances of the same term are not included in the nine spiral. Terms *in* the nine spiral are expected to indicate emerging areas of future growth of the SDSS literature.



III.7 Mapping the Universe: Space, Time, Discovery!

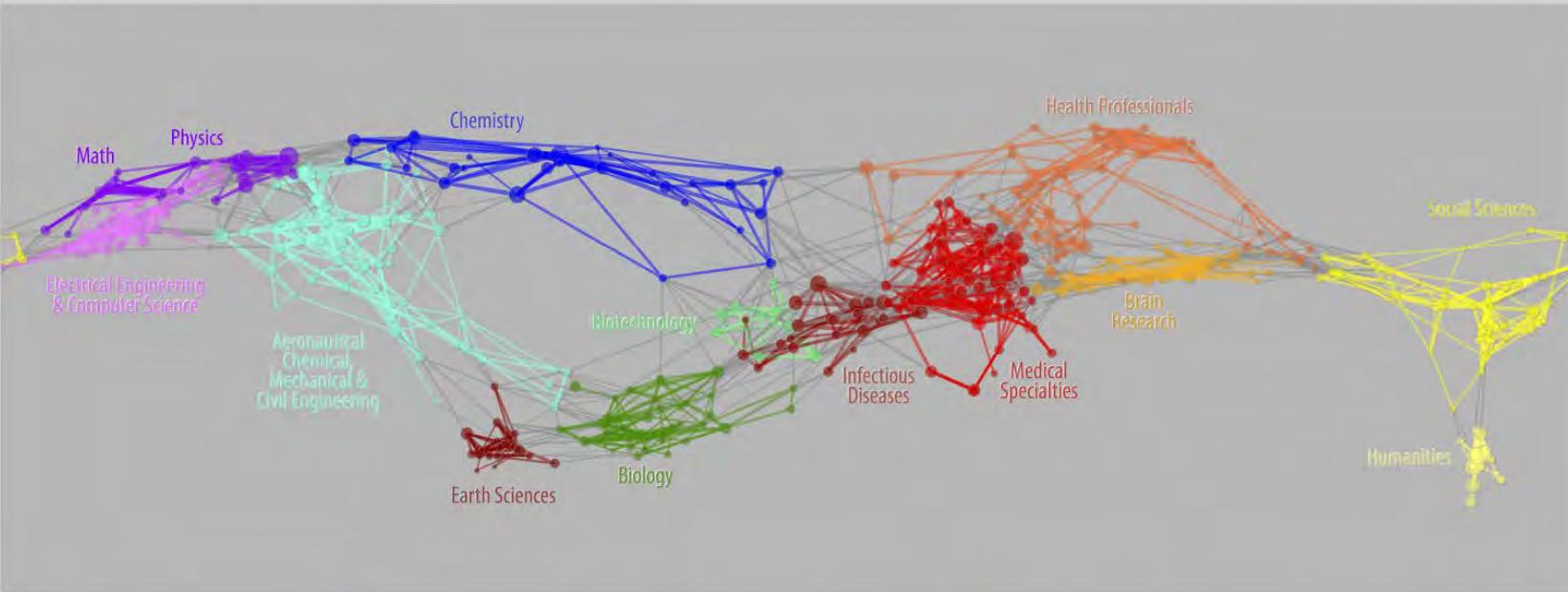
Chaomei Chen, Jian Zhang, Lisa Kershner, Michael S. Vogeley, J. Richard Gott III, and Mario Juric - 2007



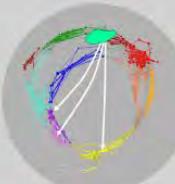
This map of science was constructed by sorting more than 16,000 journals into disciplines. Disciplines, represented as circles, are sets of journals that cite a common literature; links (the lines between disciplines) are pairs of disciplines that share a common literature. A three-dimensional model was used to determine the position of each discipline on the surface of a sphere based on the linkages between disciplines. The model treats links like rubber bands attempting to bring two disciplines close to each other. Pairs of disciplines without links tend to end up on different sides of the map.

The spherical map, which is not shown here, was unrolled in a mercator projection (the same one used to show the continents of the earth). In a two-dimensional map, to give the large majority of disciplines a reasonable aspect ratio of the map, we must distort it. Note that the disciplines tend to string along the middle of the map - if this were a map of the earth it would be like a single continent undulating along the equator. There are no disciplines at the top (north pole) or the bottom (south pole). Mercator projections also introduce distortions. We tend to forget that the left side is connected to the right side, and assume that the middle is most important. In this map, the social sciences (yellow) on the right connect with the computer sciences (pink) on the left in one continuous swirl.

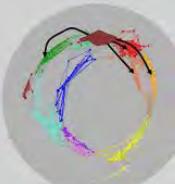
The six map projections shown at the bottom are images of what one would see of looking directly down at the south pole of the map, at six different rotations. When viewed this way, the map looks like a wheel with an inner ring and outer rings. This wheel of science corresponds very closely with the two-dimensional maps we have previously produced.



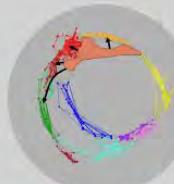
Electrical Engineering & Computer Science (EECS), indicated by the light green shape above, has the largest overall increase in connectedness with other fields (16%). It has relatively few connections with the EECS, Math & Physics, and Social Sciences fields, but its connections had the largest fractional increase. The connection with EECS, which had the single largest growth rate (91% of any connection), reflects recent growth in the area of bioinformatics. Over time, these stronger connections will distort the map, and may bring EECS into a more central position.



Infectious Diseases, indicated by the dark red shape above, has an overall decrease in connectedness (-2%) with other fields. This is dominated by decreasing connection strength between this field and the medical fields and biology. The other fields, however, have been increasing their connection strength with Infectious Diseases. The field with the largest increasing strength is the one to EECS, which is not shown here, but was shown as a white arrow in the current structure.



Medical Specialties, indicated by the red shape above, has an overall decrease in connectedness (-2%) with other fields. This is dominated by decreasing connection strength to the other medical fields and biology, as well as by decreasing connections with all cases, as shown by the black arrows. With the increasing connection strengths throughout medicine, we expect the map structure in these areas to relax slightly over time.



The **Health Professionals** field, indicated by the orange shape above, has the largest overall increase in connectedness (9%) with other fields. As with the other medical fields, its connection strength with medical fields is decreasing in all cases, as shown by the black arrows. With the increasing connection strengths throughout medicine, we expect the map structure in these areas to relax slightly over time.



The **Social Sciences**, indicated by the yellow shape above, has an overall increase in connectedness (9%) with other fields. Although its greatest connectedness gains were with EECS and Biotechnology (see white arrows), it also had considerable increases in connectedness with all the other fields. In general, the fields of EECS, Biotechnology, and the Social Sciences are becoming more connected, and are pulling on the physical sciences as well.

Source: University of California, San Diego Knowledge Mapping Laboratory. Code: Images © Regenstrief Institute and the University of California. This visualization can be found in two places: i) Semantic Scholar; ii) Mapping metainformatics and citation networks by Eric Klavans, President, Semantic Scholar Corporation, Inc., Jim Kevin Boyack, Samira Khatami, Lorraine Freeman, and Richard Klavans. Graphics & Opportunity by Emily Mooney and Michael J.

Special acknowledgments to Katy Börner, Art Eddleman, Brian Hayes, Len Shaeffer, and Henry Small

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Maps of Science

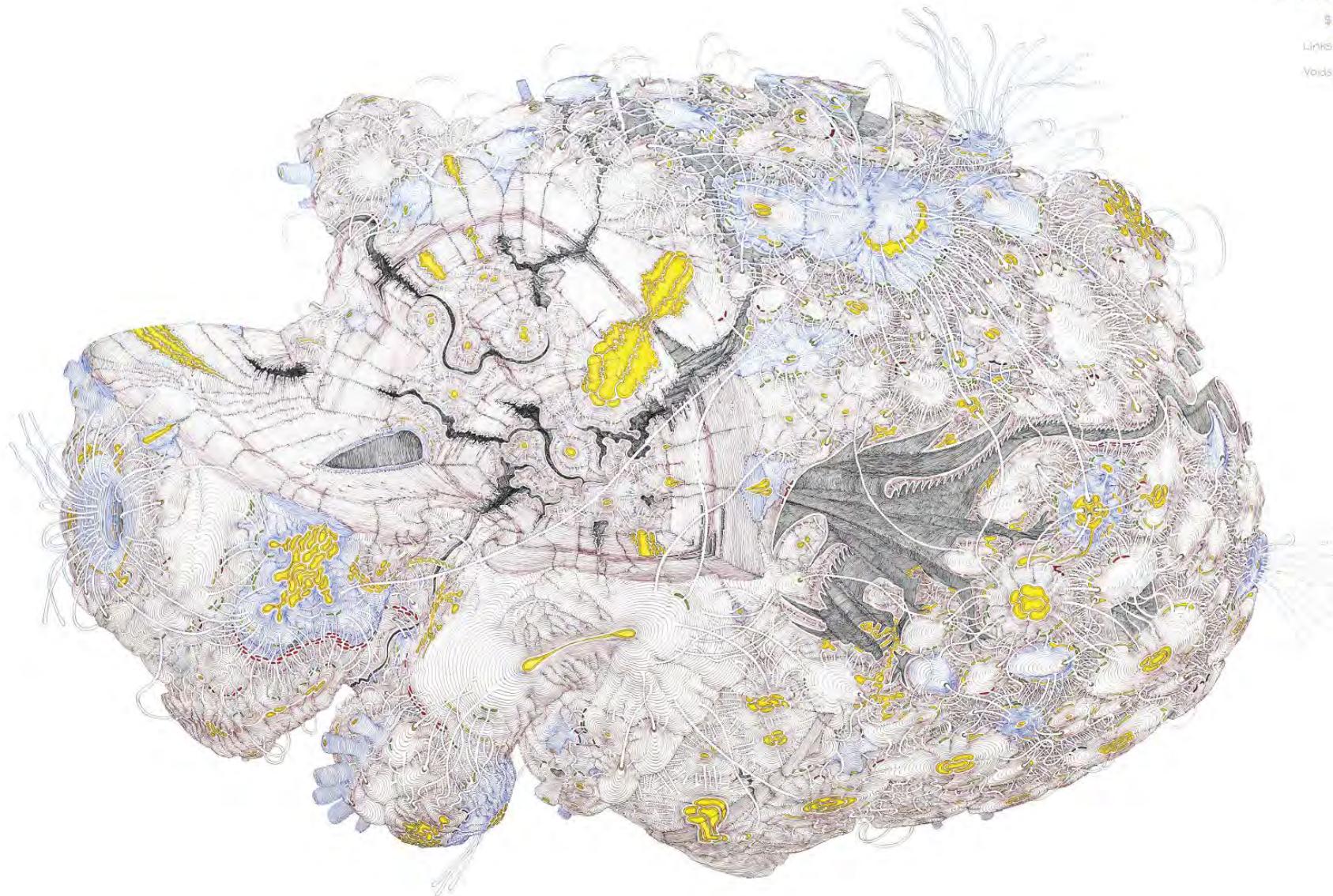
Calculations were performed using the large colored groupings of disciplines (fields) in the structure of science over time. Connectedness coefficients between fields were calculated for each individual year, 2001-2005. A simple regression analysis was conducted to see if there were significant changes in these connectedness coefficients from year-to-year.

If the structure of science shown below is moving toward stability, we would expect connectedness between neighboring fields to increase, and connectedness between distant fields to decrease. We found the opposite, suggesting that the underlying structure is unstable and likely to change dramatically over the next decade.

Six stories, representing how the structure is likely to change, are provided below. Maps with white arrows represent a scenario of dispersion, where fields are likely to pull closer to each other in the future. Maps with dark arrows represent fields that are currently close-knit, that are likely to become more dispersed. We expect that future maps of science will show changes in structure corresponding to these observations. Medicine will disperse slightly, while the physical sciences will tighten and draw closer to the medical fields.

HYPOTHETICAL MODEL of the EVOLUTION and STRUCTURE of SCIENCE

Emerging
Established
\$
Links
Voids



One of Many Possible Interpretations

Daniel Zeller 2007

III.10 Hypothetical Model of the Evolution and Structure of Science - Daniel Zeller - 2007

Exhibit Venues



April 15 - 19, 2015, International Science Festival, Gothenburg, Sweden.



May 1 - October 30, Galter Health Sciences Library, Northwestern University, Chicago, IL.



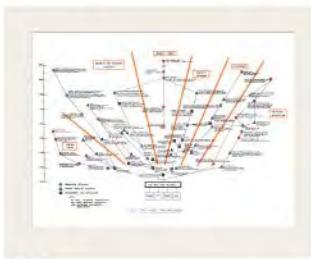
January 1 - June 1, 2013, National Academy of Sciences, Upstairs Gallery, Washington, D.C.

Iteration IV (2008)

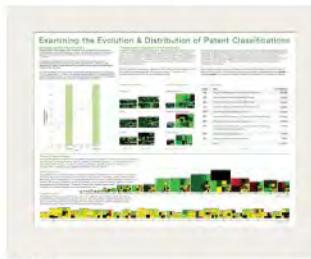
Science Maps for Economic Decision Makers



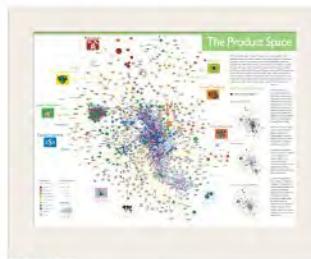
IV.1



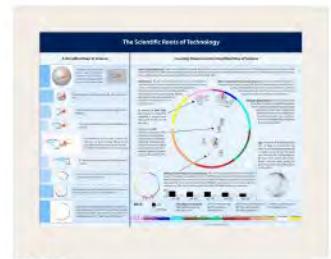
IV.3



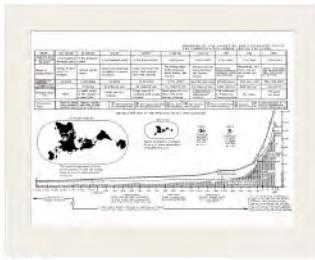
IV.5



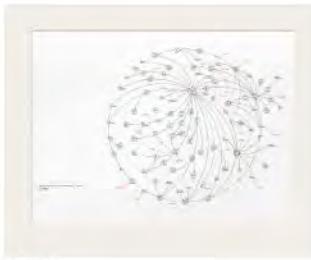
IV.7



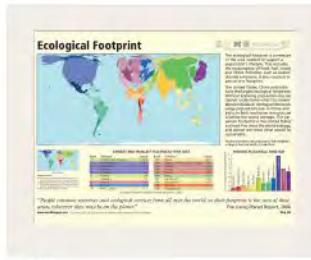
IV.9



IV.2



IV.4



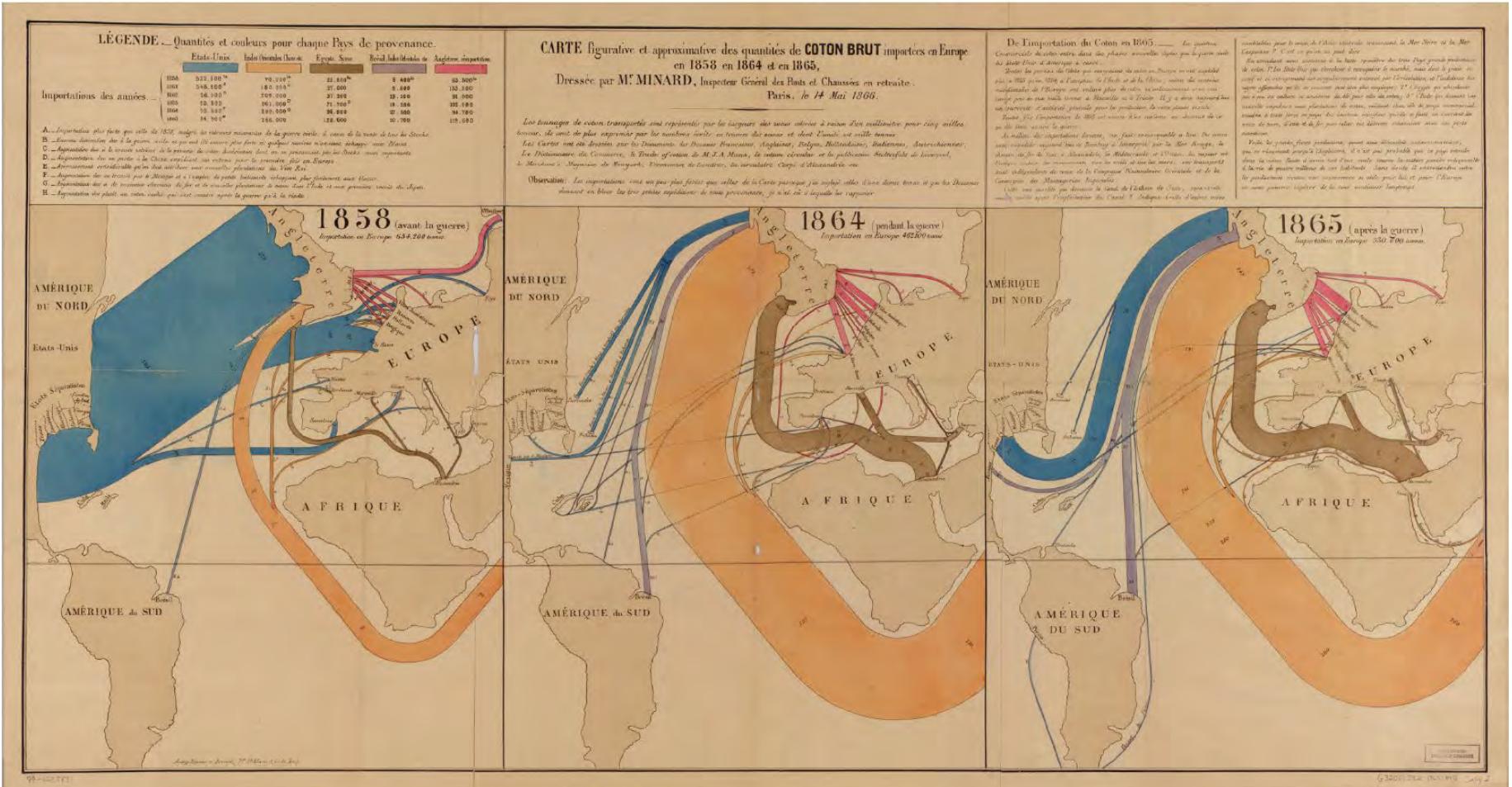
IV.6



IV.8



IV.10

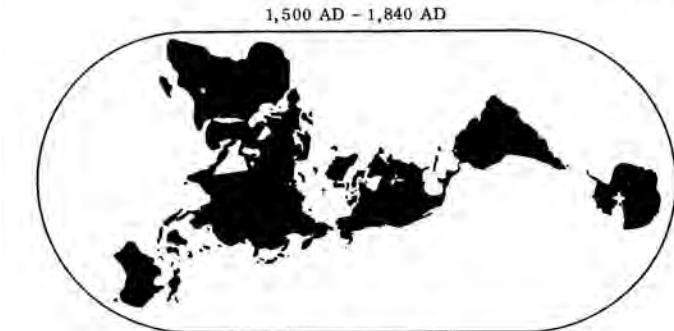


IV.1 Europe Raw Cotton Imports in 1858, 1864 and 1865 - Charles Joseph Minard - 1866

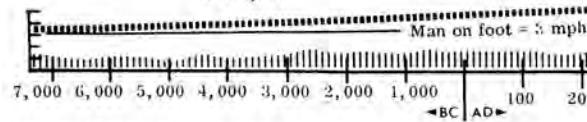
SHRINKING OF OUR PLANET BY MAN'S INCREASED TRAVEL
AND COMMUNICATION SPEEDS AROUND THE GLOBE

YEAR	500,000 BC	20,000 BC	300 BC	500 BC	1,500 AD	1,900 AD	1925	1950	1965
Required time to travel around the globe	A few hundred thousand years	A few thousand years	A few hundred years	A few tens of years	A few years	A few months	A few weeks	A few days	A few hours
Means of transportation	Human on foot (over, ice bridges)	On foot and by canoe	Canoe with small sail or paddles or relays of runners	Large sail boats with oars, pack animals, and horse chariots	Big sailing ships (with compass), horse teams, and coaches	Steam boats and railroads (Suez and Panama Canals)	Steamships, transcontinental railways, autos, and airplanes	Steamships, railroads, auto, jet, and rocket aircraft	Atomic steamship, high speed railway, auto, and rocket-jet aircraft
Distance per day (land)	15 miles	15-20 miles	20 miles	15-25 miles	20-25 miles	Rail 300-900 miles	Rail 500-1,500	Rail 1,000-2,000	
Distance per day (sea or air)		20 by sea	40 miles by sea	135 miles by sea	175 miles by sea	250 miles by sea	3,000-6,000 air	6,000-9,500 air	408,000 air
Potential state size	None	A small valley in the vicinity of a small lake	Small part of a continent	Large area of a continent with coastal colonies	Great parts of a continent with transoceanic colonies	Large parts of a continent with transoceanic colonies	Full continents & Transocean Commonwealths	The Globe	The globe and more
Communications	Word of mouth, drums, smoke, relay runners, and hand printed manuscripts prior to 1441 A.D.	① The Gutenberg printing press 1441	② The rapid print Web newspaper press 1863	③ The Bell telephone 1895	④ The Marconi telegraph 1895	⑤ First commercial radio broadcast 1920	⑥ National Television 1950	⑦ Transcontinental T.V. with the introduction of Early Bird satellite 1965	

THE RELATIVE SIZE OF THE WORLD AS TRAVEL TIME DECREASES

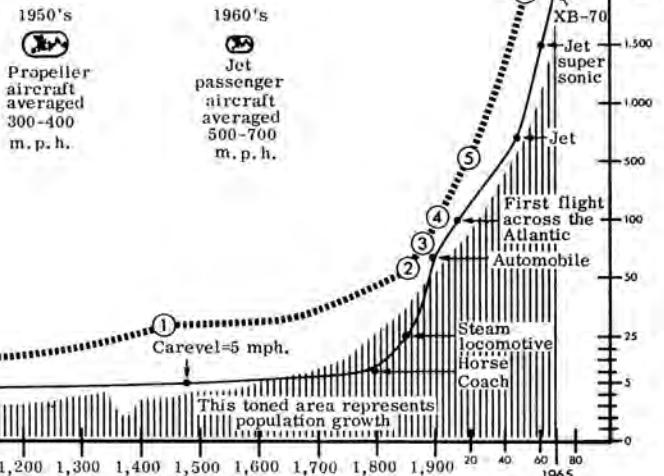


The best average speed of horse drawn coaches on land and sailing ships at sea was approximately 10 m.p.h.



Rome was the only metropolis of over 1,000,000 people from this date forward until 1,800 AD.

Rome's population declined by 30,000



Bubonic plague wiped out 1/4 of Europe's population.

For the first time in history it began to be safe for men to live in large cities because of advances in medicine and sanitation. Life was made more secure and comfortable by the Industrial Revolution & mechanized farming

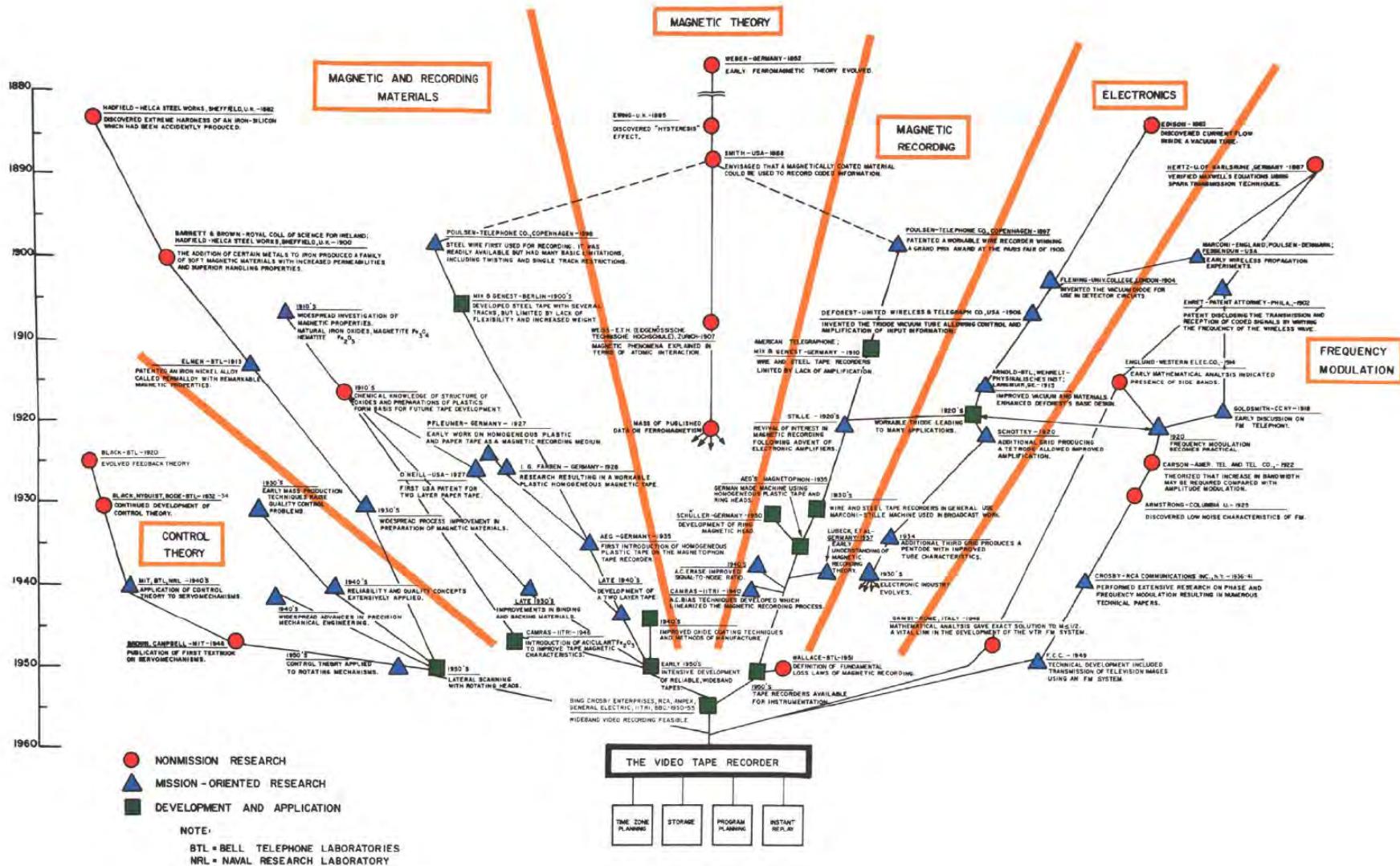
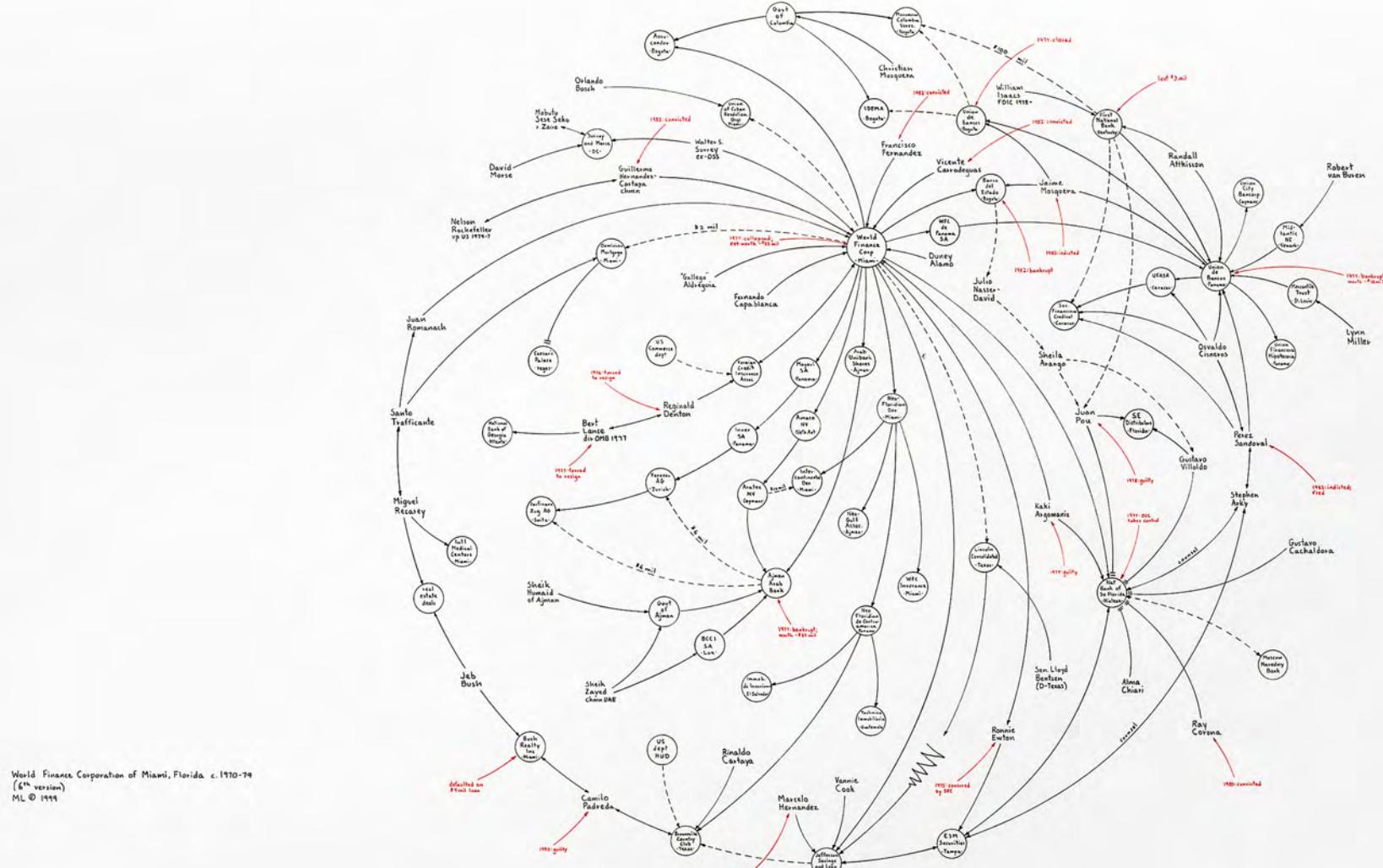


FIG. 7. THE VIDEO TAPE RECORDER



IV.4 World Finance Corporation, Miami, Florida, ca. 1970-79 (6th Version) - Mark Lombardi - 1999

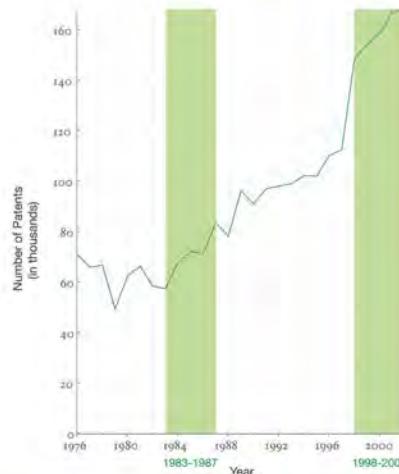
Examining the Evolution & Distribution of Patent Classifications

Managing Growing Patent Portfolios

Organizations, businesses, and individuals rely on patents to protect their intellectual property and business models. As market competition increases, protecting innovation and intellectual property rights becomes ever more important.

Managing the staggering number of patents demands new tools and methodologies. Grouping patents by their classifications offers an ideal resolution for better understanding how intellectual borders are established and change over time.

The charts below show the annual number of patents granted from January 1, 1976 to December 31, 2002 in the United States Patent and Trademark Office (USPTO) patent archive; slow and fast growing patent classes; the top 10 fast growing patent subclasses; and two evolving patent portfolios.



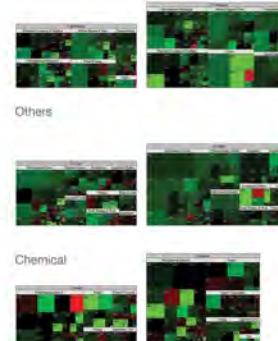
The Structure and Evolution of the Patent Space

The United States Patent and Trademark Office assigns each patent to one of more than 450 classes covering broad application domains. For example, class 514 encompasses all patents dealing with 'Drug, Bio-Affecting and Body Treating Compositions.' Classes are further broken down by subclasses that have hierarchical associations. As one example, class 455 features subclass 99 entitled "with vehicle."

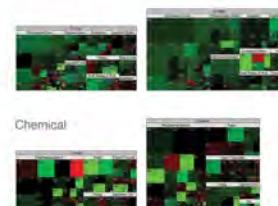
The top 10 fast growing patent classes for 1998–2002 are listed together with the number of patents granted. Most come from the 'Computer and Communications' and the 'Drugs and Medical' area.

Slow Growing Classes

Mechanical



Others



Chemical

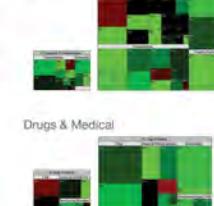


Fast Growing Classes

Electrical & Electronic



Computers & Communications



Drugs & Medical



The evolving hierarchical structure of patent classes and their sizes is represented using treemaps, a space-filling visualization technique developed by Ben Shneiderman at the University of Maryland. A treemap presents a hierarchy as a collection of nested rectangles—demarcating a parent-child relationship between nodes by nesting the child within the parent rectangle. The size and color of each rectangle represent certain attributes of the nodes.

Here, each rectangle represents a class and the area size denotes the total number of patents in that class. The rectangle's color corresponds to percentage increase (green) or decrease (red) in the number of patents granted in that class from the previous interval.

Top-10 Subclasses

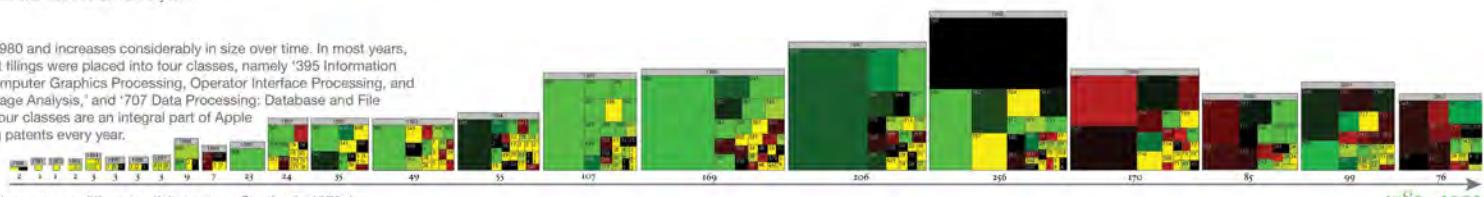
Class	Title	# of Patents
514	Drug, Bio-Affecting and Body Treating Compositions	18,778
438	Semiconductor Device Manufacturing:Process	17,775
435	Chemistry: Molecular Biology and Microbiology	17,474
424	Drug, Bio-Affecting and Body Treating Compositions	13,637
428	Stock Material or Miscellaneous Articles	13,314
257	Active Solid-State Devices (e.g., Transistors, Solid-State Diodes)	12,924
395	Information Processing System Organization	9,955
345	Computer Graphics Processing, Operator Interface Processing, and Selective Visual Display Systems	9,510
359	Optical: Systems and Elements	9,151
365	Static Information Storage and Retrieval	8,392
Total		130,910

Patent Portfolio Analysis

A longitudinal analysis of portfolios reveals different patenting strategies. For each year (given in gray above each treemap), a treemap of all new patents granted to the assignee is shown. The number of patents is given below each treemap. The same size and color coding as above was used. In addition, yellow indicates that no patent has been granted in that class in the last 5 years.

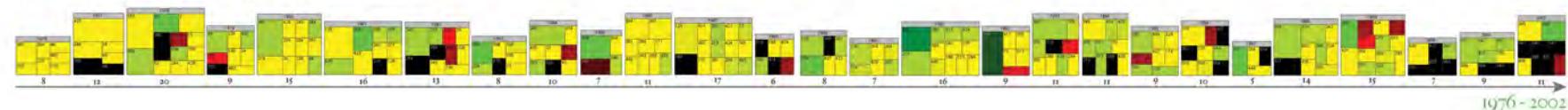
Apple Computer, Inc.

Apple Computer, Inc.'s portfolio starts in 1980 and increases considerably in size over time. In most years, more than half of Apple Computer's patent filings were placed into four classes, namely '395 Information Processing System Organization,' '345 Computer Graphics Processing, Operator Interface Processing, and Selective Visual Display Systems,' '382 Image Analysis,' and '707 Data Processing: Database and File Management or Data Structures.' These four classes are an integral part of Apple Computer, Inc.'s patent portfolio, receiving patents every year.



Jerome Lemelson

The patent portfolio of Jerome Lemelson shows a very different activity pattern. Starting in 1976, he publishes between 6–20 patents each year. However, the predominance of yellow shows that there is little continuity from previous years in regards to the classes into which patents are filed. No class dominates. Instead, more and more new intellectual space is claimed.



Ecological Footprint



The University
Of
Sheffield.



The Leverhulme Trust
Produced by the SASI group (Sheffield) and Mark Newman (Michigan)



Technical notes

- Data are from the WWF (Worldwide Fund for Nature) International and Institute of Zoology.
- Ecological footprint is measured in global hectares.
- One global hectare is an area that has the world average biological productivity of one hectare.
- See website for further information.

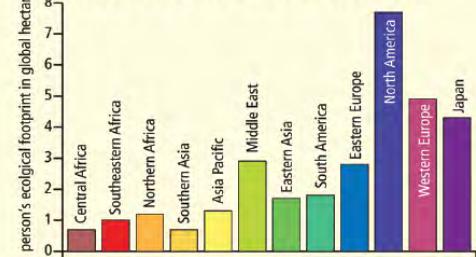
LARGEST AND SMALLEST ECOLOGICAL SHOE SIZES

Rank	Territory	Value	Rank	Territory	Value
1	United Arab Emirates	10.6	191	Nepal	0.61
2	United States	9.7	192	Democratic Republic of Congo	0.58
3	Greenland	7.7	193	Zambia	0.58
3	Bahamas	7.7	194	Congo	0.58
5	Canada	7.5	195	Malawi	0.57
6	Kuwait	7.4	196	Haiti	0.57
7	Australia	7.0	197	Cambodia	0.55
8	Finland	6.8	198	Bangladesh	0.47
9	Estonia	6.1	199	Somalia	0.23
10	New Zealand	6.1	200	Afghanistan	0.11

ecological footprint in global hectares per person, 2002*

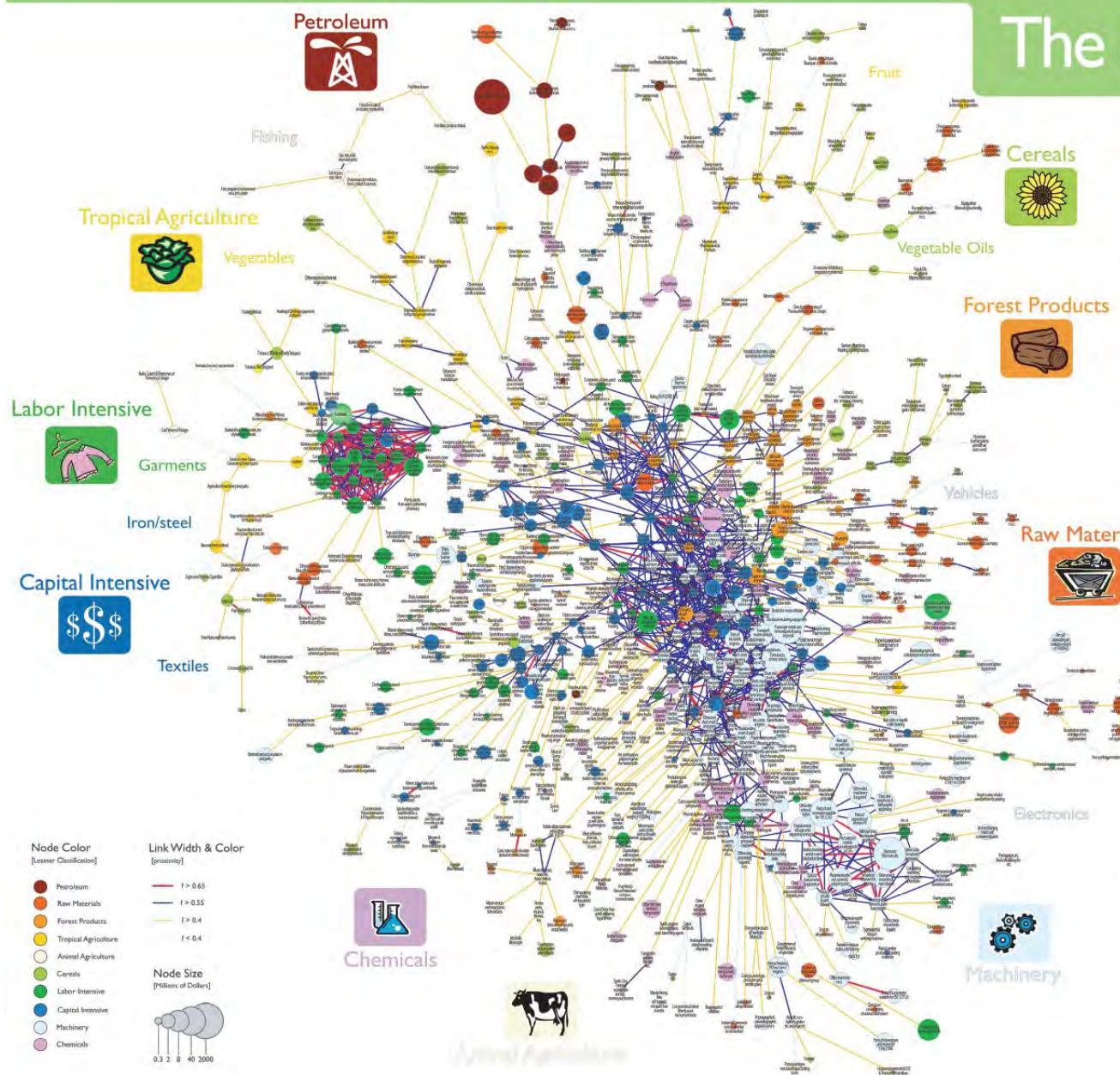
“People consume resources and ecological services from all over the world, so their footprint is the sum of these areas, wherever they may be on the planet.”

AVERAGE ECOLOGICAL SHOE SIZE



The Living Planet Report, 2006

The Product Space

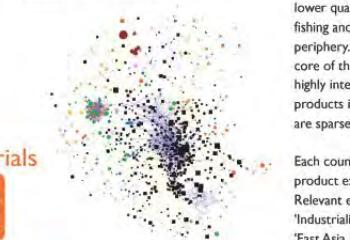


World trade flow data compiled by Feenstra et al. and available at the National Bureau of Economic Research were used to identify the complete co-export matrix of 775 industrial products for 1998-2000. A Maximum Spanning Tree (MST) algorithm was used to reduce the complete co-export matrix to less than 1% of the links. The resulting network, which combines the MST plus all links with a co-export frequency of at least 0.55, was laid out using a force-directed layout algorithm. Node sizes represent the value of traded products in millions of U.S. dollars. Their color corresponds to ten product groups identified using the Leamer classification. Each product class is labeled by an icon. Link color and width indicate the frequency of joint exports.

Economic Footprint

■ Indicate Relevant Exports

Industrialized Countries

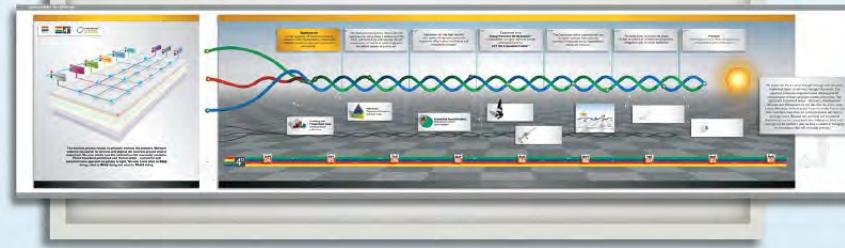
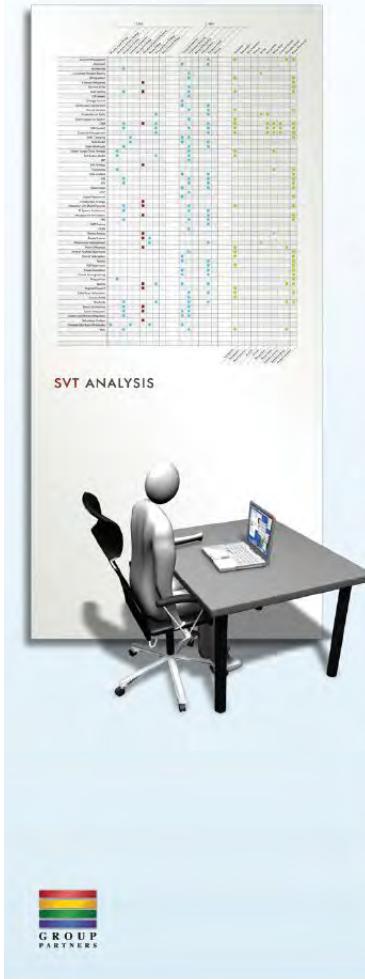


The network has a core-periphery structure with higher value product classes, e.g., machinery, and chemicals, in the core and lower quality classes, e.g., fishing and garments, in the periphery. Products at the core of the network are highly interconnected while products in the periphery are sparsely interlinked.

Each country has a certain product export footprint. Relevant exports by 'Industrialized Countries', 'East Asia Pacific' and 'Latin America & the Caribbean' are given on the right.

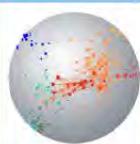
Traditional growth theory assumes that there is always a more sophisticated product within reach. However, given the core-periphery structure of the product space, the distances between products differ considerably.

Countries that operate at the core have capabilities to develop and manufacture a wide range of products. Yet, countries that mostly operate in the periphery of the product space have much fewer opportunities for diversification. A country's current footprint and the structure of the product space have a major impact on a country's future development.



The Scientific Roots of Technology

A Simplified Map of Science



The original map of science was spherical, with 554 disciplines comprised of over 16,000 journals. Details of this map are given in another Places & Spaces poster.



Unfortunately, with a spherical map, only one side can be seen at a time.



This spherical map of science can be unfolded in order to see the hidden side.



As the sphere is unfolded, more and more of the hidden side is revealed.



The unfolded map shows the entire surface of the sphere on a 2-D plane. Remember that the left and right edges are actually connected, just as in the Mercator maps of the world that we are so used to viewing.



This rectangular map can be refolded to take on the shape of a cylinder.



At the same time, the cylinder can be rotated such that the map is being viewed from the bottom up.



When looking down into the cylinder, nodes of the same color are in the same general area, but are not sequentially located.



The model can be simplified by shifting disciplines (nodes) of the same color to be next to each other. This can be done with only minor loss of information, and results in a circular map of 554 disciplines organized into 13 major areas, denoted by color.

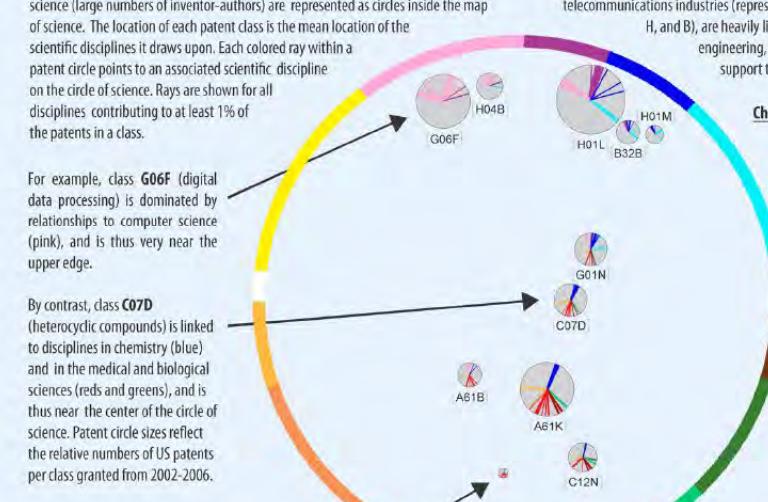
Locating Patents on the Simplified Map of Science

Science-Technology Linkage: Patents were linked to the 554 scientific disciplines on the map of science. These links were based on a set of 18,250 people who were both inventors (on 55,400 patents) and authors (of 132,600 scientific publications) from 2002–2006. Additional information about the method for linking inventors and authors is available in Boyack & Klavans, "Measuring science-technology interaction using rare inventor-author names," Journal of Informetrics, 2008.

Patent Classes: Ten large international patent classes with very strong linkages to science (large numbers of inventor-authors) are represented as circles inside the map of science. The location of each patent class is the mean location of the scientific disciplines it draws upon. Each colored ray within a patent circle points to an associated scientific discipline on the circle of science. Rays are shown for all disciplines contributing to at least 1% of the patents in a class.

For example, class **G06F** (digital data processing) is dominated by relationships to computer science (pink), and is thus very near the upper edge.

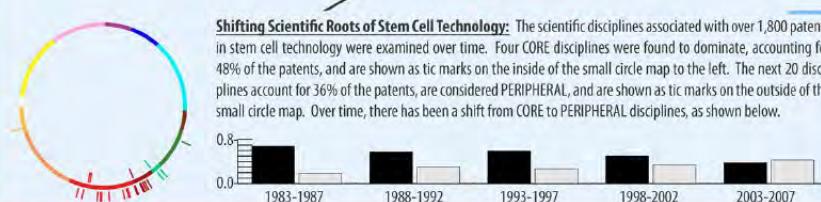
By contrast, class **C07D** (heterocyclic compounds) is linked to disciplines in chemistry (blue) and in the medical and biological sciences (red and greens), and is thus near the center of the circle of science. Patent circle sizes reflect the relative numbers of US patents per class granted from 2002–2006.



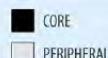
Physics and Computer Science Based Patents: The electronics, hardware & software, and telecommunications industries (represented mainly by international patent classes in sections G, H, and B), are heavily linked to the physical sciences. Computer science, electrical engineering, physics, and chemistry are the core areas of science which support technical progress in the above-named industries.

Chemical & Medical Patents: Patents in chemistry (mainly from classes in section C) and medicine (mainly from classes in section A) do not build exclusively on single areas of science. Rather, patents in these classes tend to build on science from a combination of the chemical and medical areas, and are thus far more interdisciplinary in their science base than are electronics patents.

Gaps: The positions of 20,000 individual patents are shown on the small circle map below. Areas of concentration and areas with few patents can both be seen. The largest gaps at the edges of the circle are adjacent to the social sciences (yellow), earth sciences (brown), and health services (peach). Few patents are associated with scientific advances in these fields.



KEYS



Patent Classes: From top left

G06F: Digital data processing
H04B: Transmission

H01L: Semiconductor devices
B32B: Layered products
H01M: Batteries, etc.

G01N: Analyzing material properties
C07D: Heterocyclic compounds
A61K: Medical preparations

C12N: Micro-organisms; enzymes
A61B: Diagnosis; surgery

CS; EE Math; Physics Chemistry Engineering Earth Sciences Biology Biotech Infect Disease Med Specialties Health Services Brain Research Humanities Social Sciences

Happiness Depends on Various Factors

Social scientists are starting to include relative happiness with hard data on economic status, health, and other factors as they assess quality of life. They rely on surveys of "subjective well-being"—how good people feel about their lives. A world map of one "happiness index" shows many, but not all, wealthy northern countries faring well. Residents of sub-Saharan Africa and the former Soviet Union, meanwhile, report particularly low levels of contentment.

Any attempt to measure happiness will fall short—each life is a series of joys, struggles, and sorrows, and satisfaction can depend as much on outlook as on circumstances. Averages obscure the happy moments in struggling nations, as well as people who suffer from poor health, poverty, or discrimination in countries that rank high. Still, happiness indices can help researchers move beyond simple economics as they track progress—or backsliding—over time.

MEASURING THE INTANGIBLE

The map is derived from the New Economics Foundation's 2006 "Happy Planet Index," which drew on over 100 surveys of subjective well-being. Its "satisfaction with life scale"—a happiness index—ranks the relative happiness of nations, from a high of 273 (Denmark and Switzerland) to a low of 100 (Burundi).

Happiness Index
■ Very Happy
■ Happy
■ Content
■ Unhappy
■ No data

SOURCE: WHITE, A. 2006



HEALTH

Japan boasts the world's longest life expectancy—one measure of overall health. Swaziland, at the other end of the scale, is plagued by poverty, disease, and violence. Disparities in access to health care divide many countries into haves and have-nots.



WEALTH

Money still can't buy love, or happiness, and wealthier people aren't always more content. Still, tiny Luxembourg, which takes top rank in per capita Gross Domestic Product (GDP), also rates a 253 on the happiness index. Real poverty means real misery, a fate shared by billions.



EDUCATION

Residents of Australia can expect to spend more time in school—an average of almost 21 years—than citizens of any other country. But only a basic education is needed to see a significant jump in overall happiness. Around the world, hundreds of millions lack even that.

"It's time we admitted there's more to life than money."

- David Cameron, U.K. leader of the opposition, 2008

RANKING THE WORLD'S HAPPIEST PLACES

Northern Europe, North America, and several wealthy countries make the list, but so do many less prosperous island nations.

- 1 DENMARK SWITZERLAND
- 2 AUSTRIA ICELAND
- 3 BAHAMAS FINLAND SWEDEN
- 4 BHUTAN BRUNEI CANADA IRELAND LUXEMBOURG
- 5 COSTA RICA MALTA NETHERLANDS
- 6 ANTIQUA AND BARBUDA MALAYSIA NEW ZEALAND NORWAY SEYCHELLES ST. KITTS AND NEVIS UNITED ARAB EMIRATES UNITED STATES VANUATU VENEZUELA

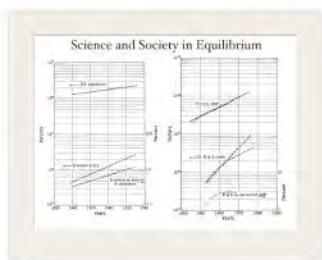
Check out our Zoom Maps online!



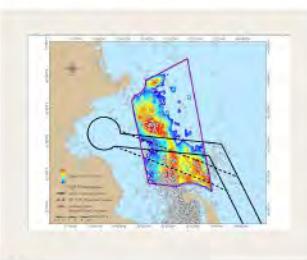
Visit scimaps.org and check out all our maps in stunning detail!

Iteration V (2009)

Science Maps for Science Policy Makers



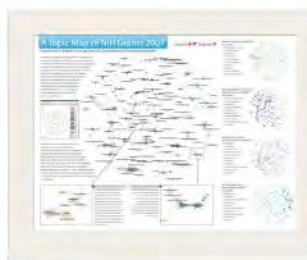
V.1



V.3



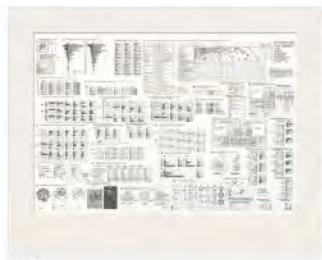
V.5



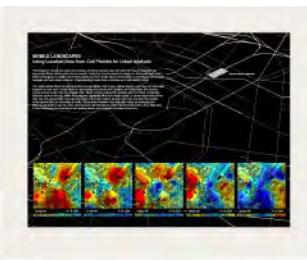
V.7



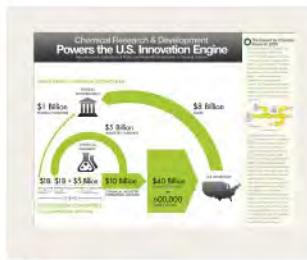
V.9



V.2



V.4



V.6

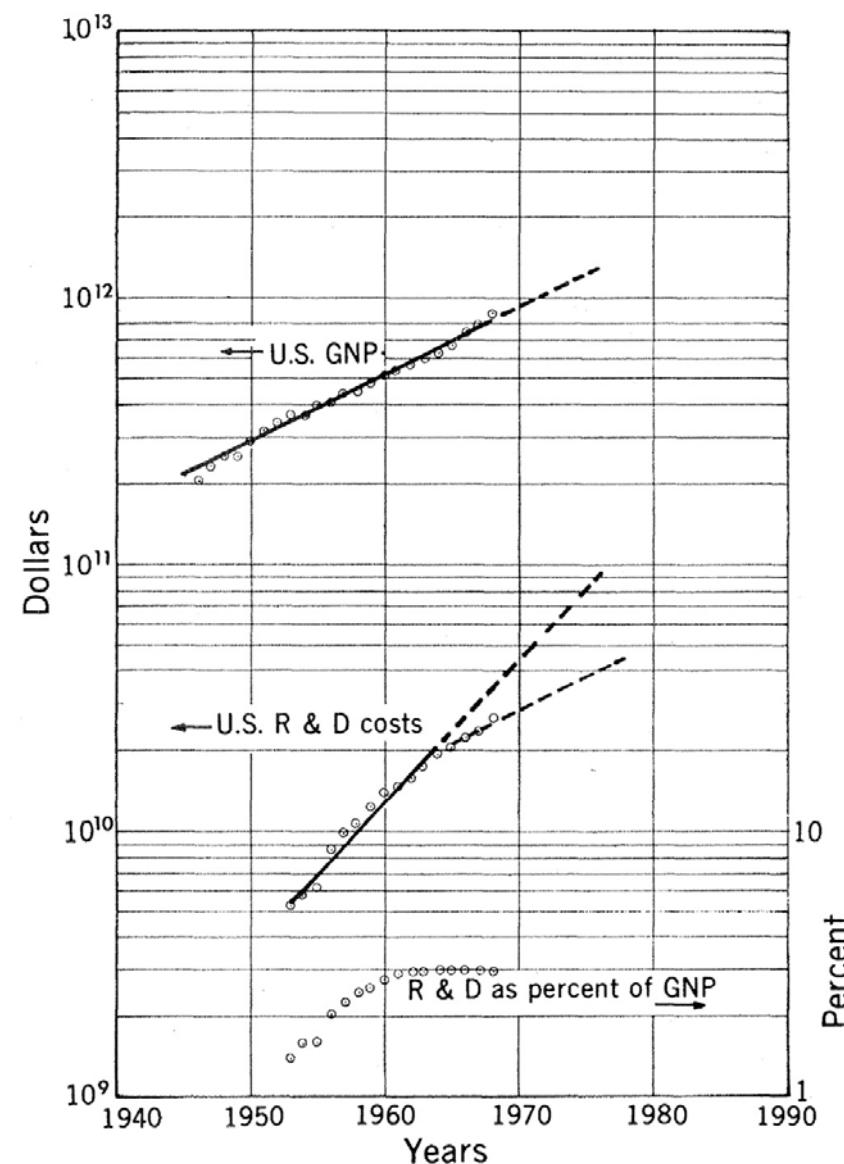
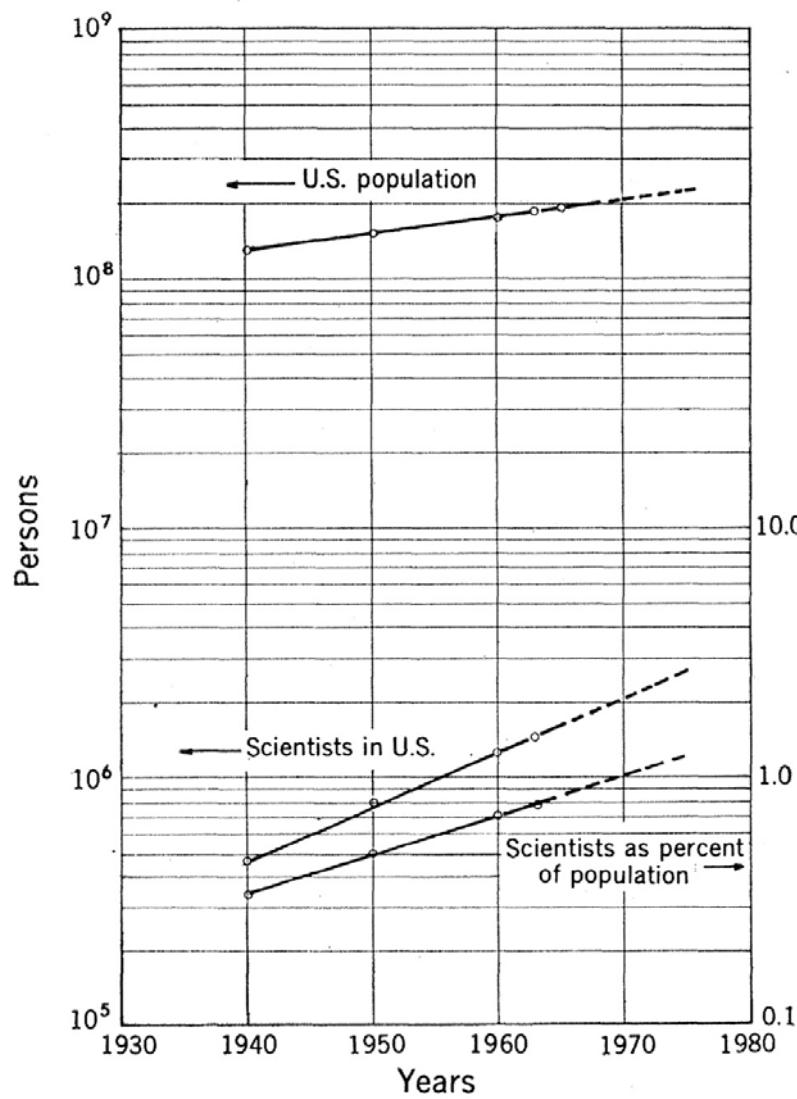


V.8

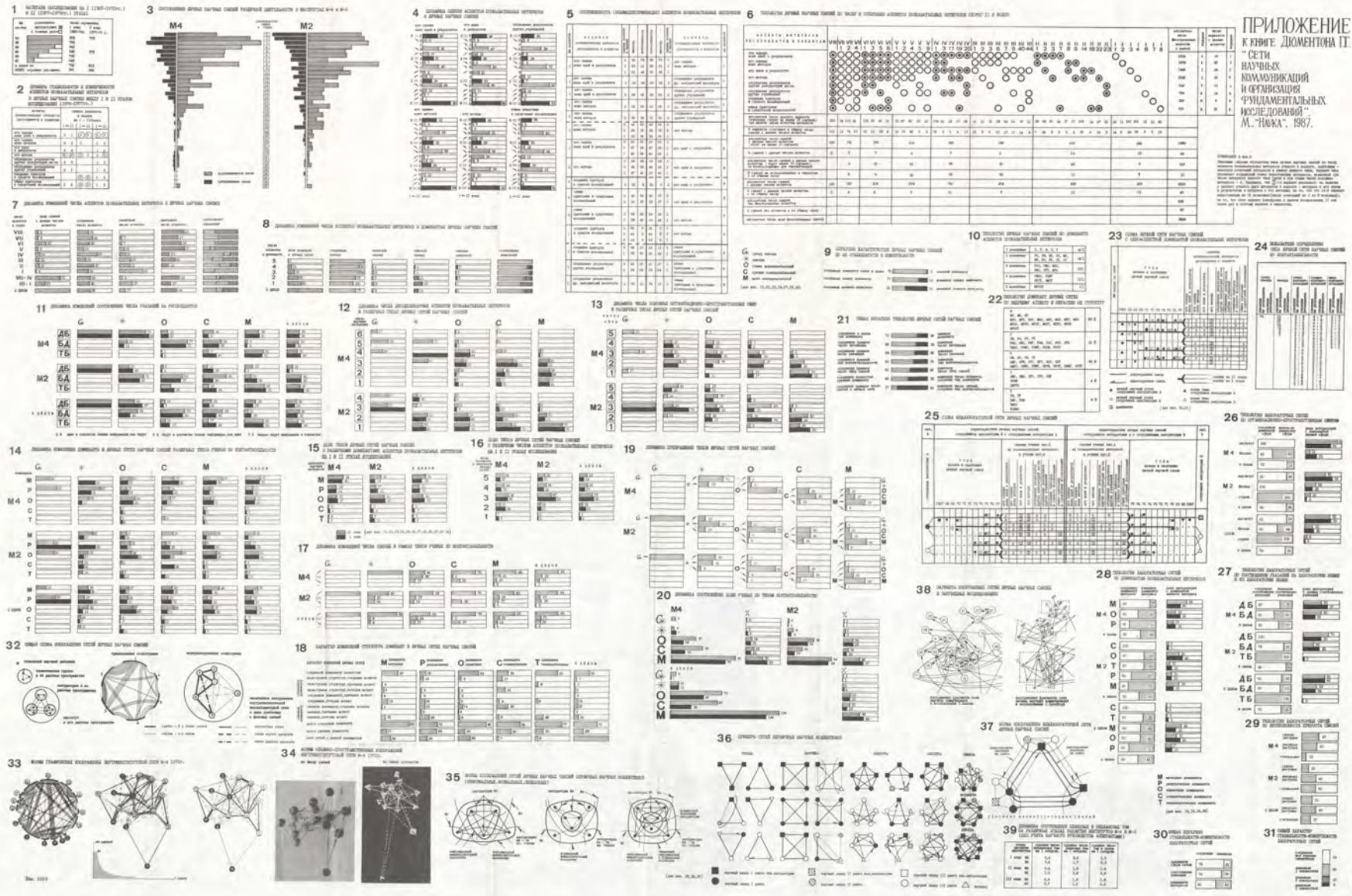


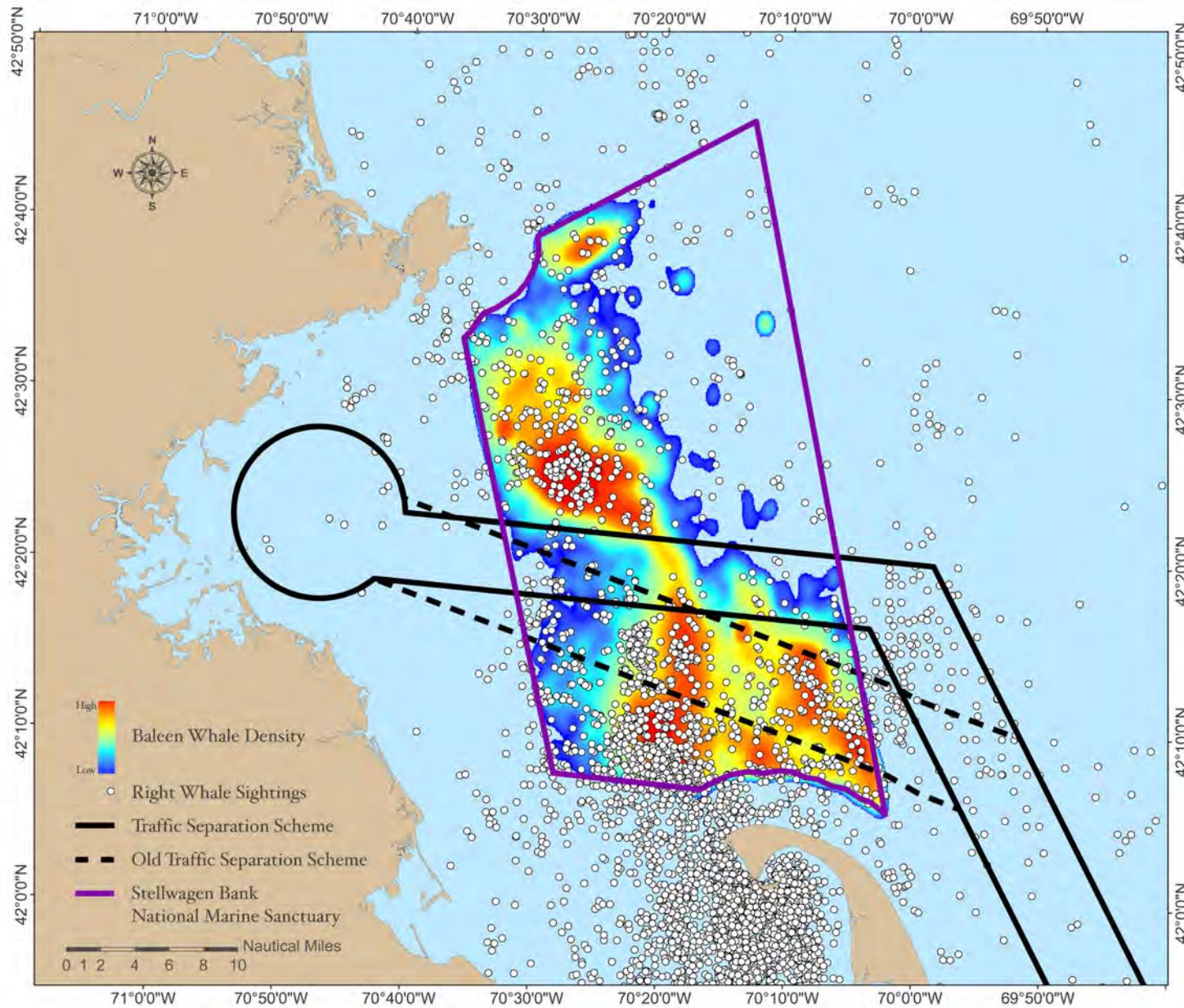
V.10

Science and Society in Equilibrium



ПРИЛОЖЕНИЕ
к книге ДЮМЕНТОНА Г.Т.
“СЕТИ
НАУЧНЫХ
КОММУНИКАЦИЙ
и организаций
ФУНДАМЕНТАЛЬНЫХ
ИССЛЕДОВАНИЙ”
М. “Наука”, 1987.





V.3 Realigning the Boston Traffic Separation Scheme to Reduce the Risk of Ship Strike to Right and Other Baleen Whales

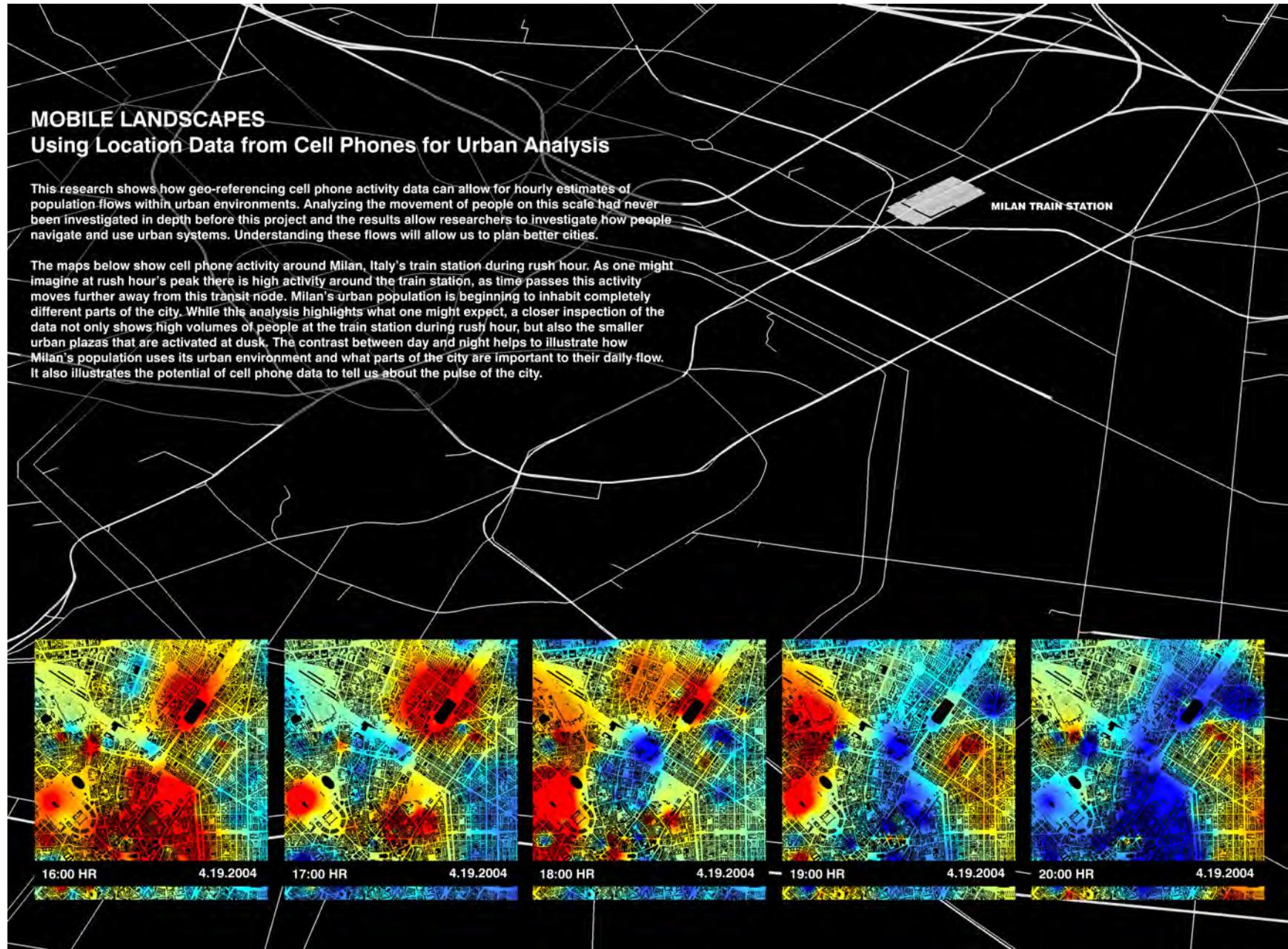
David N. Wiley, Michael A. Thompson, and Richard Merrick - 2006

MOBILE LANDSCAPES

Using Location Data from Cell Phones for Urban Analysis

This research shows how geo-referencing cell phone activity data can allow for hourly estimates of population flows within urban environments. Analyzing the movement of people on this scale had never been investigated in depth before this project and the results allow researchers to investigate how people navigate and use urban systems. Understanding these flows will allow us to plan better cities.

The maps below show cell phone activity around Milan, Italy's train station during rush hour. As one might imagine at rush hour's peak there is high activity around the train station, as time passes this activity moves further away from this transit node. Milan's urban population is beginning to inhabit completely different parts of the city. While this analysis highlights what one might expect, a closer inspection of the data not only shows high volumes of people at the train station during rush hour, but also the smaller urban plazas that are activated at dusk. The contrast between day and night helps to illustrate how Milan's population uses its urban environment and what parts of the city are important to their daily flow. It also illustrates the potential of cell phone data to tell us about the pulse of the city.



DEATH & TAXES

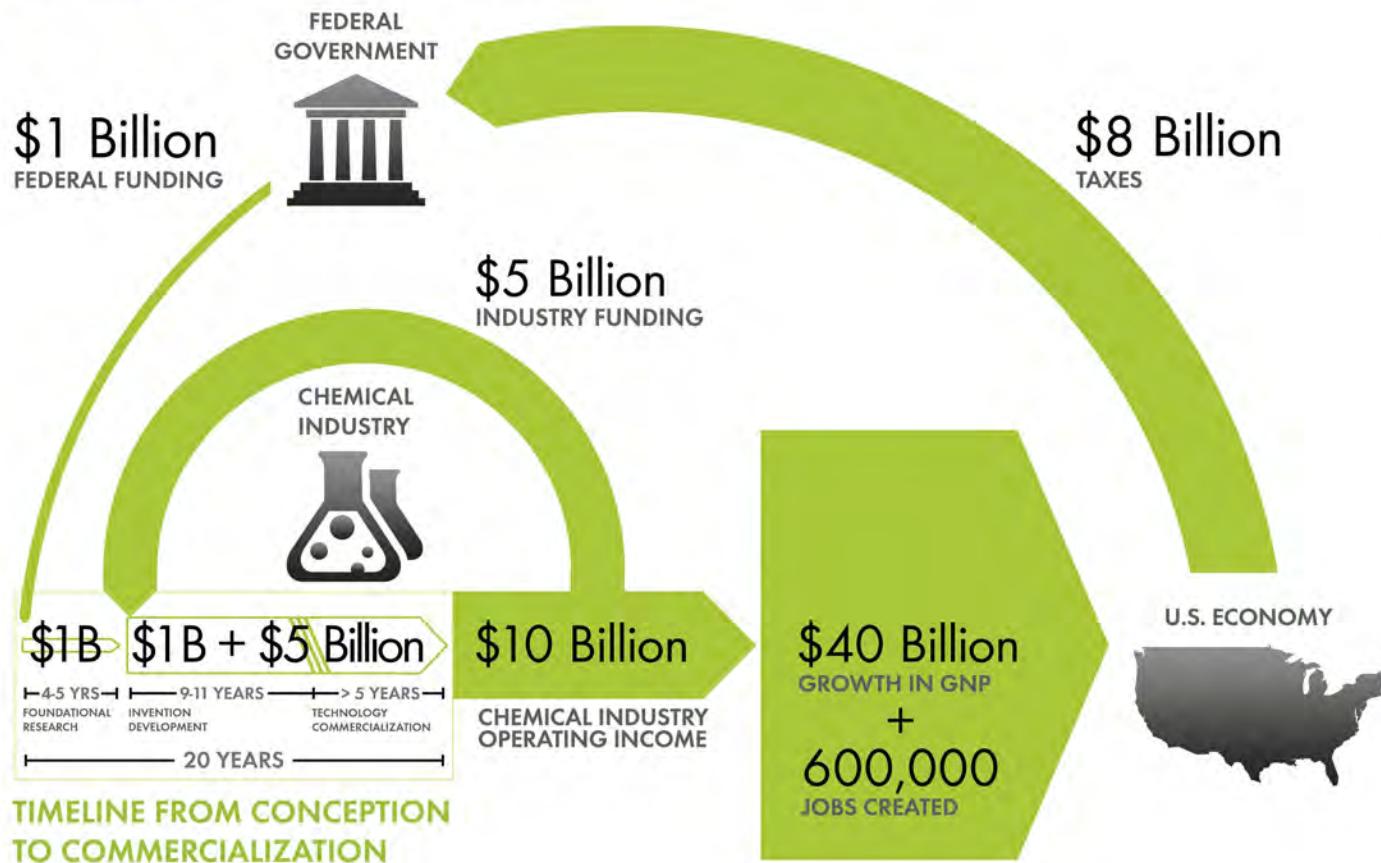
A VISUAL GUIDE TO WHERE YOUR FEDERAL TAX DOLLARS GO



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

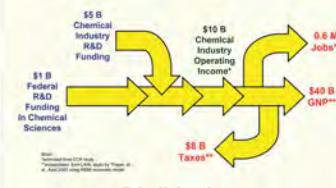
Macroeconomic Implications of Public and Private R&D Investments in Chemical Sciences

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 Council for Chemical Research

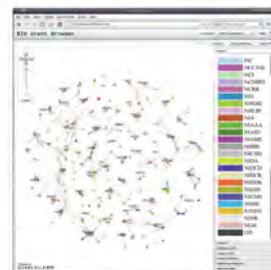
The design shows that an input of \$1B in federal investment, leveraged by \$5B in industry investment, brings new technologies to market and results in \$10B of operating income for the chemical industry, \$40B of growth in the Gross National Product (GNP) and further impacts the US economy by generating 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 in tax base that in turn is available for investment in basic research.

A Topic Map of NIH Grants 2007

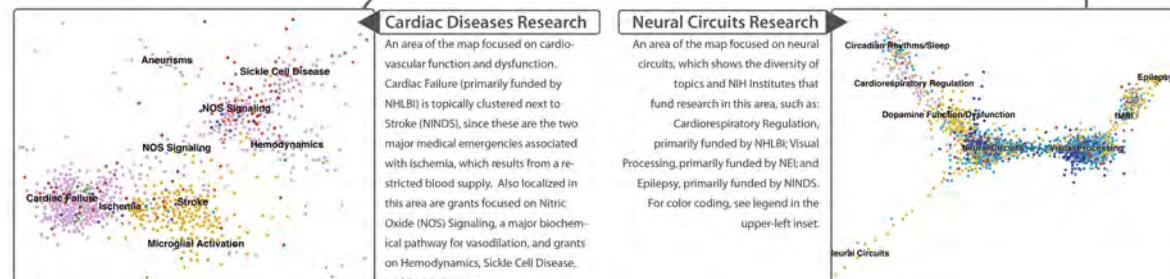
ChalkLabs  UCIRVINE 

Bruce W. Herr II (Chalklabs & IU), Gully Burns (ISI), David Newman (UCI), Edmund Talley (NIH)

The National Institutes of Health (NIH) is organized as a multitude of Institutes and Centers whose missions are primarily focused on distinct diseases. However, disease etiologies and therapies flout scientific boundaries, and thus there is tremendous overlap in the kinds of research funded by each Institute. This creates a daunting landscape for decisions on research directions, funding allocations, and policy formulations. Shown here is devised an interactive topic map for navigating this landscape, online at www.nihmaps.org. Institute abbreviations can be found at www.nih.gov/icd.



Topic modeling, a statistical technique that automatically learns semantic categories, was applied to assess projects in terms used by researchers to describe their work, without the biases of keywords or subject headings. Grant similarities were derived from their topic mixtures, and grants were then clustered on a two-dimensional map using a force-directed simulated annealing algorithm. This analysis creates an interactive environment for assessing grant relevance to research categories and to NIH Institutes in which grants are localized.



National Cancer Institute (NCI)

TOP 10 TOPICS

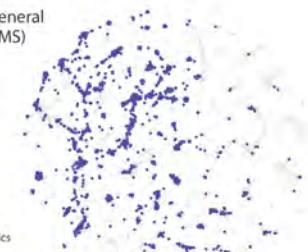
- Oncology Clinical Trials
- Cancer Treatment
- Cancer Therapy
- Carcinogenesis
- Risk Factor Analysis
- Cancer Chemotherapy
- Metastasis
- Leukemia
- Prediction/Prognosis
- Cancer Chemoprevention



National Institute of General Medical Sciences (NIGMS)

TOP 10 TOPICS

- Bioactive Organic Synthesis
- X-ray Crystallography
- Protein NMR
- Computational Models
- Yeast Biology
- Metalloproteases
- Enzymatic Mechanisms
- Protein Complexes
- Invertebrate/Zebrafish Genetics
- Cell Division



National Heart, Lung, and Blood Institute (NHLBI)

TOP 10 TOPICS

- Cardiac Failure
- Pulmonary Injury
- Genetic Linkage Analysis
- Cardiovascular Disease
- Atherosclerosis
- Hemostasis
- Blood Pressure
- Asthma/ Allergic Airway Disease
- Gene Association
- Lipoproteins



National Institute of Mental Health (NIMH)

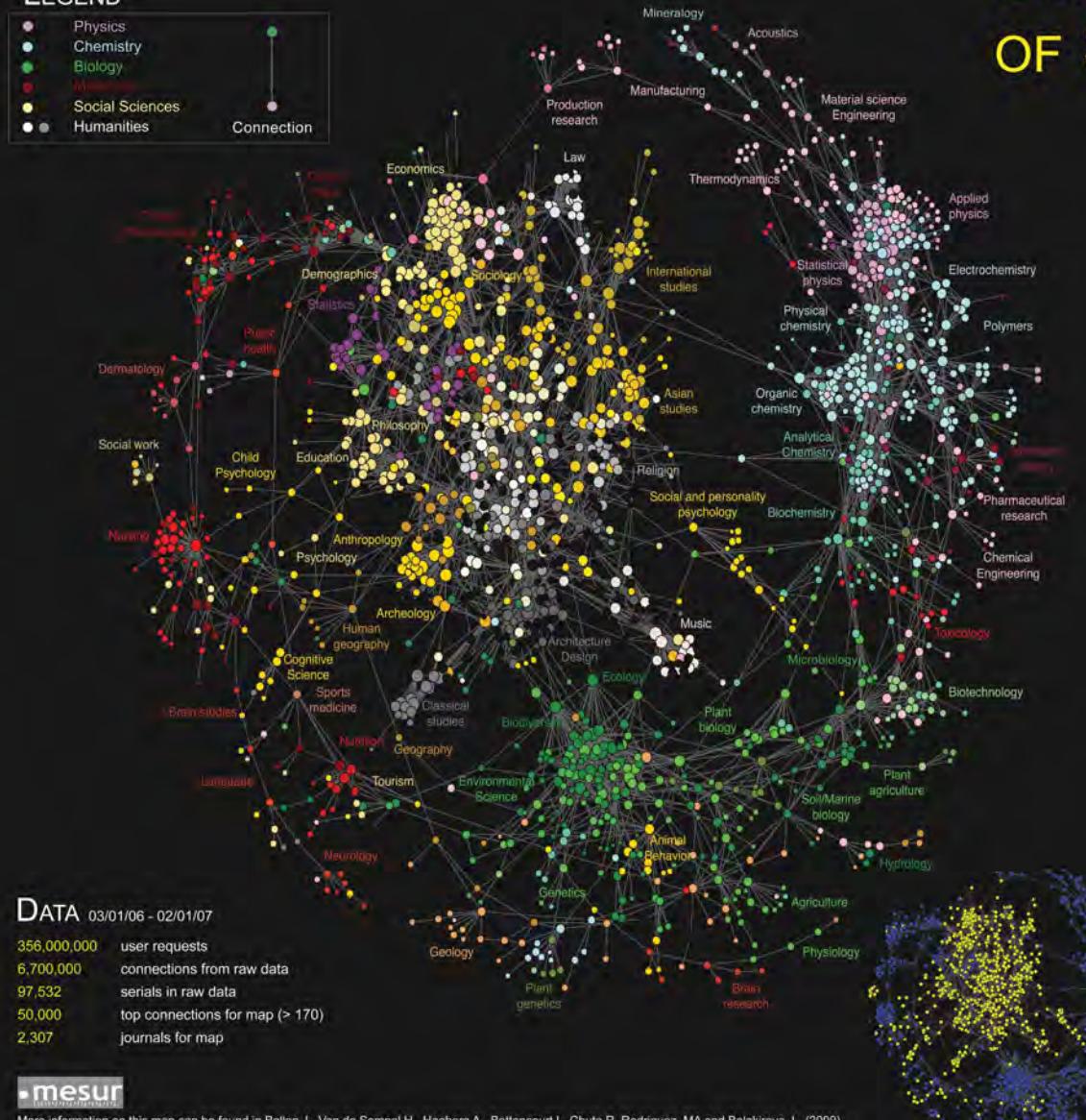
TOP 10 TOPICS

- Mood Disorders
- Schizophrenia
- Behavioral Intervention Studies
- Mental Health
- Depression
- Cognitive-Behavior Therapy
- AIDS Prevention
- Genetic Linkage Analysis
- Adolescence
- Childhood



CLICKSTREAM MAP OF SCIENCE

LEGEND



This is the first map created from large-scale, world-wide, scholarly usage data. It visualizes the collective flow of scientists' movements from one journal to another in their online navigation behavior.

The MESUR project (www.mesur.org) collected a database of nearly 1 billion user requests recorded by the web portals of some of the world's most significant publishers, aggregators, and large university consortia, among them Thomson Scientific (Web of Science), Elsevier (Scopus), JSTOR, Ingenta, University of Texas (9 campuses, 6 health institutions), and California State University (23 campuses). All usage logs acquired by the MESUR project contain session identifiers that identify the individual clickstreams of individual scientists navigating from one article to the next.

Pairs of journals are connected when they have a high probability of being followed by each other in users' clickstreams. The circles represent individual journals. A line between two circles indicates that they are strongly connected in either direction. The colors indicate the scientific domain a journal belongs to according to their Dewey Decimal and JCR classification codes that were mapped into the Getty Research Center's Arts and Architecture Taxonomy (AAT) to allow classifications at various levels of detail. The size of circles corresponds to the strength (degree centrality) of a journal's connections in the map. The map is arranged by the Fruchterman-Reingold algorithm that treats connections like springs: connected journals are drawn together, but they are not allowed to get too close.

This map is derived from usage data and therefore also reflects the actions of those who read the literature but rarely publish themselves, e.g., practitioners and laypersons. As a result practitioner-driven domains such as nursing, social work, and tourism studies are prominently featured. The natural sciences vs. the social sciences and humanities emerge as two distinct clusters that are connected via various specific interdisciplinary spokes. Most domains are highly interdisciplinary, but this is more so the case for the social sciences and humanities. Surprisingly, mathematics and computer science are not represented as one specific cluster, but spread out through the map.

Like citation maps, this map is based upon a particular sample of the scientific community, albeit one that includes non-publishing scientists and practitioners and a much greater sample of publications. From MESUR's database of 1 billion user events, we created a matrix of 6 million connections between approximately 100,000 serials. From that matrix we selected only 50,000 connections with the highest number of observations, ranging from approximately 40,000 to 170 observations. This subset of connections pertained to the 2,307 most used journals. This procedure may introduce specific biases which require investigation. This map should therefore not be construed as a final map of scientific activity, but as a showcase for the feasibility of tracking scientific activity from usage data. We hope this methodology will provide unique insights into the real-time structure of scientific activity as it can be observed from scholarly clickstream data.

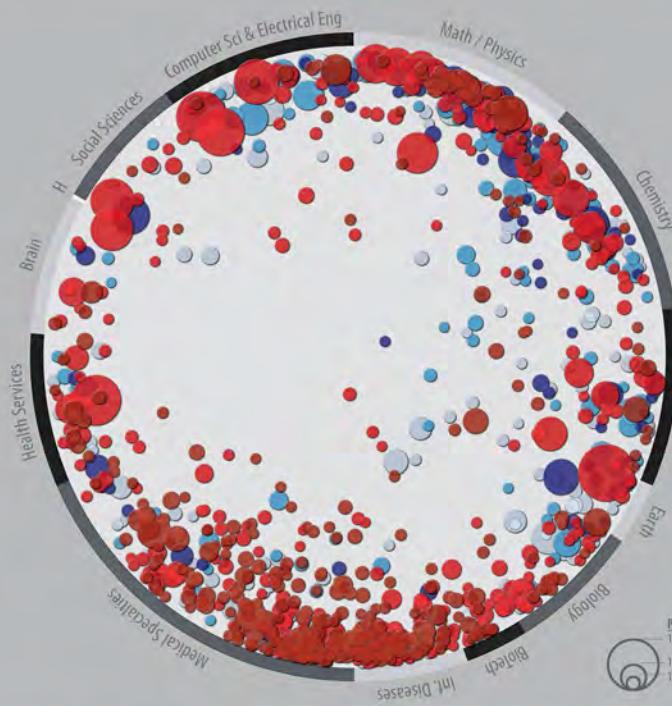
When we cut the AAT taxonomy at the top level, only two distinctions remain: natural science (blue nodes) vs. the social sciences and humanities (yellow nodes). Some journals along the spokes of the wheel have classifications (colors) that do not correspond to their location in the map. This indicates either the journal in question is highly interdisciplinary and/or has been assigned a classification that does not correspond to how scientists actually use the particular journal.

Design layout by: Jeremy D. Chacon

U.S. VULNERABILITIES IN SCIENCE

National Strengths are more accurately assessed using a reference-based classification system.

Research Leadership in the U.S.



Placing the U.S. strengths (red) on top of the strengths from other nations (blue) helps to highlight the U.S. vulnerabilities (blue that isn't covered by red). The most prevalent vulnerabilities are in computer science, engineering, and the interdisciplinary work linking biology and earth science.

Research Leadership in 12 Nations



The traditional approach identifies very few disciplines in which a country other than the U.S. is #1 in terms of publications or impact. The new method identifies large numbers of subdisciplinary and interdisciplinary strengths for these same countries, giving a much more accurate and detailed picture of the actual scientific strengths of those nations.

A new reference-based classification system has been generated using the Scopus database. Over 2.3 million highly cited references, and over 4.6 million articles (2003-2007) that cite their references, have been assigned to over 20,000 categories (called paradigms) using co-citation methods.

This new classification system is used to identify national strengths from the unique point of view of each nation. Paradigms in which a nation has a high publication share are clustered based on the idiosyncratic publication activity in that nation. Each red or blue circle shown in these maps represents a cluster of paradigms where the nation is a research leader.

The layout of these maps is based on ordering disciplines (and corresponding paradigms) sequentially around the perimeter of a circle. Related paradigms (and disciplines) tend to be at or near each other. The ordering of disciplines is based on a consensus from 20 maps of science.

Disciplinary research is located on the periphery. Interdisciplinary research is closer to the center.

Traditional method: For determining national leadership, we're consensual to this new method.

The traditional method assigned the same influence to all disciplines. We used ten journal-disciplinary classification systems that was developed for the University of California at San Diego. These 5.6 million articles and 2.1 million highly cited references were assigned to 5,14 disciplines. Common criteria were used to determine the three types of leaders:

Old new method: request that the same criterion is best shared. In citation analysis also uses 20,000 paradigms. These paradigms are then clustered further, based on the paper that are only in that cluster. Nation-specific clusters were excluded if they can not meet the same criteria of size (at least 1,000 papers) for leadership.

The improvement in accuracy can be seen in the three examples shown on the right.

The results for Great Britain were quite different.

A disciplinary approach suggests that Great Britain is generally strong in a variety of social sciences and health services.

The new method considers the social sciences and health care across disciplines. Disciplinary paradigm: Great Britain was strongest in the upper right and more quadrants.

The results for Germany were quite different.

A disciplinary approach suggests that Germany only has a few strengths in engineering and interdisciplinary climate management.

The new method shows a diversified set of strengths for Spain. Many of these strengths were not identified using the traditional methods.

The results for Spain were quite different.

A disciplinary approach suggests that Spain has two strengths in engineering and interdisciplinary climate management.

The new method shows a diversified set of strengths for Spain. Many of these strengths were not identified using the traditional methods.

We focused on three types of leadership: the most common measure is publication leadership (PUB). This is defined as having the largest number of publications in a discipline or strength. The second is reference leadership (REF), having the largest number of highly cited references in a discipline or strength. The third, and perhaps most important, is state-of-the-art leadership (SOA). This category is reserved for those disciplines or strengths where the researchers lead in the most recent advances in their field. SOA requires every paper at least a 0.8 Hirsch index (0.80 as large as the number of the total plus or strength) to qualify.

The intensity of color (red for the U.S., blue for the 12 nations) is an indication of:

- All three strengths (PUB and REF and SOA)
- Two of the three strengths
- Only one strength (PUB or REF or SOA)



A Global Agenda to End Poverty

NATIONAL
GEOGRAPHIC

The Millennium Development Goals: A Partnership for Progress

The Millennium Development Goals (MDGs) are a challenge the global community has set for itself. They are a challenge to poor countries to demonstrate good governance and a commitment to reducing poverty. They are also a challenge to wealthy countries to keep their promise to support economic and social development. For rich and poor countries alike, the MDGs are measurable goals for making progress around the world.

We are now one-third of the way to the target date of 2015, and there are 100 million fewer people living in extreme poverty than in 1990. This goal—to reduce by half the proportion of people living on less than one dollar a day—is the first of eight MDGs. By 2015, this first goal will likely have been achieved, with another 500 million people having escaped out of the world poverty. But trends show uneven progress, and the poorest countries—especially in Africa—lag behind.

To ensure that maximum progress is made, and that all of the world's people and regions share in it, wealthy countries must increase their aid to the poor ones. Both groups need to work harder in building a lasting partnership to strengthen economies, improve access to markets, expand access to health care and education, and protect the environment.



The Millennium Development Goals and their human impact

- | | | | | | | | |
|--|--|--|--|---|--|--|--|
| 1 End poverty and hunger | 2 Education for all | 3 Quality education for women | 4 Save children's lives | 5 Make motherhood safe | 6 Stop HIV/AIDS, malaria and other diseases | 7 Protect the environment | 8 Build a global partnership for development |
| <p>Reduce by half, between 1990 and 2015, the
number of people who earn less than \$1 a day.
■ Reduce by half the proportion of people who
suffer from hunger.</p> | <p>Ensure that by 2015, education everywhere, boys
and girls, will be able to complete a full
course of primary schooling.</p> | <p>Eliminate gender disparity in primary and
secondary education, everywhere by 2015,
and at all levels of education no later than 2015.</p> | <p>Reduce by two-thirds, between 1990 and 2015,
the under-five mortality rate.</p> | <p>Reduce the maternal mortality ratio by three-quarters
between 1990 and 2015.</p> | <p>Have halved by 2015 and begin to reverse the
spread of HIV/AIDS, malaria and other
diseases. ■ Double by 2015 the number of
people with access to drinking water and basic
sanitation. ■ Achieve significant improvements in
at least 10 million slum dwellers by 2020.</p> | <p>Integrate the policies of sustainable
development into country policies and programs, and reverse
the loss of environmental resources. ■ Double by half
the proportion of people with sustainable
access to drinking water and basic sanitation.
■ Achieve significant improvements in
at least 10 million slum dwellers by 2020.</p> | <p>Address the needs of the least developed countries.
■ Foster decent work and sustainable development
systems. ■ Double proactively with developing
countries the number of international visitors.
■ Provide access to affordable essential drugs
in developing countries. ■ Promote private sector
innovations, especially information and communications.</p> |

V.10 *The Millennium Development Goals Map* - The World Bank and National Geographic - 2006

Exhibit Venues



April 15 - 19, 2015, International Science Festival, Gothenburg, Sweden.



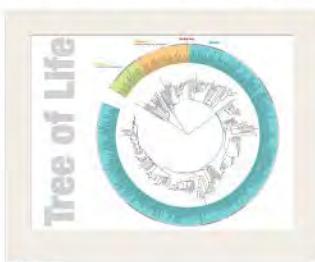
May 1 - October 30, Galter Health Sciences Library, Northwestern University, Chicago, IL.



January 1 - June 1, 2013, National Academy of Sciences, Upstairs Gallery, Washington, D.C.

Iteration VI (2010)

Science Maps for Scholars



VI.1



VI.3



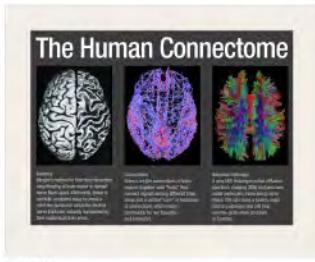
VI.5



VI.7



VI.9



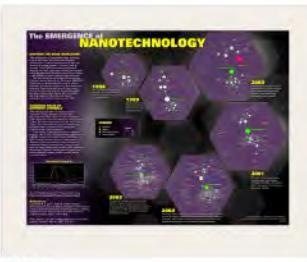
VI.2



VI.4



VI.6

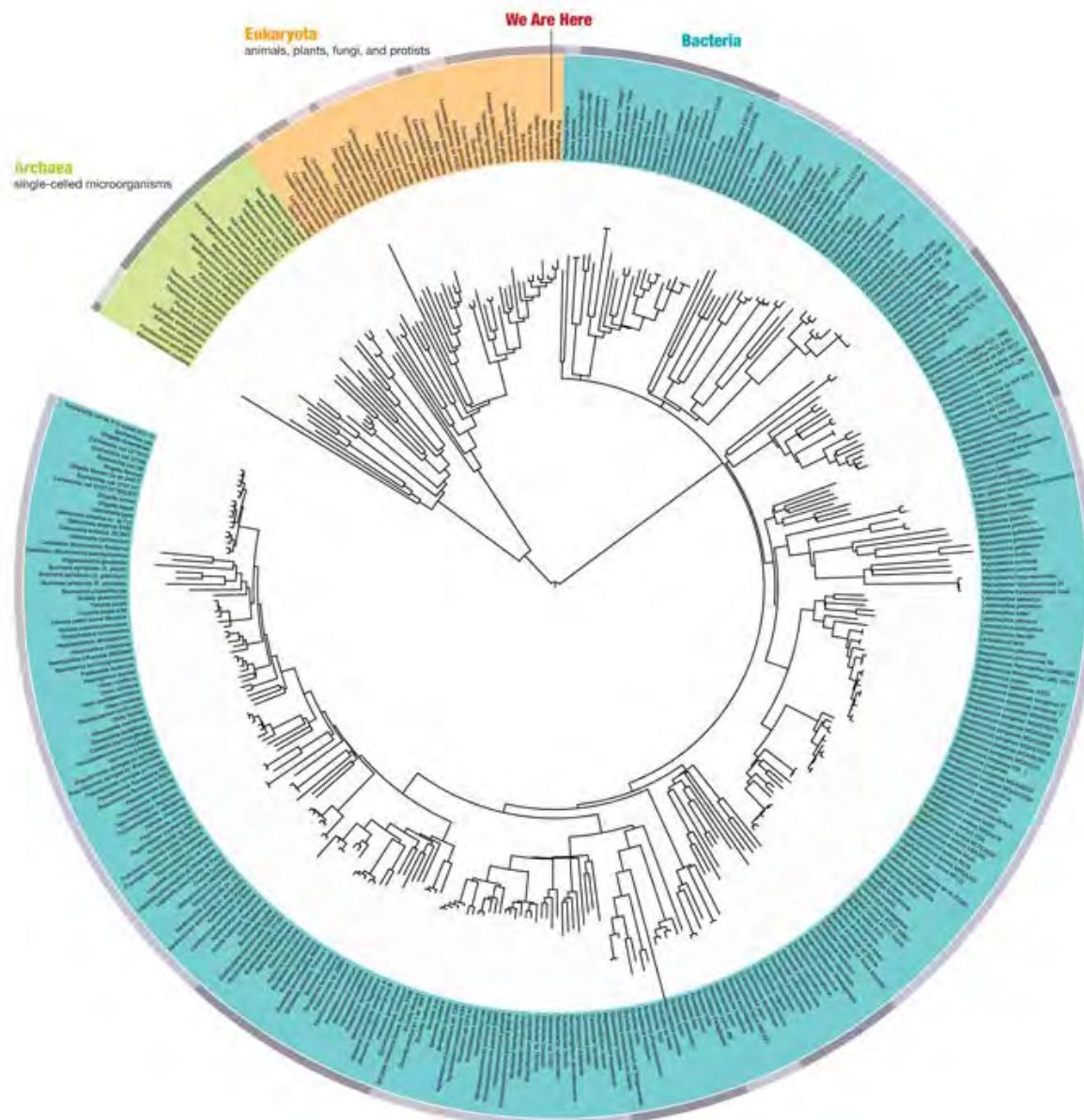


VI.8



VI.10

tree of life

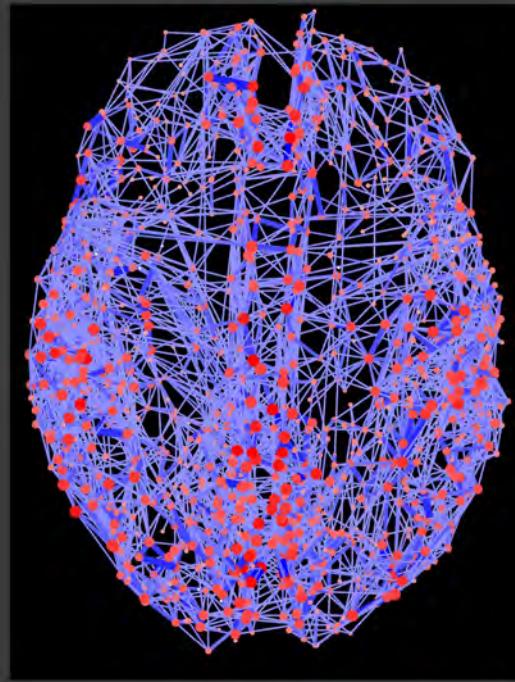


The Human Connectome



Anatomy

Klingler's method for fiber tract dissection uses freezing of brain matter to spread nerve fibers apart. Afterwards, tissue is carefully scratched away to reveal a relief-like surface in which the desired nerve tracts are naturally surrounded by their anatomical brain areas.



Connectome

Shown are the connections of brain regions together with "hubs" that connect signals among different brain areas and a central "core" or backbone of connections, which relays commands for our thoughts and behaviors.



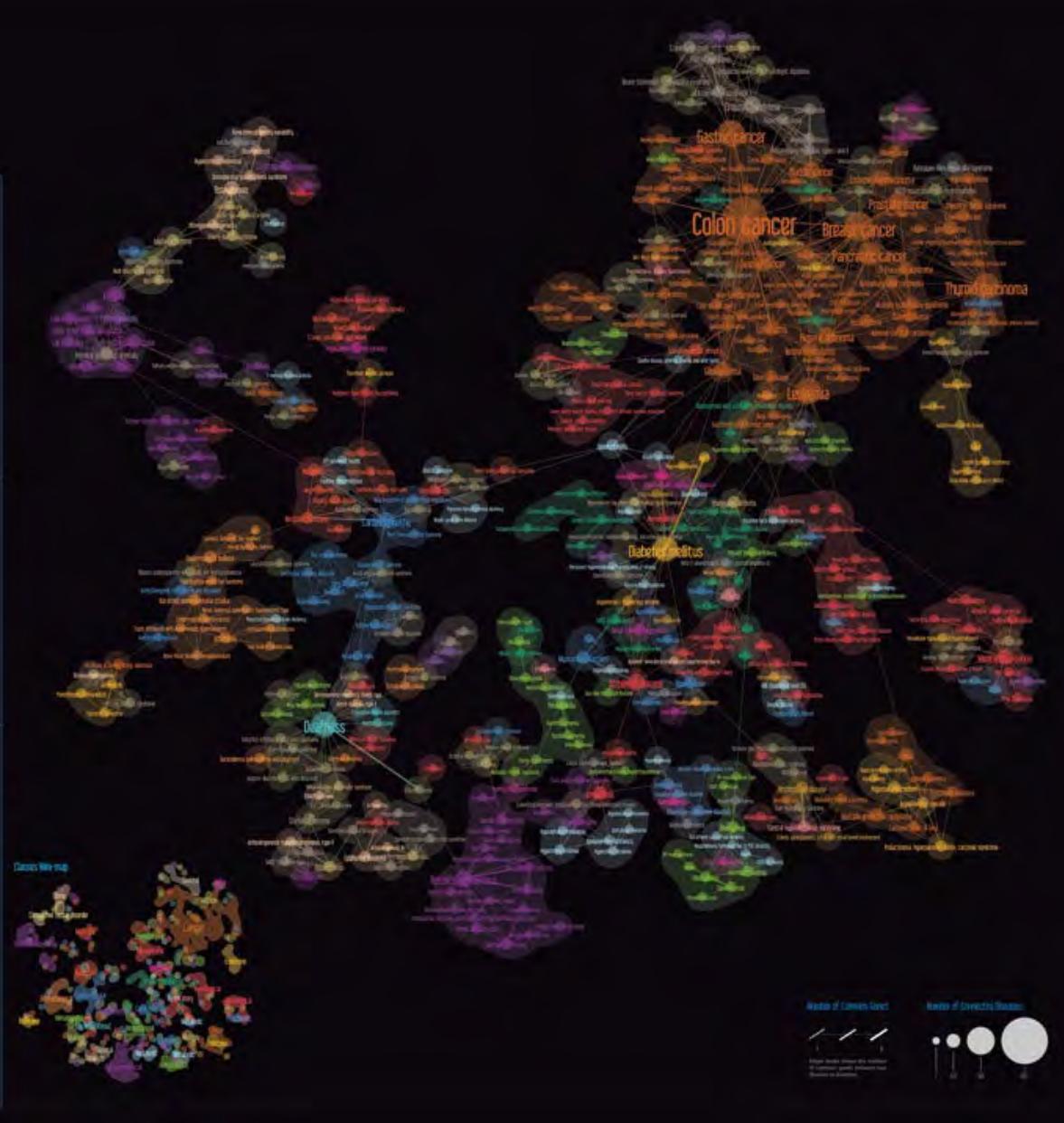
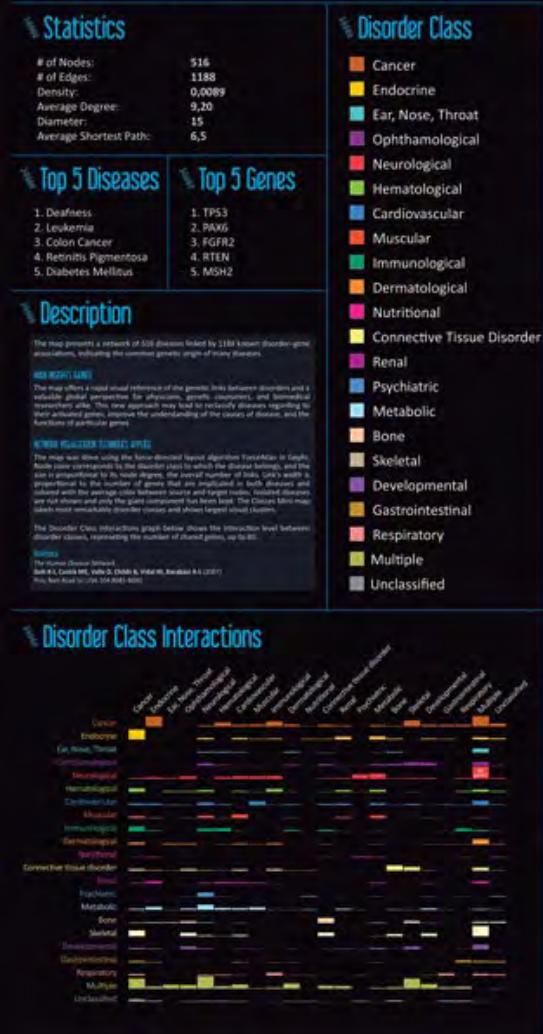
Neuronal Pathways

A new MRI technique called diffusion spectrum imaging (DSI) analyzes how water molecules move along nerve fibers. DSI can show a brain's major neuron pathways and will help neurologists relate structure to function.

Diseasome

The Human Disease Network

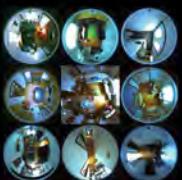
Explore online at <http://diseasome.eu>



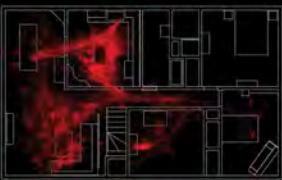
HUMAN SPEECH HOME PROJECT



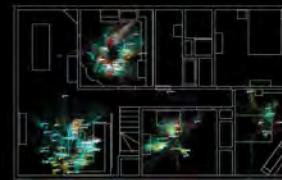
Camera locations



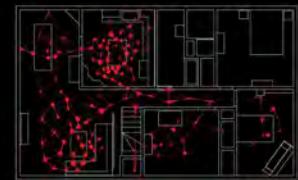
Views from 9 cameras



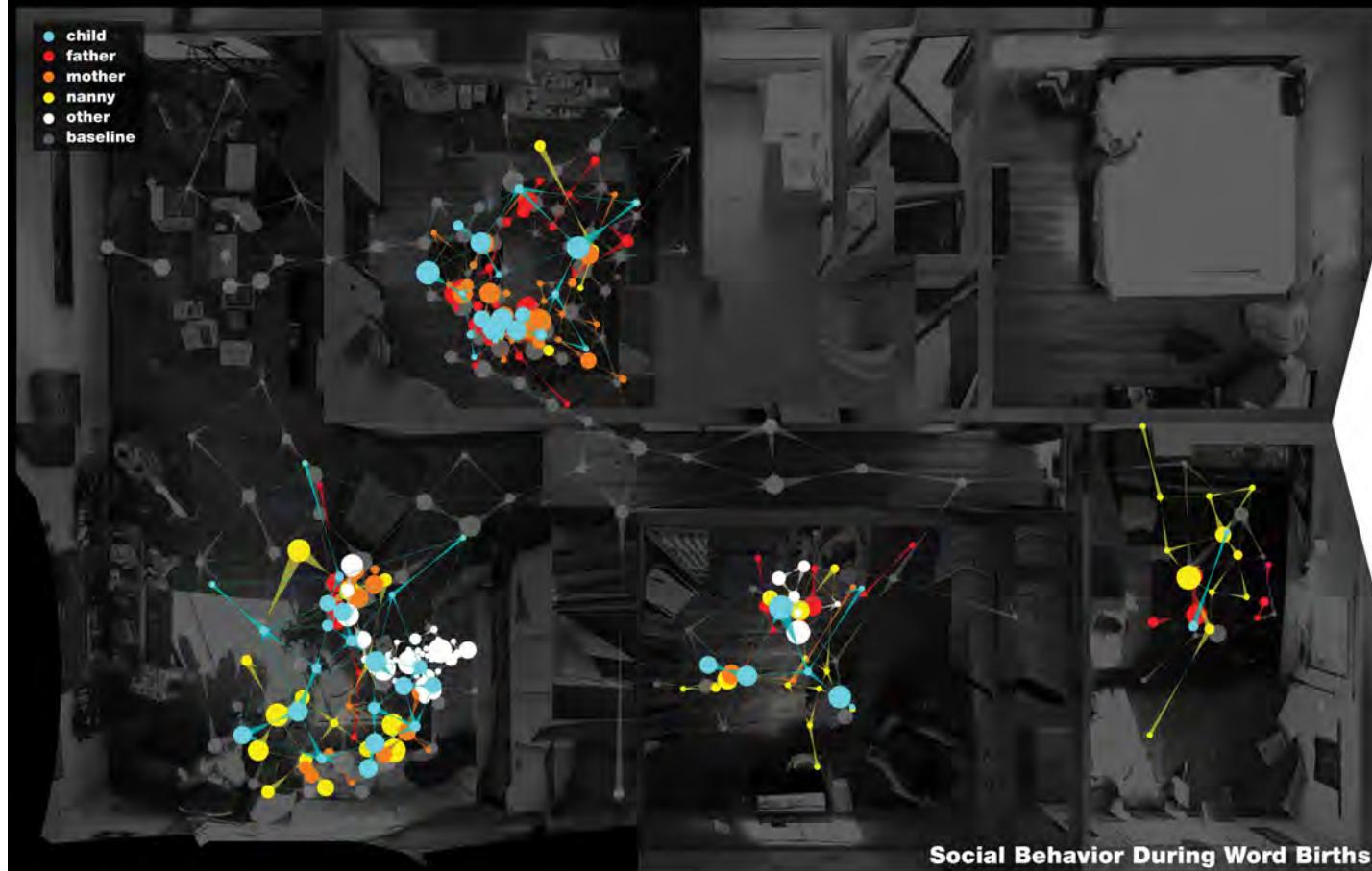
Individual movement traces



50 word birth locations and tracks



Baseline movement patterns throughout the home



Language is one of the defining features of the human species, unique in its compositional structure and referential capacity, critical for creation and transmission of cultural knowledge, devastating to an individual when impaired or lost. For all that is at stake, our current understanding of language acquisition in humans is woefully grounded in surprisingly incomplete and biased observational data. As a consequence, many promising theories of language acquisition remain vaguely articulated, contradictory, and untested. More precise and empirically validated theories would shed light on central aspects of human cognition, guide new ways for children to learn, and lead to effective treatment of language disorders.

A critical bottleneck in the study of language acquisition is the quality of naturalistic observational recordings of child development available to researchers. Although young children's language skills change rapidly from day to day, typical nativistic studies of child development are based on observations spaced weeks or months apart. Furthermore, most home recordings of child development consist of speech recordings and/or speech transcriptions but lack any record of non-linguistic situational context. Children of course learn language by connecting words to the people, things, and activities around them. Thus, recording only speech produces an incomplete picture.

To address these concerns, four years ago we launched the Human Speechome Project with the goal of making a comprehensive and unbiased record of one child's development at home. We have completed the recording phase of the project, yielding the Speechome corpus of approximately 90,000 hours of video and 140,000 hours of audio recordings spanning the child's life from birth to age three. Analysis is currently underway, and the images shown here represent a small piece of this early analysis.

Camera locations. Shown are the locations in the home (second floor only) of 6 (of 11) video cameras.

Views from 9 cameras. Cameras utilize fisheye lenses for full coverage of the space.

Individual movement traces. Objects in the video are tracked automatically, with their locations stored over time.

50 word birth locations and tracks. A word birth occurs each time the child produces a word for the first time. Tracks are classified automatically as to the identity of the subject being tracked. With transcripts of what was said in the house correlated with identified tracks, word birth locations can be derived.

Baseline movement patterns throughout the home. This image shows a "star graph," a visualization intended to capture the behavioral topology of a subject's movement through a space. The star graph here represents the aggregate movement patterns of all people in the home during approximately 1,000 minutes of video.

Social behavior during word births. The behaviors, in particular the movement of caregivers in relation to the child during word births, might lead to a better understanding of the dynamics of these words. By overlaying star graphs for each of the participants in the home during word births, we can gain a sense of the social dynamics surrounding the acquisition of a new word by the child. The large image shows star graphs generated for the child, 3 caregivers, and all other adults present during 50 word births. We can see, for example, that the child learned many words in the kitchen while in the presence of their mother and father, and moved around little during these events. In the living room, however, the child moved around more freely, and was more often in the presence of the nanny during word births.

MAPPING THE ARCHIVE: PRIX ARS ELECTRONICA

<http://vis.mediaartresearch.at>

SUBMISSIONS



Hier präsentieren wir die Gesamtzahl aller 37.432 Werke, die jemals zum Prix Ars Electronica von Künstlern aus aller Welt eingereicht worden sind. Nur die wenigsten haben fröhlich einen Preis gewonnen, der Rest verschwand im Archiv. Wir haben diese wertvollen Daten jetzt aufbereitet und zugänglich gemacht.

Die Zuordnung der Einreichungen zu den sich über die Jahre ändernden Prix Kategorien, den Heimatländern der Künstler und den Prix Jahrgängen erlaubt es nicht nur, die Historie des Preises Revue passieren zu lassen, sondern auch Hypothesen über die Mechanismen der "Welt der Ars" zu generieren.

Here we present the native number of 37.432 art works and projects that have been submitted in the Prix Ars Electronica by artists from all over the world. Obviously only a fraction was awarded and the rest has disappeared in the archive. We have examined and edited this valuable data and made it accessible.

The assignment of the submissions to the Prix categories (which have changed over the years), to the countries of residence, and the Prix years, allows not only for a review of the history of the Prix, but reveals also hypotheses on the mechanisms of the "Ars-world".

JURY PROCESS



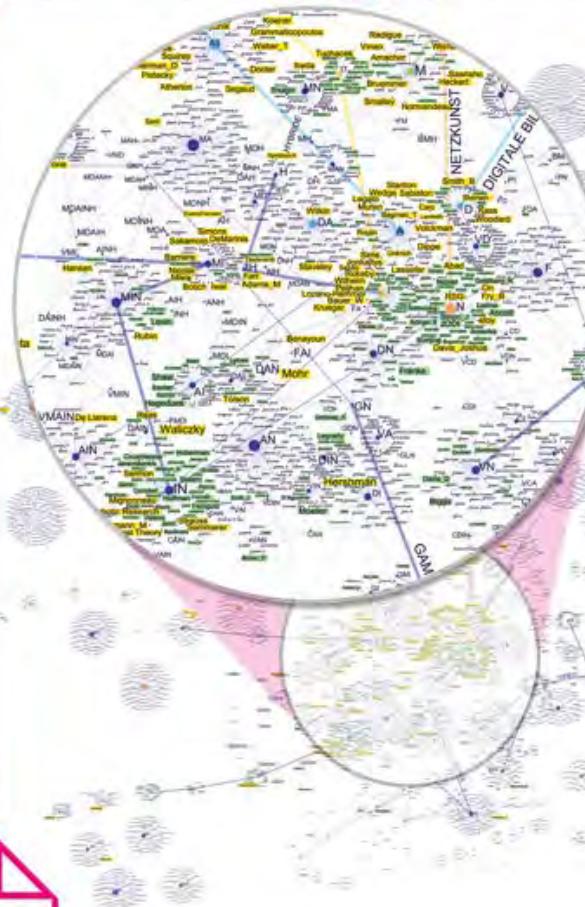
In den Jurysitzungen zur Ermittlung der Gewinnerprojekte sieht man jedes Jahr neue und altebekannte Gesichter, und oft werden auch ausgewählte Künstler in den folgenden Jahren als Juroren eingeladen. Ein Blick auf das entstandene soziale Netzwerk enthüllt, wie manche Strukturen.

Weiter verfasst die Jury für jedes Gewinnerprojekt ein Jurypresumt – diese Statements sind über die Jahre zu einer großen Textsammlung angewachsen, die wir ebenfalls untersucht haben.

Each year a combination of new and recurrent jury members must identify the winning projects. Often the awarded artists from the previous year are invited as jury members. A social network has evolved over the years, which is here on display.

Furthermore the jury writes a statement for each winning project. Over the years, these statements have been growing into a large collection of texts, which we analyzed here.

WINNERS



Besondere Aufmerksamkeit verdienen die Gewinner aus 23 Jahren Prix Ars Electronica - hier geht es nicht nur um Goldene Nica, auch Honorary Mentions, Distinctions oder Special Prizes werden verliehen. Auch hier bergen die Daten aus dem Archiv bisher unbekannte Strukturen. Unsere Visualisierungen laden dazu ein, Verbindungen zwischen den Künstlern oder zwischen Künstlern und Werken zu entdecken.

The winning projects from 23 years of Prix Ars Electronica deserve special attention. It is not only about the Golden Nica but also Honorary Mentions, Distinctions and special prizes that have been awarded. The data from the archive conceal as far unknown structures. Our visualizations invite to explore connections between artists as well as similarities between art works.

about

Das Projekt präsentiert die Ergebnisse einer interdisziplinären Untersuchung des Prix Ars Electronica Archivs in Form interaktiver und statischer Informationsvisualisierungen. Das Archiv wird dabei auf drei Ebenen betrachtet: zunächst die Gesamtheit der Einreichungen seit 1987 als quantitative Analyse (links), weiters der Juryprozess als soziale Netzwerkanalyse (mitte), schließlich die Gewinnerprojekte und ihre kunstwissenschaftliche Kontextualisierung (rechts). Das Projekt ist eine Zusammenarbeit des Ludwig Boltzmann Instituts für Medien.Kunst.Forschung. und der Ars Electronica.

The project presents the result of a interdisciplinary study on the Prix Ars Electronica archive in the form of interactive and static visualization of information. The archive is examined on three different levels: at first a quantitative analysis of the entries at large since 1987 (left); then the jury process as a social network analysis (middle); and finally the winning projects in their art historic conceptualization (right). This project is a collaboration between the Ludwig Boltzmann Institute Media.Art.Research. and the Ars Electronica.

legend

Digital Communities	Interactive Art
Media	UI/UX
Animation	New Ideas
Computer Graphic	Music
Hybrid Art	Timeline

FIGURES from an ATLAS of RESEARCH in
KNOWLEDGE CARTOGRAPHY

as designed by MARCO QUAGGIOTTO

Politecnico di Milano, Italy. INDACO Dept.

ATLAS is a software prototype for the management of research resources (texts, people, projects, events), aimed at supporting common tasks of research such as survey, mapping, and analysis.

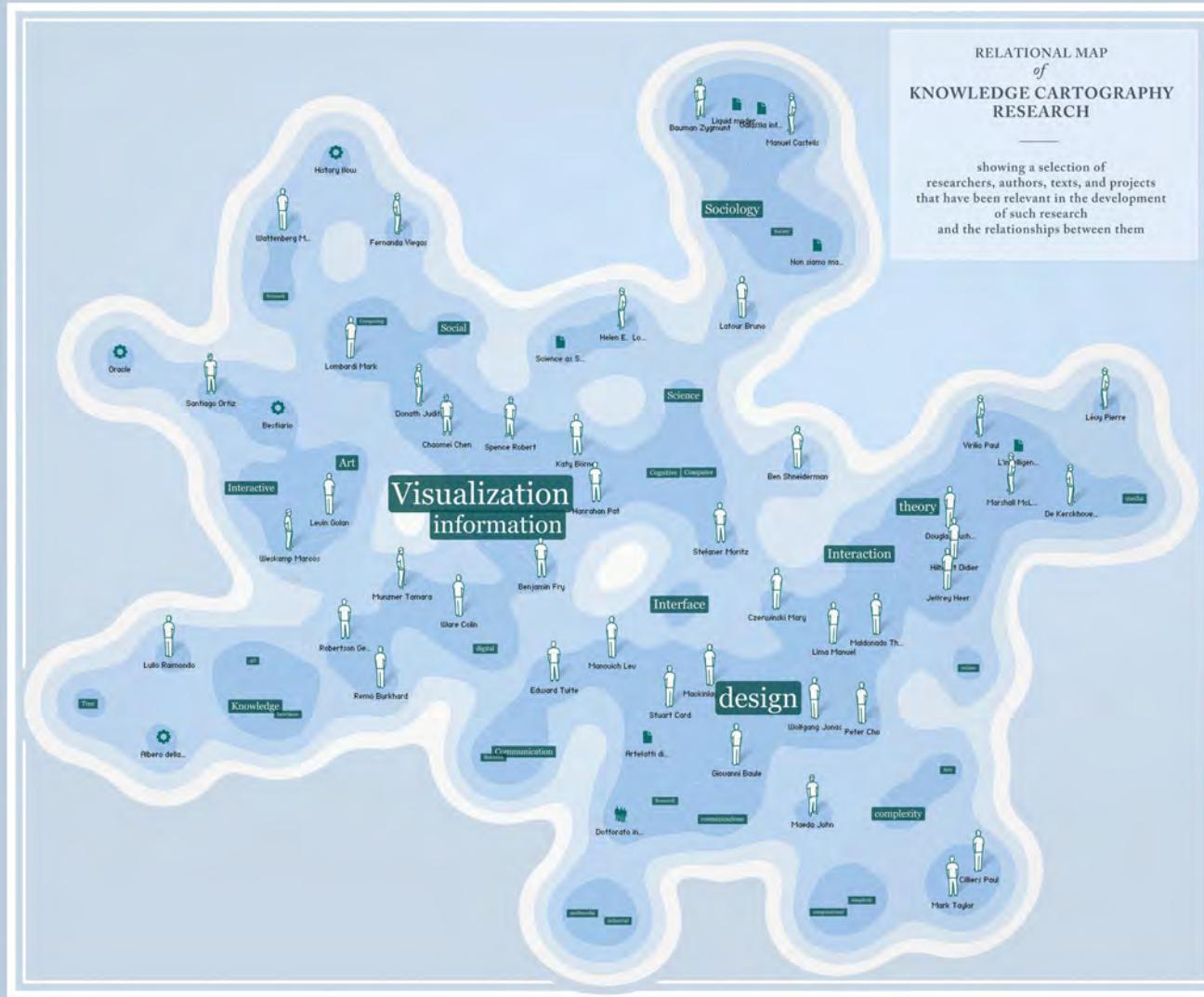
The social nature of the software allows users to share resources with each other, discover the existence of potentially interesting studies or authors, and explore other users' research maps. Every user of the system can add resources to a personal or shared list, describe them, and establish connections with

other resources (e.g., authorship, citation).

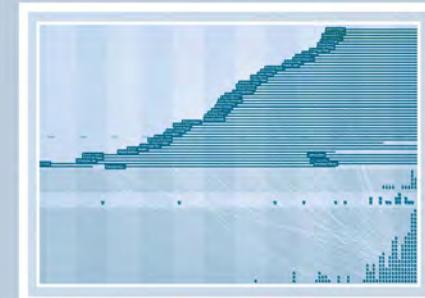
Working on such repositories, the system can provide the users with an ATLAS of their research. Relational maps of researchers, thematic maps of authors, timelines of themes and events, and maps of academic collaboration are only a few of the possible maps. As in geographic cartography, careful operations of selections, disposition, and representation allows the user-cartographer to create custom maps for specific needs.

The connection between different maps, traditionally served by print-based mechanisms such as indexes, geographic reference systems, and tables, in the digital atlas becomes a set of techniques for the navigation and exploration of space.

This poster presents a selection of maps of research in Knowledge Cartography. As with every representation, none of them are either complete or absolutely accurate, but all of them should be insightful.



GEOGRAPHIC MAP OF RESEARCHERS



TIMELINE OF PUBLICATIONS



THEMATIC MAP OF DISCIPLINES

Literary Empires

Mapping Temporal & Spatial Settings of Victorian Poetry

*Look, the world tempts our eye,
And we would know it all!
We map the starry sky,
We mine this barren hill.
We measure the sea-tides, we number the sea-shells;
We scrutinize the dates
Of long past human things,
The bounds of effaced states,
The lines of dissolved kings;
We search out dead men's words, and works of dead men's hands;*



• Poems Sorted by Temporal Setting

John Watcher Damon Baker David Sammons
Eduardo Michelante Lance Penn Jonathan Caudy

VI.7 Literary Empires: Mapping Temporal and Spatial Settings of Victorian Poetry

John A. Walsh, Devin Becker, Bradford Demarest, Jonathan Tweedy, Theodora Michaelidou, and Laura Pence - 2010

The EMERGENCE of NANOTECHNOLOGY

MAPPING THE NANO REVOLUTION

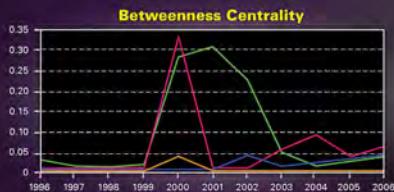
The emergence of nanotechnology has been one of the major scientific-technological revolutions in the last decade and it led to a structural reorganization of major fields of science. Price (1965) showed that fields of science and their development can be mapped using aggregated citations among the journals 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 occur on many shortest paths between other journals in a network have higher BC value than those that do not. In the maps, 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 take the lead, and a new specialty structure with low BC value journals results.

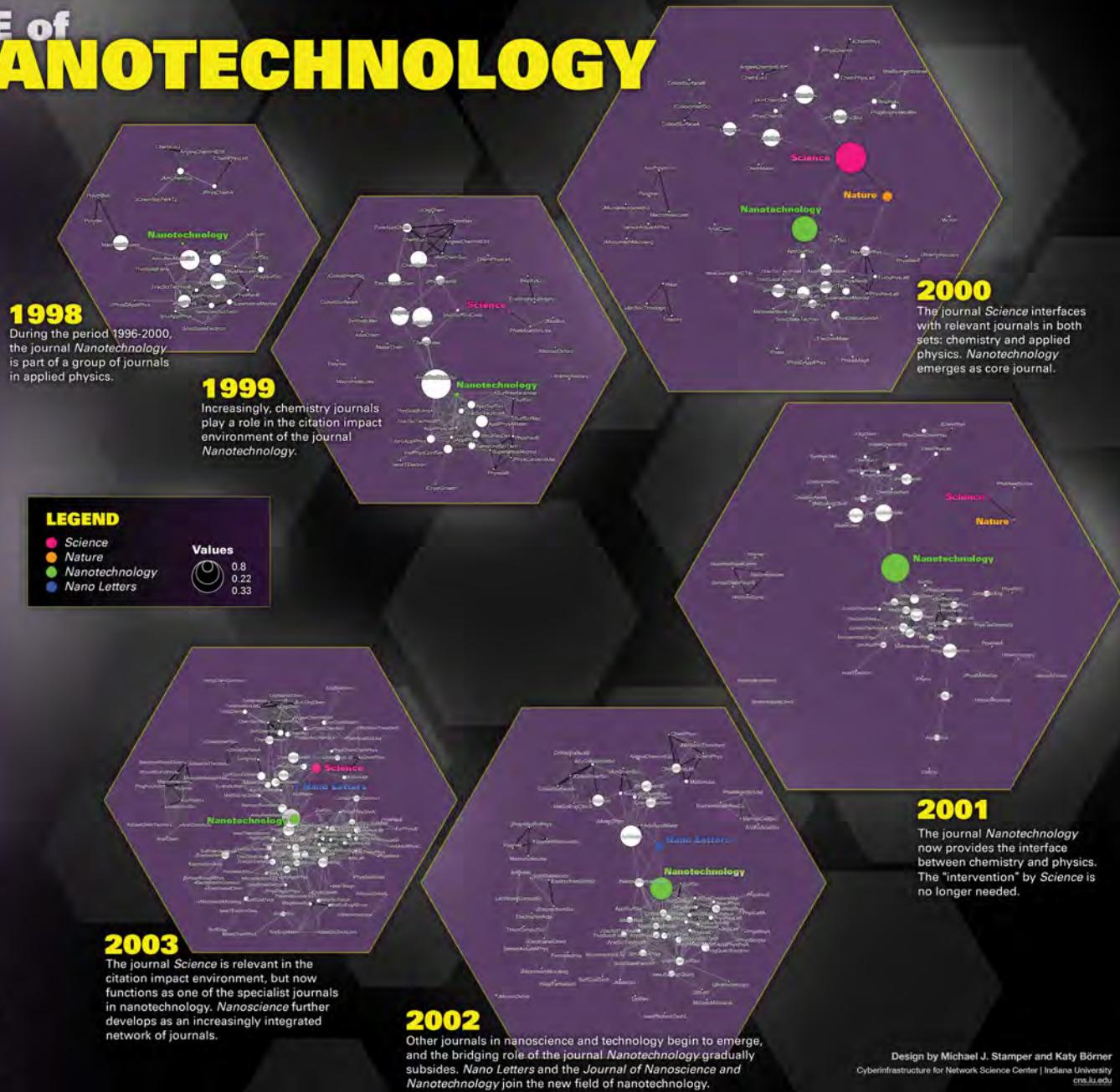


An animated sequence of this evolution is at:
<http://www.leydesdorff.net/journals/nanotech>.

References

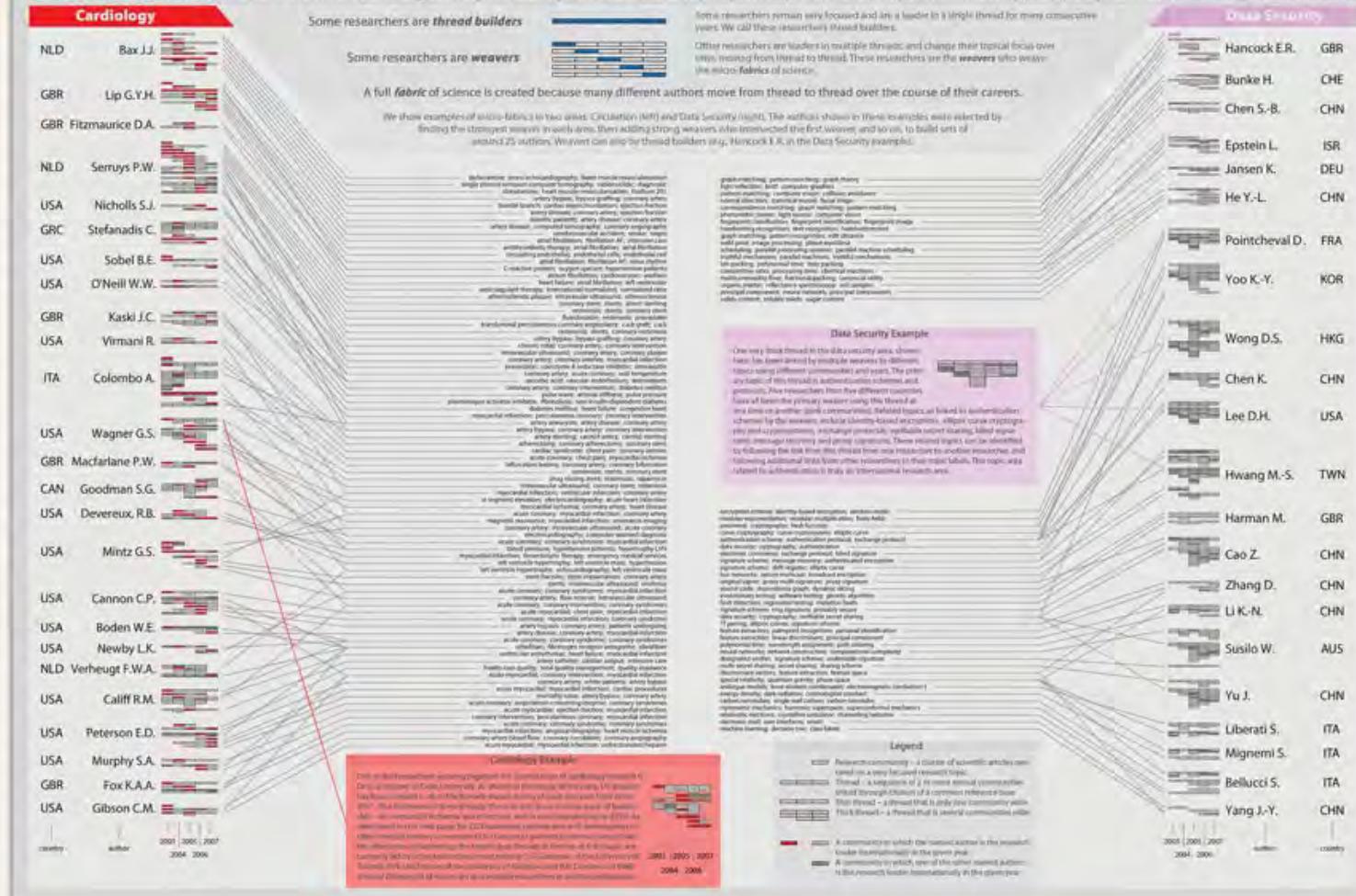
- Leydesdorff, L. and T. Schank. 2008. Dynamic Animations of Journal Maps: Indicators of Structural Change and Interdisciplinary Developments. *Journal of the American Society for Information Science and Technology*, 59(11), 1810-1818.

Price, Derek J. de Solla (1965). Networks of scientific papers. *Science*, 149, no. 3683, 510- 515.



WEAVING THE FABRIC OF SCIENCE

More people assume that there is a fabric of science. Our analysis illustrates that the structure of science is much more like a fabric than a web. This conclusion is based on an analysis of the scientific literature we model how science is structured and how it changes over time. Using co-authorship analysis, we create annual threads of science. Each annual thread clusters around 2 million reference papers, and then aligns the articles from that year and the previous years to those clusters. Each annual thread contains 10 to 90 thousand such clusters, and around 8 million recent articles. Each cluster is called a research community. To create the fabric of science we link to weave research communities in two different ways. First, communities from annual threads are linked sequentially in time along a timeline of common references. These common references are like **fibers** that can be twisted together into **threads**; this is what researchers do inherently through writing papers. Over time, linked sets of communities are called **threads**, and are shown as the sequences of braided rectangles in the image to the left and right. Threads can be thin or thick depending on the citation structure. The second way we link communities is intrinsically by linking references. We identify the leading researchers in each thread.



Labor Statistics

From the start of the recession in December 2007 through the end of 2009, more than 8 million jobs were lost in the United States. In October 2009, the U.S. unemployment rate peaked at 10.1 percent (after adjustment for seasonal variations). In April 2010, unemployment was still at 9.9 percent. In May 2010, about 6.8 million individuals, or 46 percent of those unemployed, had been unemployed for at least 27 weeks. Each month, 100,000 people enter the U.S. labor market—including high school and college graduates. They join 15 million Americans looking for work.

Unemployment rates are calculated and adjusted by the Bureau of Labor Statistics within the U.S. Department of Labor and reported in their monthly Economic News Release on the Employment Situation. Historical employment data, including unemployment rates with and without seasonal adjustment and divided by individual characteristics and employment sectors, are also available from the Bureau of Labor Statistics.

U.S. Job Market:

Where are the Academic Jobs?

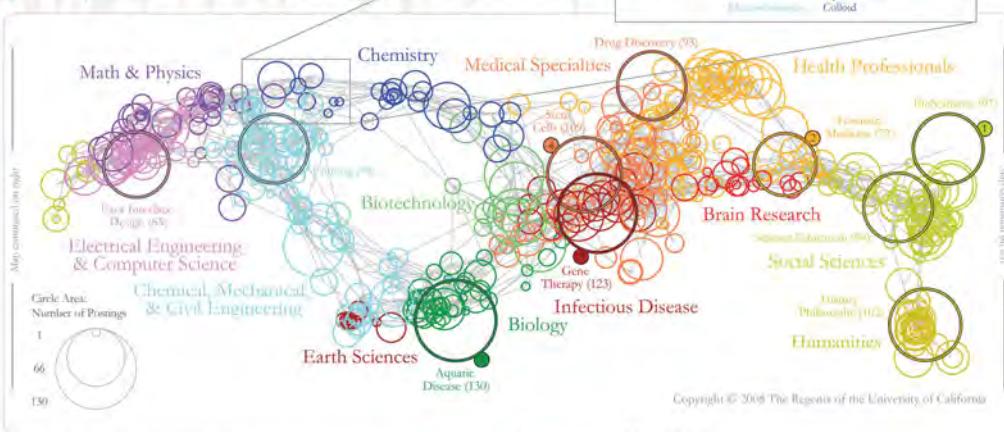
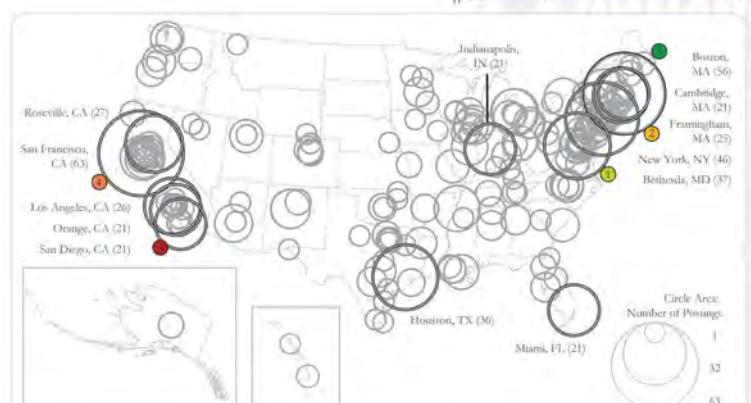
General Trends

The charts to the left show annual national economic indicators. These indicators serve as background data; they flow beneath and around more specific analyses of the job market. Business cycle data come from the National Bureau of Economic Research. Historical debt data come from the U.S. Department of Treasury. Unemployment rates come from the Bureau of Labor Statistics.

GDP data come from the Bureau of Economic Analysis.

Stock Price Index data come from the research of Dr.

Robert Shiller at Yale University Department of Economics. Individual conversion factors (compiled from Bureau of Labor Statistics Consumer Price Indices by the Oregon State University Political Science Department) were applied where appropriate.



Sample Jobs

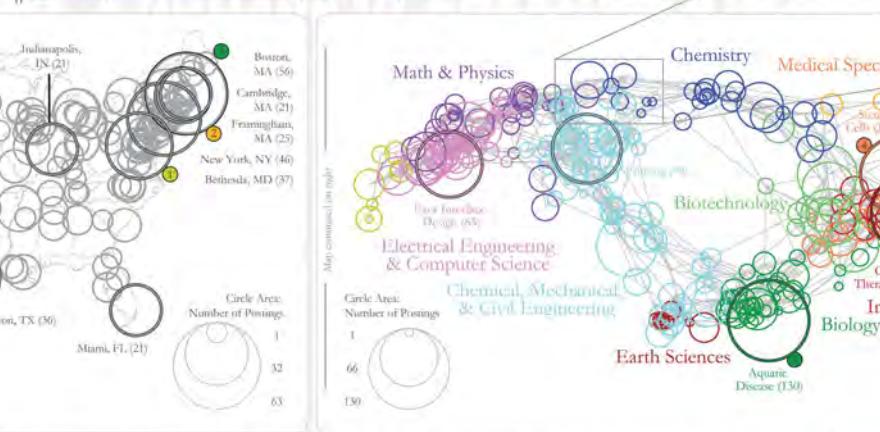
- (1) Bioinformatics Programming/Senior NIH/NHGRI (Bethesda, MD)
- (2) Human Sur/Lead Musculoskeletal Diseases (Orthopedic Medicine/Bethesda, MD)
- (3) Associate Scientist II Mouse NeuroGenetics (Gene Therapy/San Diego, CA)
- (4) Scientist Early Stage Cell Culture (Stem Cells/San Francisco, CA)
- (5) Post-doctoral Training in Mammalian Genetics/Aquatic Disease/Baylor (Houston, TX)

Geospatial Map

Using U.S. city and state information, circles are placed over the location of the job postings and are sized in relation to the number of postings listed for that location. The top 10 cities with the highest number of postings are labeled, and the number of postings are given in parentheses.

Where are the Academic Jobs?

Over 3,500 jobs posted between July 2008 and February 2009 on Nature Jobs were collected and analyzed. The two maps above show the 1,037 job postings located in the U.S. and represent a directed study of the job market that sits on top of larger trends over time.



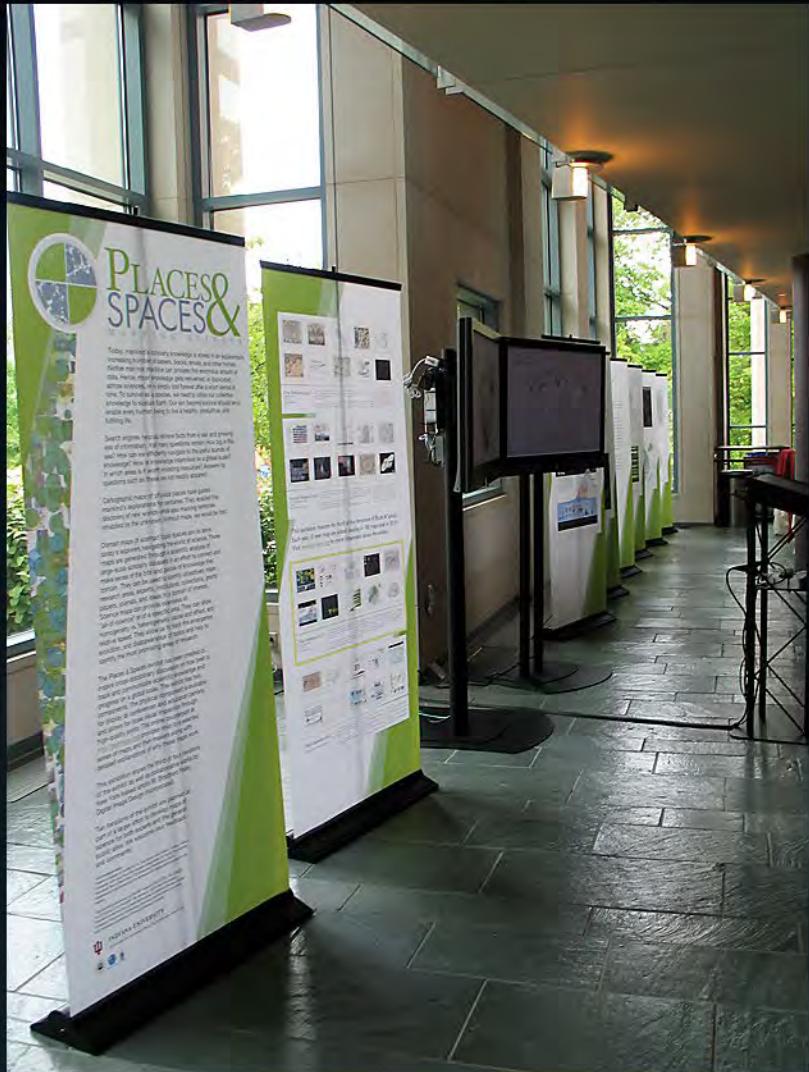
Topic Map

How many and what jobs are available in which scientific area? The UCSD Map of Science used here was created by analyzing 7.2 million papers published in over 16,000 separate journals, proceedings, and series from Thomson Scientific and Scopus over the five-year period from 2001 to 2005.

Using a hierarchical, multi-step clustering procedure, journals were grouped into 554 clusters based on common word usage and shared references (bibliographic coupling). In the map, each cluster is represented by a node, and links denote strong bibliographic coupling relations. The 554 clusters are further grouped into 13 color-coded scientific disciplines.

The 1,037 jobs were overlaid based on word matches in their description and keywords associated with each of the 554 nodes. Like in the geospatial map, circle area sizes correspond to the number of jobs posted.

Want to host the **Places & Spaces** Exhibit?



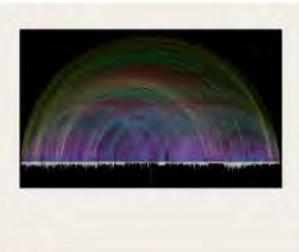
Visit scimaps.org/host
to learn how you can bring
this unique collection to
your venue!

Iteration VII (2011)

Science Maps as Visual Interfaces to Digital Libraries



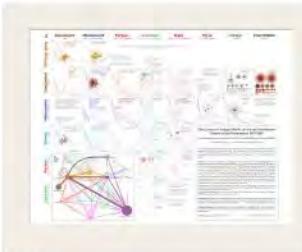
VII.1



VII.3



VII.5



VII.7



VII.9



VII.2



VII.4



VII.6



VII.8



VII.10

MONDOTHÈQUE

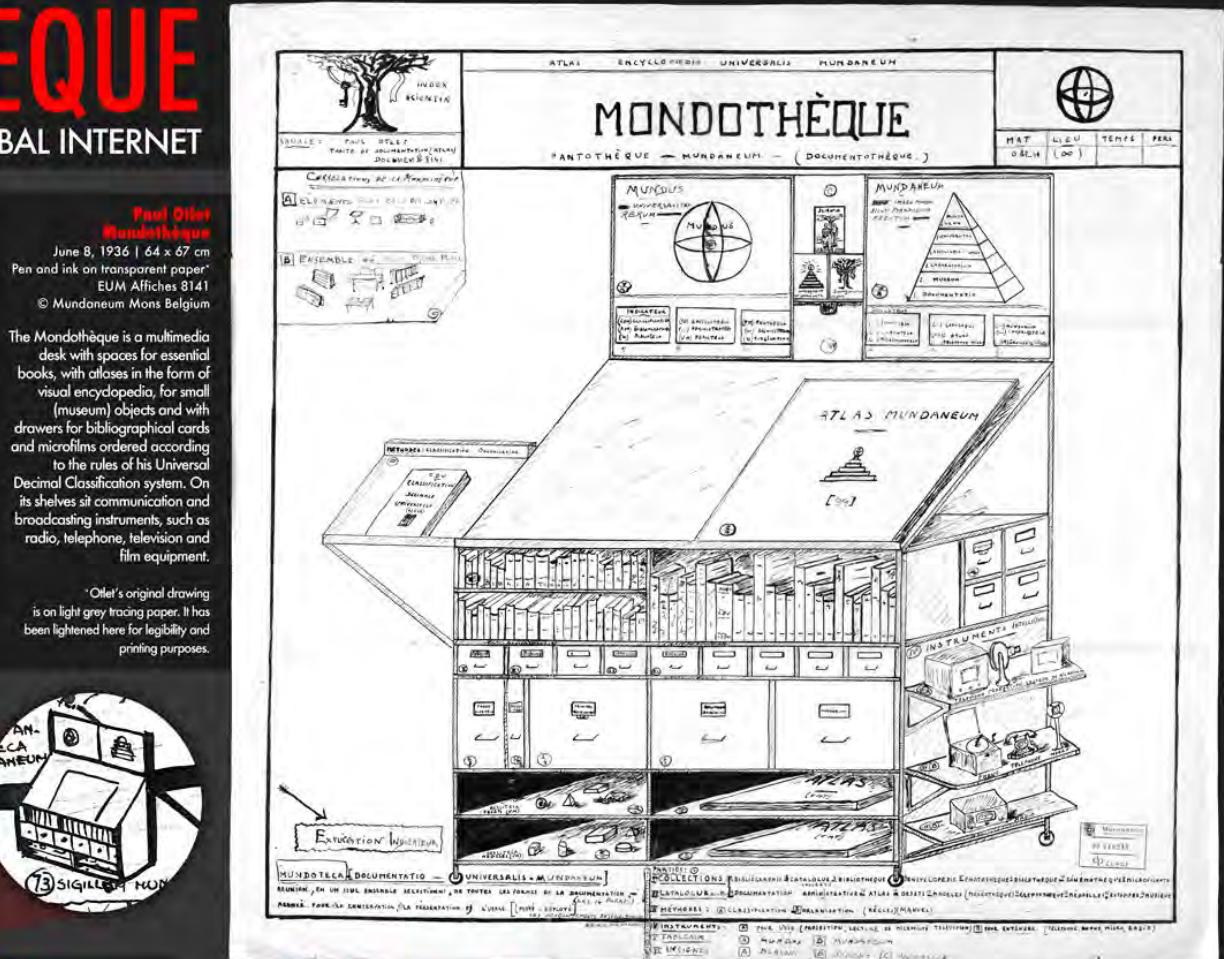
A MULTIMEDIA DESK IN A GLOBAL INTERNET

Paul Otlet (1868-1944), visionary Belgian lawyer fascinated by the problems of access to global knowledge, is often acknowledged as a pioneer of the Internet. His design of 1936 for a multimedia desk for home use, the Mondothèque, integrated access to new documentary formats including multimedia substitutes for traditional books involving all available communications technologies such as microfilm, gramophone, radio and TV. A major resource was a new form of visual encyclopedia, the Encyclopedia Universalis Mundaneum. Connected by the Mondothèque to a network of global collections (Species Mundaneum), the user could access and engage in the international production and dissemination of knowledge.



Paul Otlet
Species Mundaneum
January 16, 1937 | 21 x 28 cm
pen and ink on transparent paper
EUM 8504
© Mundaneum Mons Belgium

Text: Mondothèque. A multimedia desk in a global internet
Charles van den Heuvel, Hoygens NG (KNAW), The Hague & W. Boyd Rayward, University of Illinois, Urbana-Champaign
Acknowledgment: Stéphanie Manfrid, Mundaneum, Mons
Graphic Design: Janet Armstrong BNC | Armstrong Design, Maastricht, NL with the collaboration of Michael J. Stamper



MUNDOTECA [Documentatio-Universalis-Mundaneum]

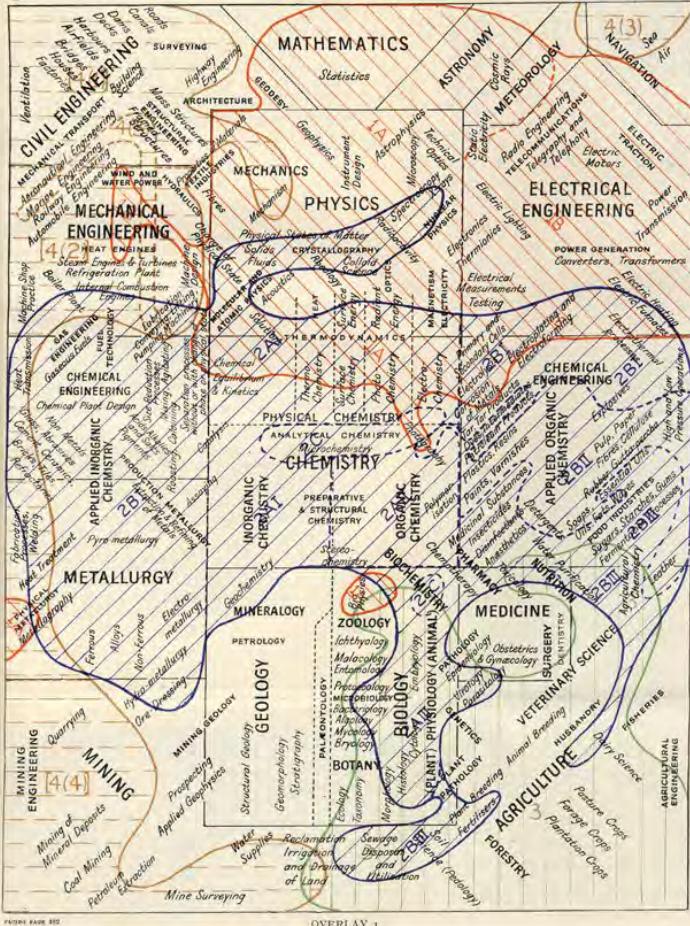
BRINGING TOGETHER OF ALL KINDS OF DOCUMENTATION - (THE 16 KINDS) IN A SINGLE ORDERED GROUPING

An agency for **conservation**, **presentation**, **use** (specific or general) – systematic developments in furniture, buildings, galleries.

COMPONENTS

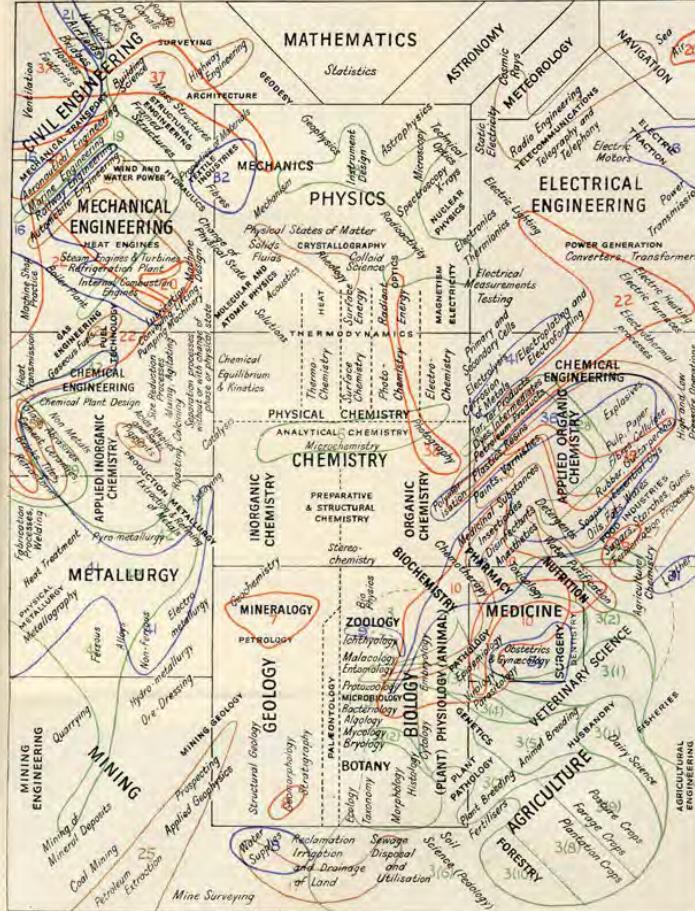
- 1 Bibliography • 2 Union Catalogue • 3 Library • 4 Encyclopedia • 5 Photographic library • 6 Music library • 7 Film library • 8 Microfilm library • 9 Administrative Documentation • 10 Atlases [collection of maps, engravings, charts, graphic representations] • 11 Objects • 12 Models [library of museum objects] • 13 Sculpture collection
- 14 Medals • 15 Prints • 16 Music
- Classification • B Organisation (Rules, Manual)
- A to see with (Projection, Microfilm reader, Television) • B To hear with (Telephone, Phonograph, Microphone, Radio)
- A Mundus • B Mundaneum
- C Coats of Arms • D Steele [Stone monuments] • E Coins

TWO CHARTS ILLUSTRATING SOME OF THE RELATIONS BETWEEN THE BRANCHES OF NATURAL SCIENCE & TECHNOLOGY BY H.J.T. ELLINGHAM. 1948



ABSTRACTS OR GROUPS OF ABSTRACTS COVERING A VERY WIDE FIELD (OVERLAY 1)

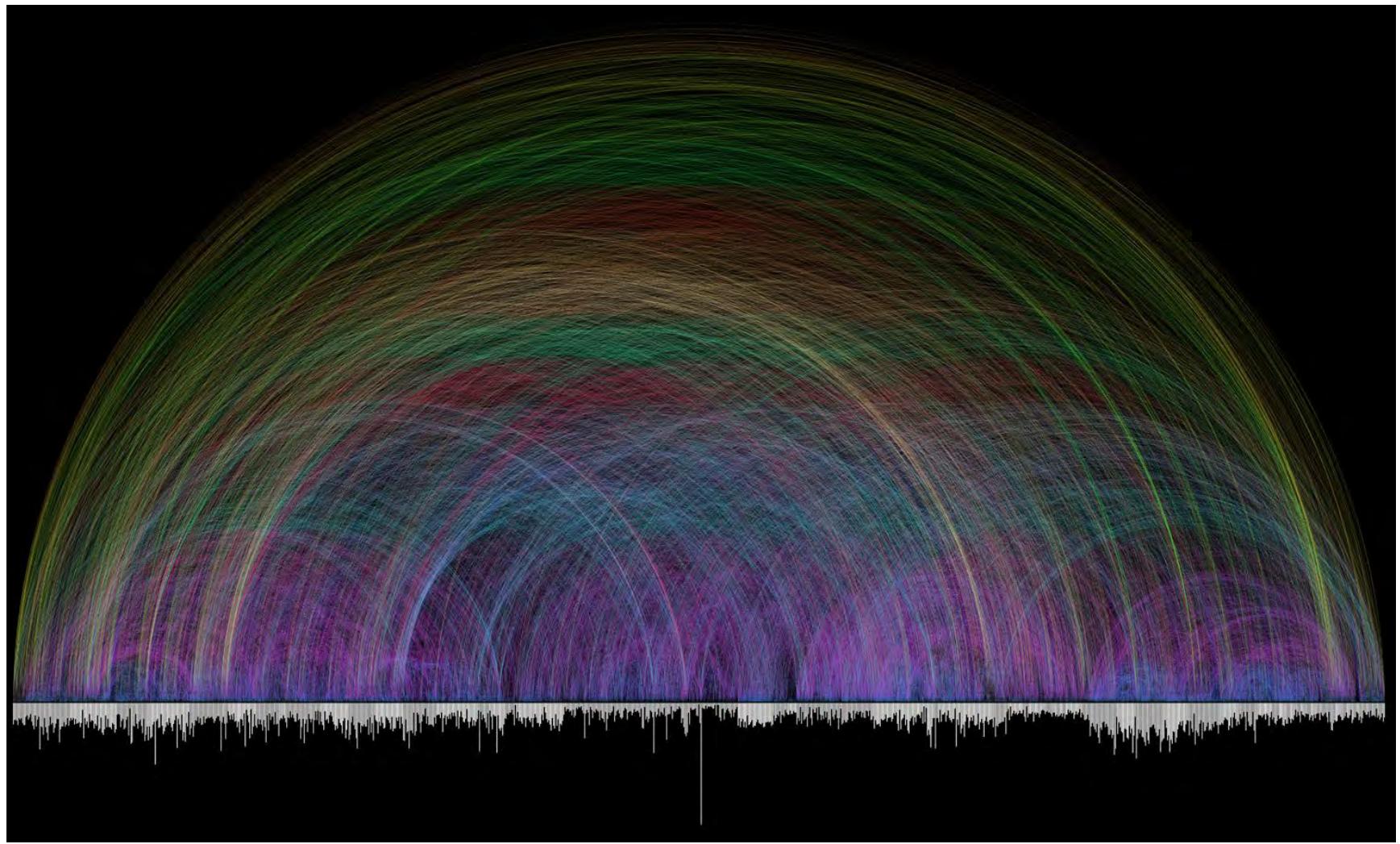
1. Science Abstracts Council Board of the Institution of Chemical Engineers and the (Physicist) Society.
A. Pure Abstracts
B. Applied Engineering.
2. British Abstracts - The Bureau of Abstracts representing the Chemical Society, the Society of Chemical Industry, the Physiological Society, the Medical Research Council, the Royal Society of Great Britain and the Institute of Chemical Engineers.
A.I. General, Physical and Inorganic Chemistry.
A.II. Organic Chemistry.
A.III. Physical, Biotechnology, Agriculture.
A.IV. Microbiology, Botany, Zoology.
A.V. Mineralogy, Petrology, Geology.
A.VI. Industrial Organic Chemistry, including Metallurgy.
A.VII. Agricultural Soil and Statistics.
A.VIII. Animal and Veterinary Sciences.
3. Comprehensive Agricultural Research Abstracts Disseminate Research for the individual sets of abstracts detailed shown on Overlay 2.
C. Abstracts on the Economic Aspects of Animal Husbandry.
D. Abstracts on the Economic Aspects of Animal Husbandry.
E. Veterinary Abstracts and References (Commemorative Bureau of Animal Nutrition).
F. Review of Applied Engineering - Agricultural, Industrial, Chemical and Metallurgical (Commemorative Bureau of Engineering).
G. Review of Applied Engineering - Agricultural, Industrial, Chemical and Metallurgical (Commemorative Bureau of Engineering).
H. Applied Biology (Commemorative Bureau of Animal Genetics).
4. Engineering Abstracts Disseminate with the co-operation of other engineering associations:
A. Abstracts on the Economic Aspects of Civil Engineering - see 304-305.
(1) Building Engineering (see above item 304-305).
(2) Industrial Engineering (see above item 304-305).
B. Abstracts on the Economic Aspects of Electrical Engineering in co-operation with the Institution of Electrical Engineers.
C. Abstracts on the Economic Aspects of Electronic Engineering.
5. Comprehensive Agricultural Research Abstracts Disseminate Research for the individual sets of abstracts detailed shown on Overlay 2.
C. Abstracts on the Economic Aspects of Animal Husbandry.
D. Abstracts on the Economic Aspects of Animal Husbandry.
E. Veterinary Abstracts and References (Commemorative Bureau of Animal Nutrition).
F. Review of Applied Engineering - Agricultural, Industrial, Chemical and Metallurgical (Commemorative Bureau of Engineering).
G. Review of Applied Engineering - Agricultural, Industrial, Chemical and Metallurgical (Commemorative Bureau of Engineering).
H. Applied Biology (see above item 304-305).



OTHER SETS OF ABSTRACTS (OVERLAY 2)

1. Journal of the Institution of Mining.
2. Engineering Abstracts of the British Metalworking Industries.
3. Abstracts of the British Society for Soil Science.
4. Abstracts of the British Society for Animal Production.
5. Abstracts of the British Society for Animal Nutrition.
6. Plant Breeding Abstracts (Commemorative Bureau of Plant Breeding and Genetics).
7. Heredity Abstracts (Commemorative Bureau of Plant Breeding and Genetics).
8. Forestry Abstracts, Spinachum et Utilitatis (Commemorative Bureau of Foresty Research).
9. Dairying Abstracts (Commemorative Bureau of Dairying Research).
10. Review of Applied Geophysics (Commemorative Bureau of Geophysics).
11. Industrial Geophysics (Commemorative Bureau of Geophysics).
12. Abstracts on the Economic Aspects of Civil Engineering - see 304-305.
(1) Building Engineering (see above item 304-305).
(2) Industrial Engineering (see above item 304-305).
13. Abstracts on the Economic Aspects of Electrical Engineering in co-operation with the Institution of Electrical Engineers.
14. Abstracts on the Economic Aspects of Electronic Engineering.
15. Abstracts on the Economic Aspects of Animal Husbandry - see 304-305.
(1) Building Engineering (see above item 304-305).
(2) Industrial Engineering (see above item 304-305).
16. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
17. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
18. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
19. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
20. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
21. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
22. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
23. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
24. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
25. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
26. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
27. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
28. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
29. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
30. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
31. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
32. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
33. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
34. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
35. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
36. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
37. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
38. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
39. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
40. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
41. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
42. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
43. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
44. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
45. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
46. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.
47. Abstracts on the Economic Aspects of Animal Husbandry in co-operation with the Institution of Electrical Engineers.

* Indicate by paper in the field of as follows in the specified field.



VII.3 Visualizing Bible Cross-References - Chris Harrison and Christoph Römhild - 2008

Finding RESEARCH LITERATURE on Autism

A Comparison of Four Bibliographic Databases

1. Overlap in Database Coverage

Search results for "autism" or "autistic" in the title

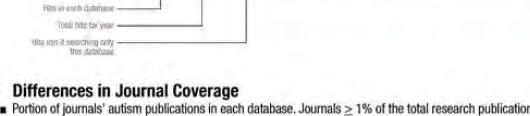
	PM	39	31	30	30
1969 -40 years	SCO	40	70	29	27
	WOS	41			
	PSY	43			

	PM	153	192	165	167
1989 -20 years	SCO	180			
	WOS	178	345		
	PSY	249	96		

	PM	220	385	265	199	276
1999 -10 years	SCO	340				
	WOS	406	605			
	PSY	329				

	PM	482	689	539	344	614
2004 -5 years	SCO	632				
	WOS	827	1171			
	PSY	557				

	PM	644	288	286	323	784
2009 As of July 1	SCO	646				
	WOS	609	932			
	PSY	148				



The four databases were compared in their coverage of the 11 journals with the most publications in Part 1. Although each database had most of the publications in these journals, there were gaps. Databases may exclude some types of publications (e.g., editorials, letters) or may have included the journal in different years.

PubMed® (PM)

Records: 19 million
Scope: Emphasis on biomedicine and health journals. Primarily MEDLINE database plus selected other records, 1949-present.

Producer: National Center for Biotechnology Information, National Library of Medicine, NIH
Selected features: Fri. Links to other NCBI resources (e.g., Entrez Gene), MeSH indexing, Automatic mapping of queries to MeSH terms and narrower concepts.

Scopus™ (SCO)

Records: 38 million
Scope: Multi-disciplinary, primarily life, health, social, and physical sciences. Journals, books, conferences, etc. back to 1823.

Producer: Elsevier
Selected features: References and citation counts (post-1996). Searches scientific web sites and patents. Proximity search. Author and affiliation identifier tools. Author details page with citations, affiliations, h-index, etc.

PsycINFO® (PSY)

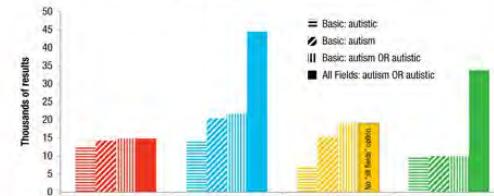
Records: 2.7 million
Scope: Psychological literature. Journals, books, dissertations, etc. 1806 to present.
Producer: American Psychological Association produces the database and Wolters Kluwer Health produces the Ovid interface.
Selected features: Mapping to thesaurus of terms. Specialized fields: test names, methods, population. Proximity search.
NB: PsycINFO is available through several vendors. The OvidSP platform was used for this analysis.

Publication Types

Books, Chapters & Conferences
Journals
Theses

3. How Search Terms Are Processed

Word variants and "Basic search"



The basic, default search in each database was used for the terms "autistic", "autism", and "autism OR autistic". The latter search was repeated in all searchable fields. Some databases search for word variations and synonyms. No field is used.

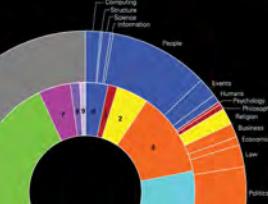
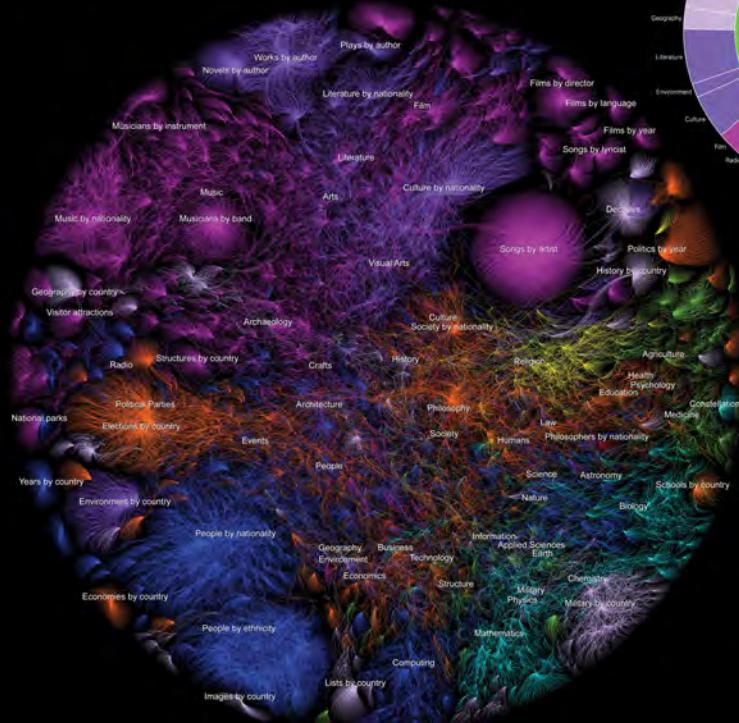
4. Conclusions

- No one database contains everything. Similar numbers of results is no indication of how similar the search results themselves are. Using multiple databases is important for doing a comprehensive search.
- Databases have different results because they include different journals, different years, and different types of publications.
- They also process a search differently, by looking in different fields or whether they automatically search for word variations and synonyms.
- Despite their differences, each database includes nearly all the journals that publish the most autism publications.
- This comparison is merely a broad overview of the content and one aspect of functionality of the databases. It cannot say which one is "best" for all purposes. Learn which resources are available to you, which tool fits which job, and how to use them.

DESIGN VS. EMERGENCE: VISUALIZATION OF KNOWLEDGE ORDERS

WIKIPEDIA'S CATEGORY STRUCTURE

The Wikipedia category structure was extracted from the January 2008 dump by Wikimedia Foundation. Wikipedia has two different types of pages: article and category pages. To lay out the main structure, we forced the directed category network (with loops) into a quasi-hierarchical, acyclic network using "Category: Main topic classifications" as a root and removing all links that do not agree with the shortest distance-to-root hierarchy. The resulting structure comprises all 234,960 categories organized up to a depth of 12 with the exception of the top-level categories. We limited the first four levels of the hierarchy consisting of 61,705 nodes and 80,314 edges. Initial network layout was calculated using GML (X-Motif) in Sci2; the final layout was rendered using the Fruchterman-Reingold layout in Gephi.

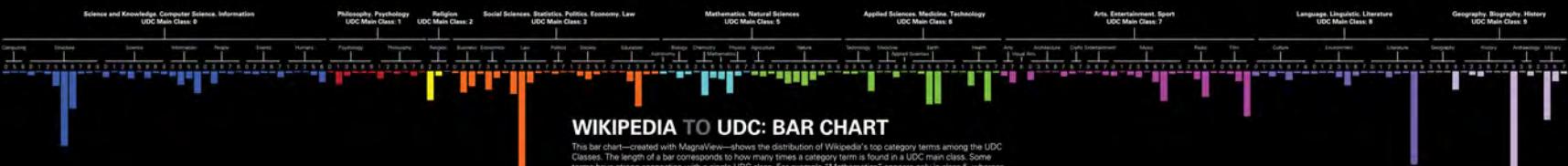
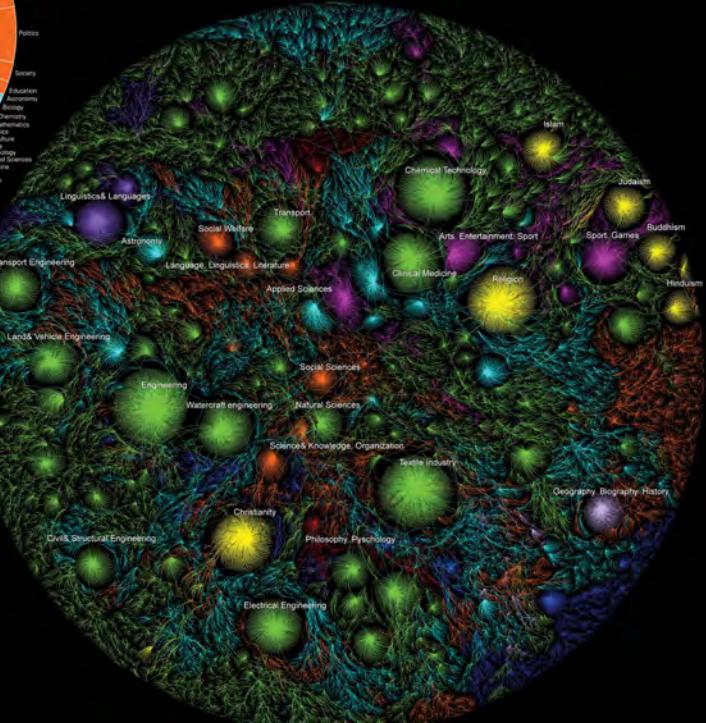


CATEGORY DISTRIBUTION OF WIKIPEDIA & UDC

This donut chart shows the distribution of the 9 UDC categories (inner ring) and the 43 top Wikipedia categories (outer ring). Wikipedia categories are further assigned to corresponding UDC classes, and the distribution is as follows: 72% of UDC categories belong to Sciences (22% Natural Sciences and 50% Applied Sciences), Wikipedia's 43 top categories, however, are distributed in a much more tailored way. The most frequent categories found under Arts, Entertainment & Sports, followed by Science, Knowledge, Organization, and Social Sciences. A large part, 17%, of Wikipedia categories are tagged as 'ambiguous'.

UNIVERSAL DECIMAL CLASSIFICATION

The UDC was created in 1935 by Paul Otlet and Henri-Marie La Fontaine in an attempt to organize all existing knowledge. The early versions of the UDC were much more balanced in the distribution of the subclasses in contrast to the version of today. Our data stems from a 2008 Master Reference File (MRF) of UDC and has a total of 68,546 classes organized in a tree layout branching out to the depth of nine, organized under nine main classes. The visualization shown here covers the whole UDC network except the auxiliaries, which consists of 55,304 nodes and 85,303 edges. Initial network layout was calculated using GML (X-Motif) in Sci2; the final layout was rendered using the Fruchterman-Reingold layout in Gephi.



WIKIPEDIA TO UDC: BAR CHART

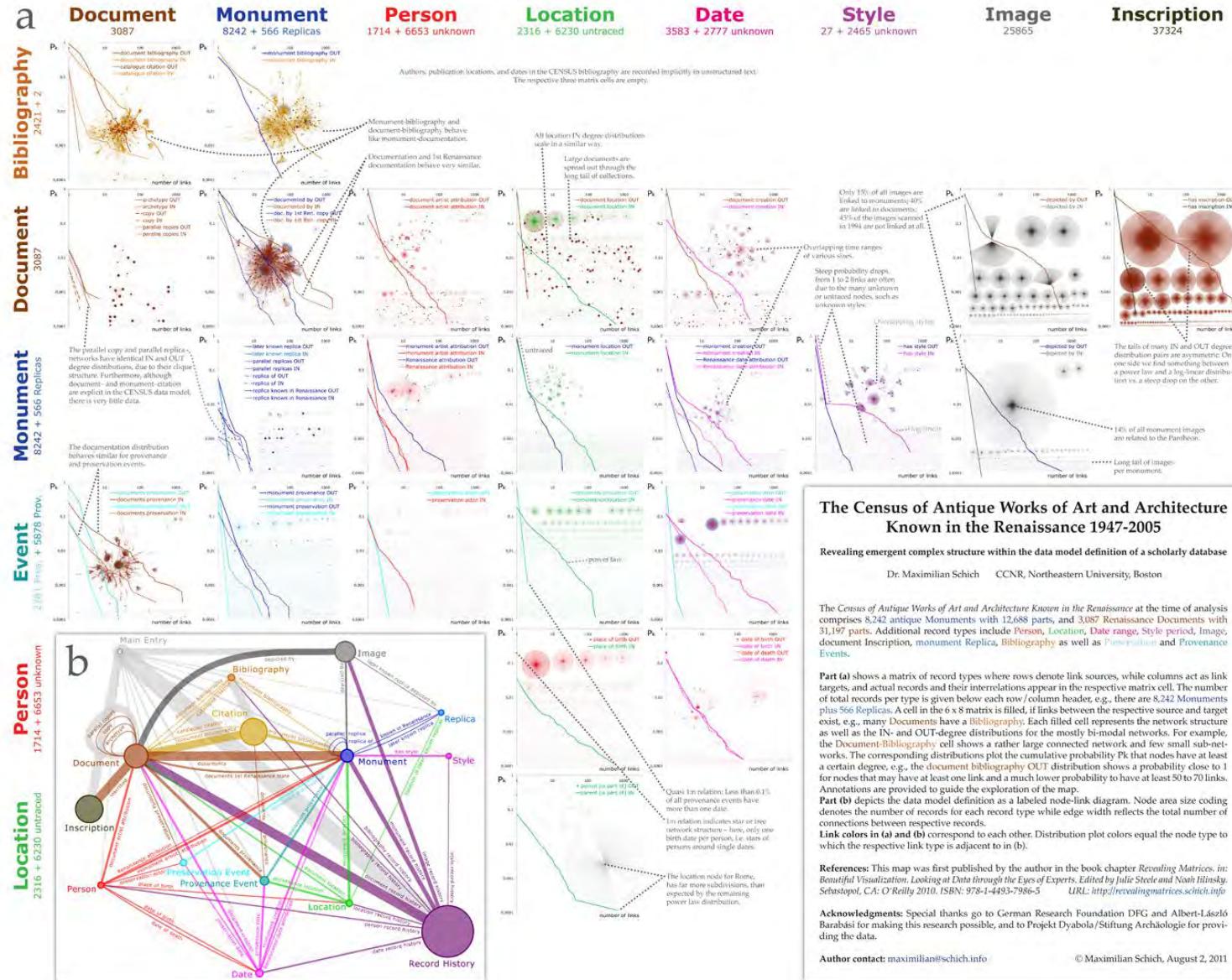
This bar chart—created with MagnaView—shows the distribution of Wikipedia's top category terms among the UDC Classes. The length of a bar corresponds to how many times a category term is found in a UDC main class. Some terms have strong connection with a single UDC class. For example "Mathematics" appears only in class 5, whereas some terms like "Nature" are distributed among 9 classes. The assignment process starts first by mapping the terms in the MRF to the corresponding UDC classes. Then we verify the assignment for each term by inspecting the context in Wikipedia category names, and third by inspecting the context of terms through close reading. To this end, we have located Wikipedia's top category terms in the MRF's expansion table, and verified that they match contextually. Each one of the 43 top categories of Wikipedia is mapped to one UDC class only, and not to multiple classes.

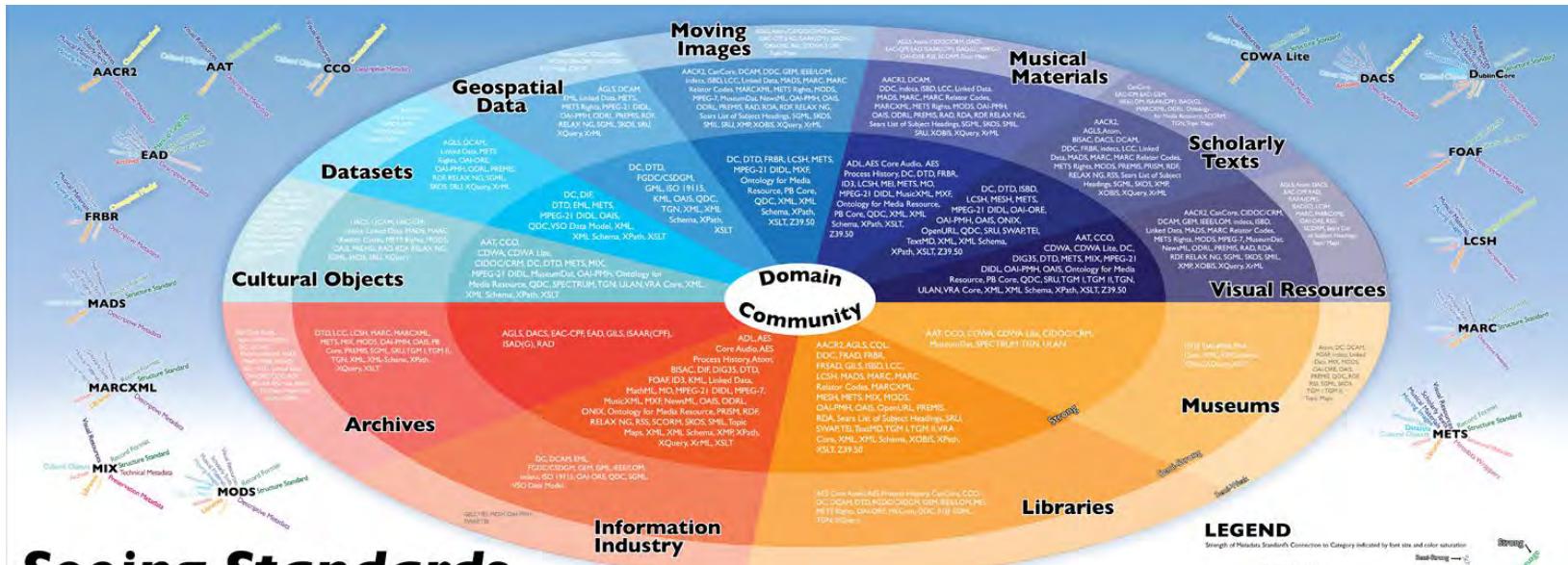
VII.5 Design vs. Emergence: Visualization of Knowledge Orders

Map of Scientific Collaborations from 2005-2009



Computed Using Data from Elsevier's Scopus

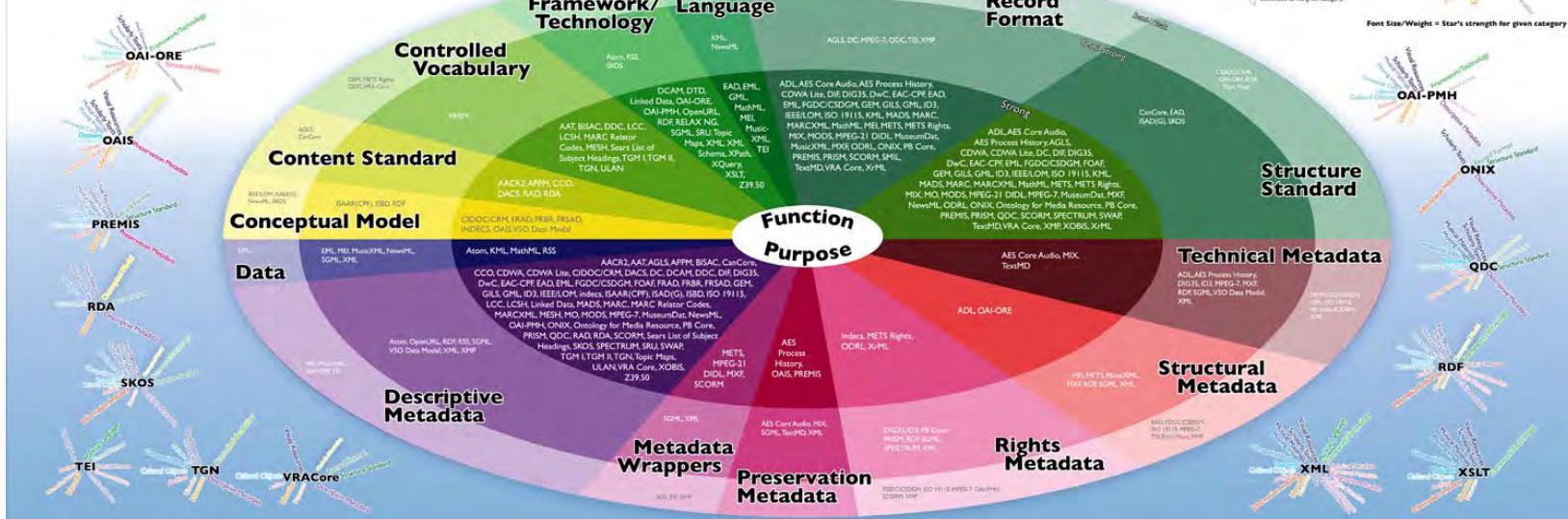




Seeing Standards

A Visualization of the Metadata Universe

Content: Jenn Riley | Design: Devin Becker



MACE

Metadata for
Architectural Contents
in Europe

TAXONOMY

This visualization reveals the structure and usage patterns of a classification taxonomy.

It is developed and used in the MACE project, which aims at providing better access to digital resources for teaching and learning about architecture.

The diagram shows the structure of the vocabulary used for tagging resources. Currently, it comprises over 2800 concepts, many of which have labels in German, English, Spanish, French, and other languages.

The layout is based on the radial layout mechanism introduced in [1], and provides a birds-eye view of the whole taxonomy tree, with the root placed at the center of the graphic, and each path to the outside representing one "route of specialization".

Accordingly, we can see how the vocabulary is organized in broad categories like *Technical Design*, *Conceptual Design*, or *Theories and Concepts* closer to the center, which contain multiple levels of sub-categories located on rings on the periphery.

In addition, circle overlays indicate the number of resources tagged with the respective term (or any child term), providing hints about the usage patterns of the taxonomy. The exact number of resources for some selected concepts can be found below the text label.

<http://www.mace-project.eu>

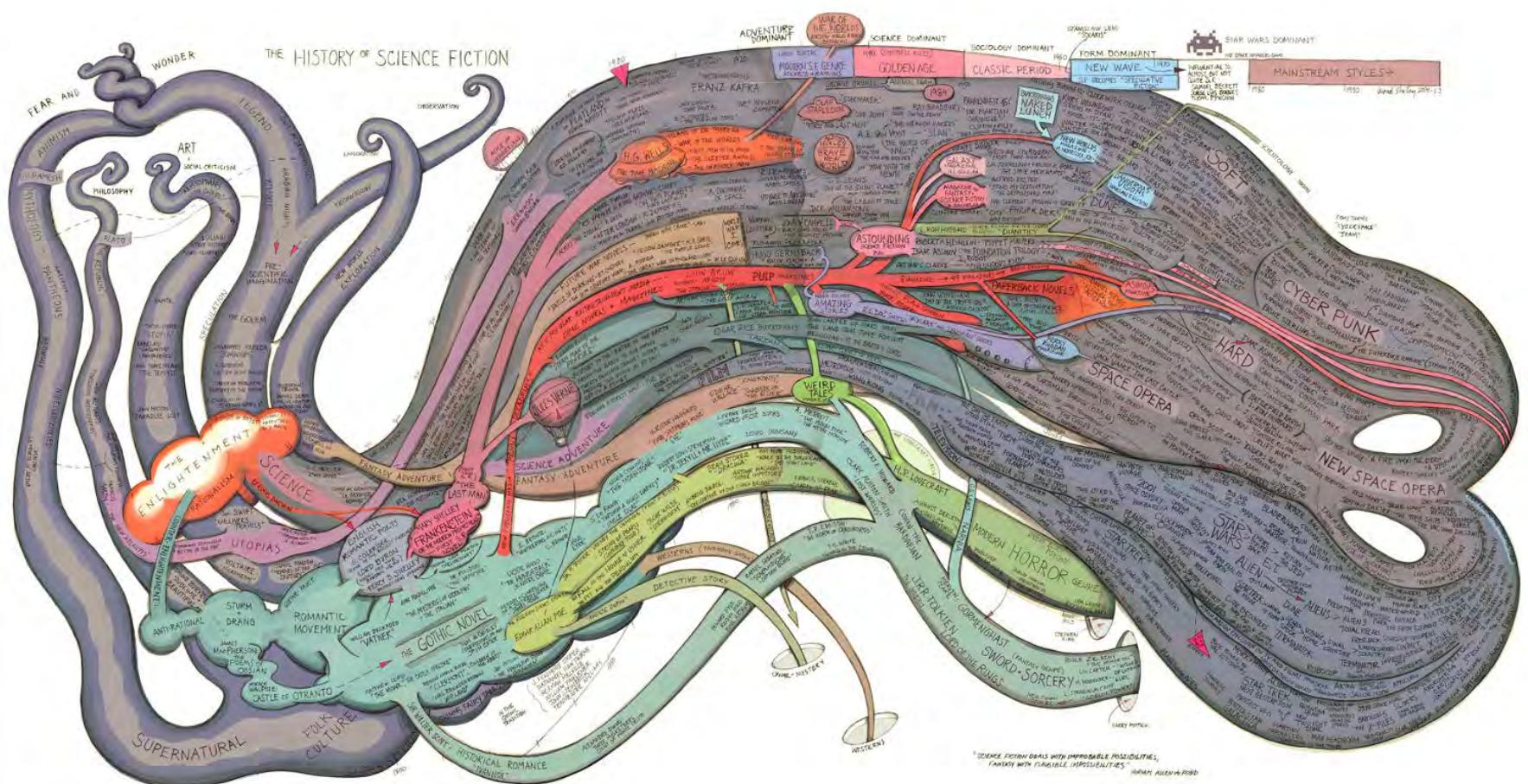
[1] Yee, K-P., Fisher, D., Dhamija, R. and Hearst, M. (2001) *Animated exploration of dynamic graphs with radial layout*, IEEE Symposium on Information Visualization, INFOVIS'01, San Diego, USA, pp.43–50.

Thanks to the MACE team for compiling the taxonomy and providing the technical infrastructure as well as the MACE users for providing the metadata.

The MACE project was co-funded by the European commission under contract number ECP 2005 EDU 038098 in the eContentplus programme.

Visualization designed and developed by
Moritz Stefaner (<http://moritz.stefaner.eu>)
while working at the Interaction Design Lab, FH Potsdam





VII.10 History of Science Fiction - Ward Shelley - 2011

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[facebook.com/mappingscience](https://www.facebook.com/mappingscience)

Iteration VIII (2012)

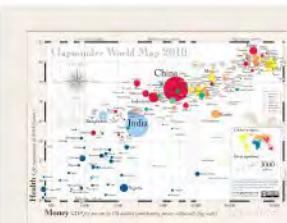
Science Maps for Kids



VIII.1



VIII.3



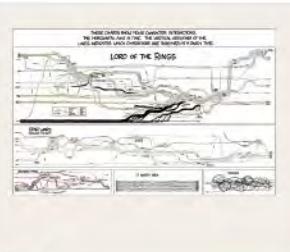
VIII.5



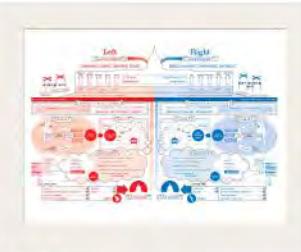
VIII.7



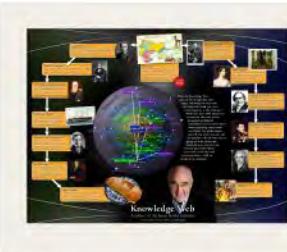
VIII.9



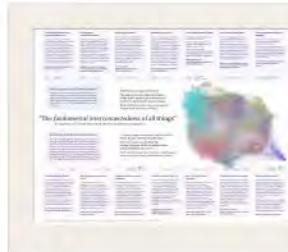
VIII.2



VIII.4



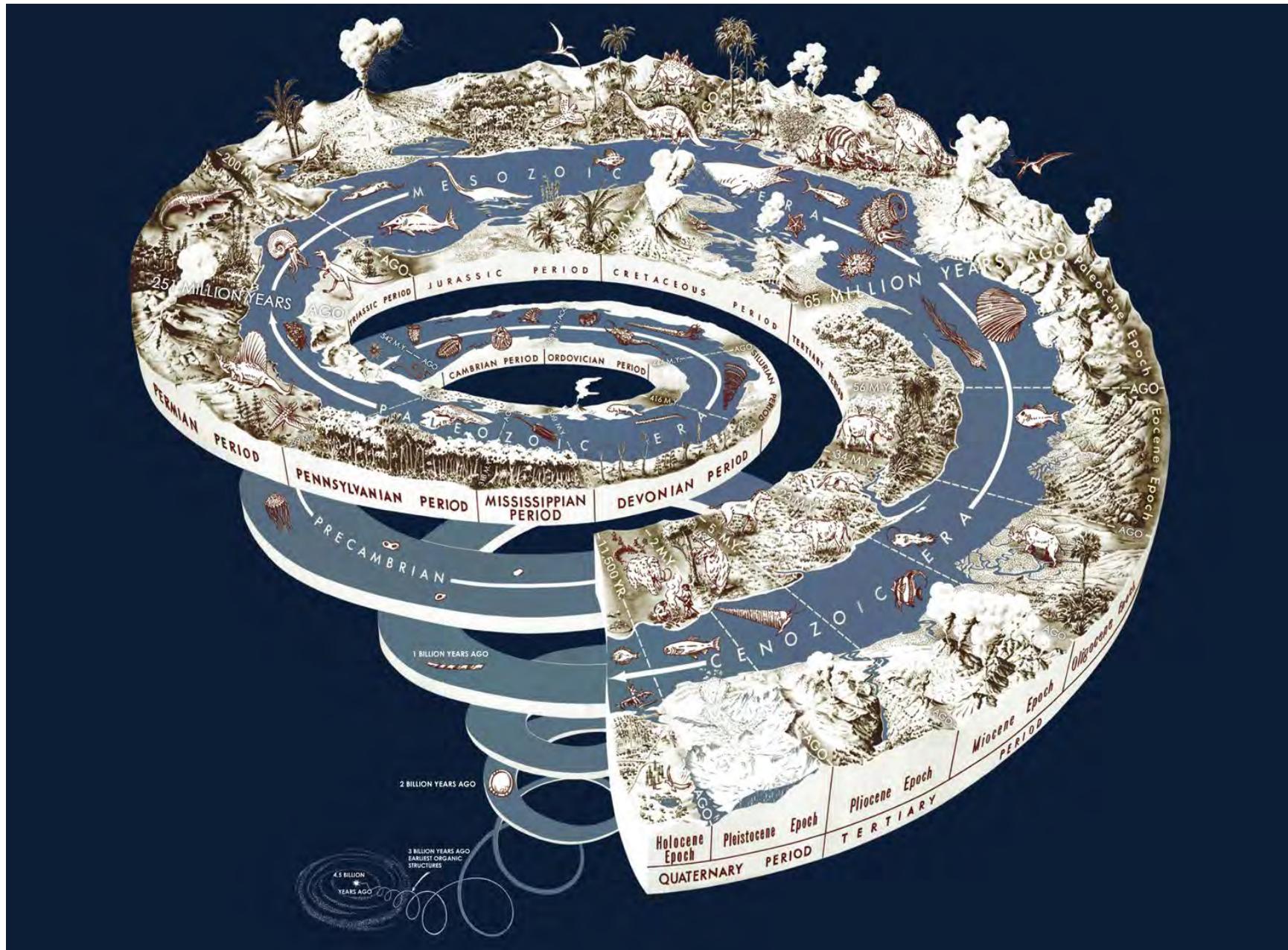
VIII.6



VIII.8



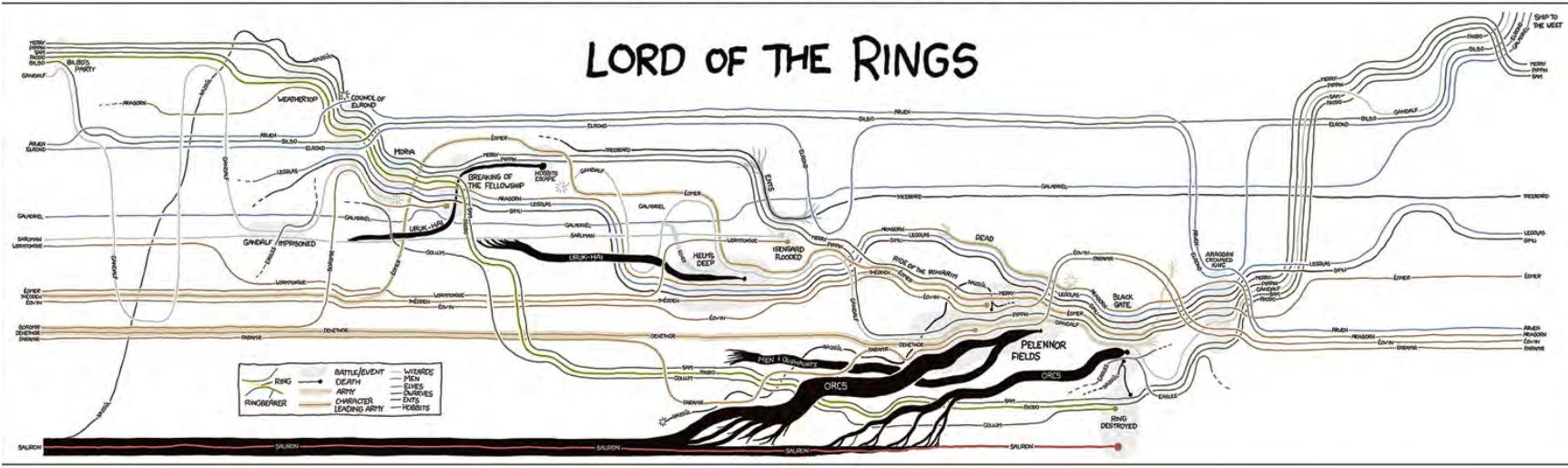
VIII.10



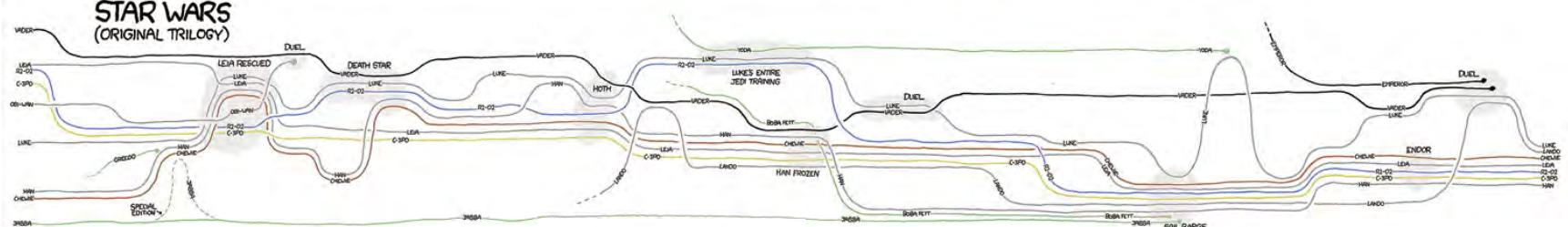
VIII.1 Geologic Time Spiral: A Path to the Past - Joseph Graham, William Newman, and John Stacy - 2008

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.

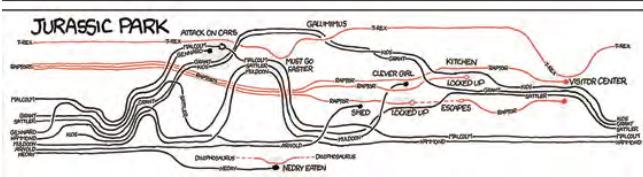
LORD OF THE RINGS



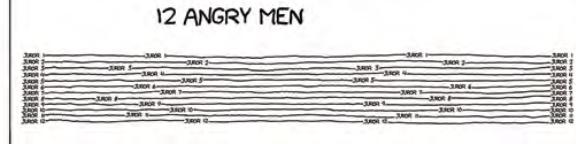
STAR WARS (ORIGINAL TRILOGY)



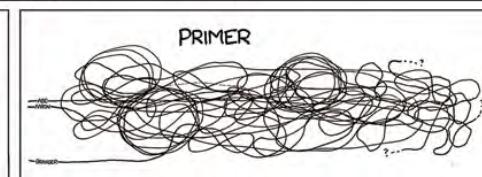
JURASSIC PARK



12 ANGRY MEN



PRIMER





discover the Met with us!

**you don't have to see everything in one day...
you can visit the Museum again and again!**

imagine yourself in another time and place

find what suits you best

be part of the big picture!

thank you for not eating in the galleries

Central Park

1 First Floor

2 Second Floor

see the art in a new way!

start your journey!

uncover treasures from around the world

remember—no flash photography!

Central Park

Modern and Contemporary Art (mezzanine)

Modern and Contemporary Art

Arts of Africa, Oceania, and the Americas

Greek and Roman Art

Ruth and Harold D. Urs Center for Education (ground floor)

Fifth Avenue

hungry? take these stairs or elevators to the cafeteria (ground floor)

Robert Lehman Collection

European Sculpture and Decorative Arts

Medieval Art

European Sculpture and Decorative Arts

Arms and Armor

The Temple of Dendur in The Sackler Wing

Egyptian Art

The Costume Institute (closed for renovations) (ground floor)

Great Hall

Met Store

Art of the Arab Lands, Turkey, Iran, Central Asia, and Later South Asia

Ancient Near Eastern Art

Asian Art

18th- and Early 20th-Century European Paintings and Sculpture

Drawings, Prints, and Photographs

Musical Instruments

The American Wing (mezzanine)

The American Wing

Modern and Contemporary Art

European Paintings

Greek and Roman Art

Art of the Arab Lands, Turkey, Iran, Central Asia, and Later South Asia

Ancient Near Eastern Art

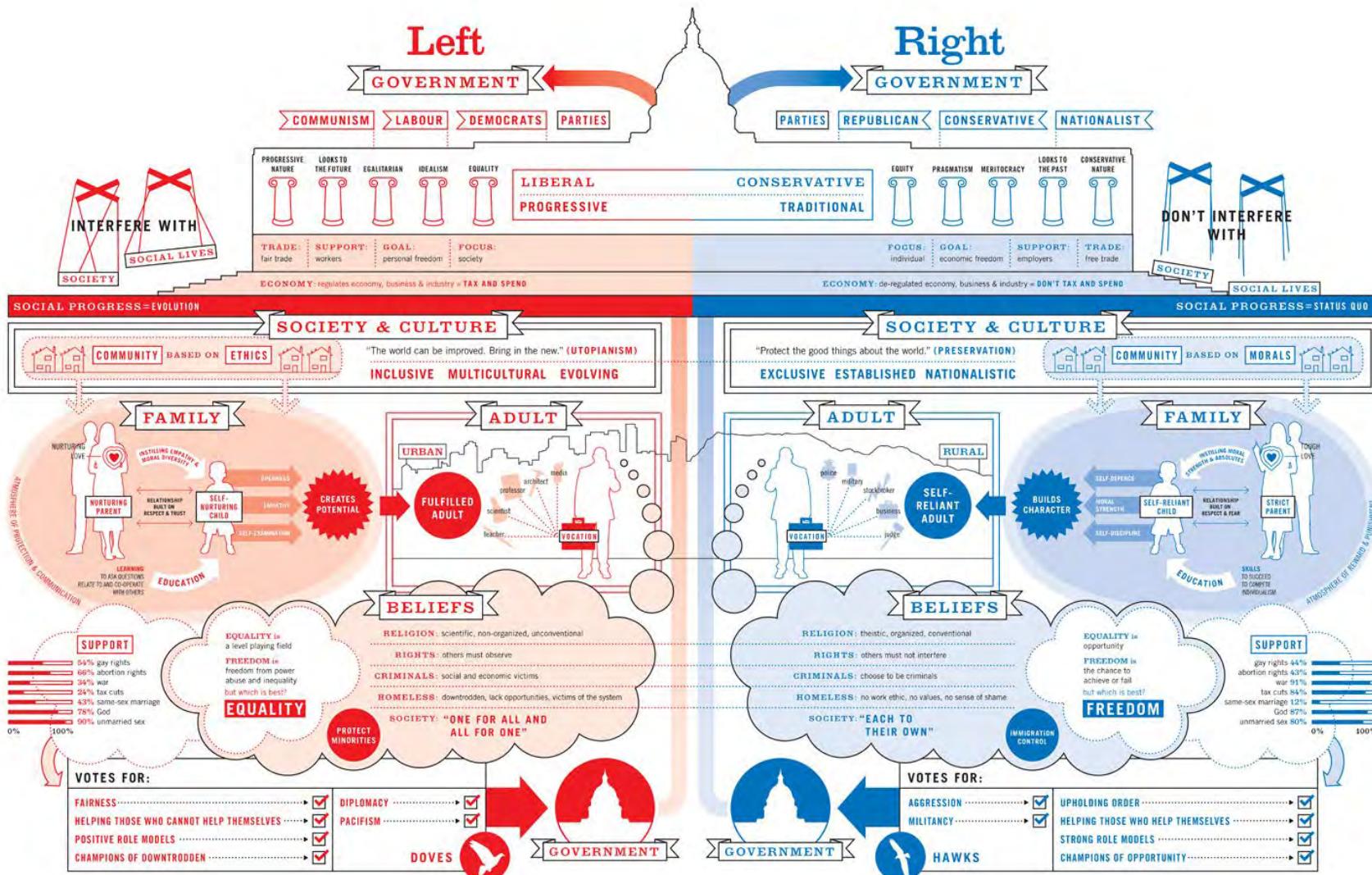
Asian Art

remind the grown-ups—please don't touch the art!

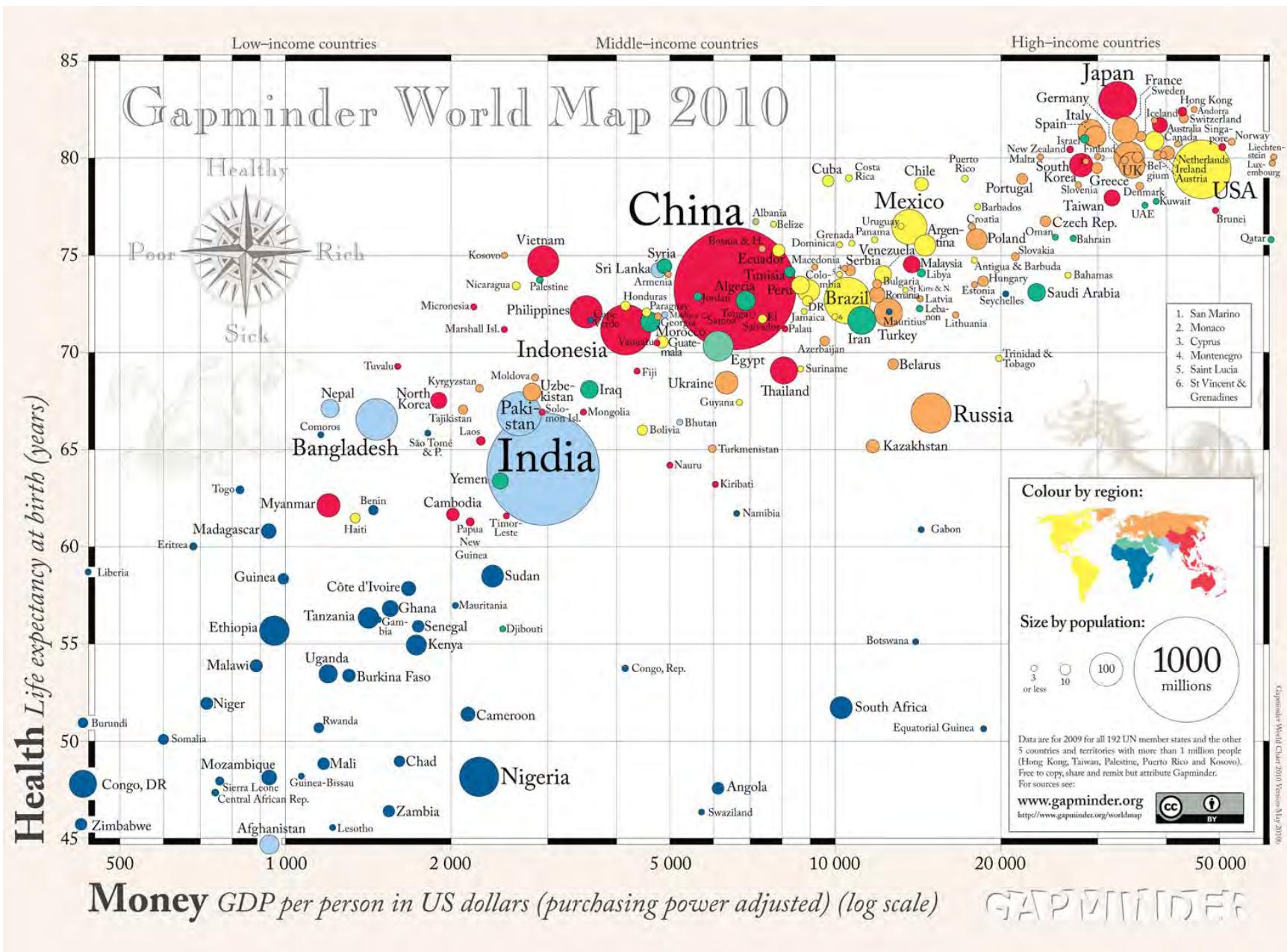
reach a higher state of mind

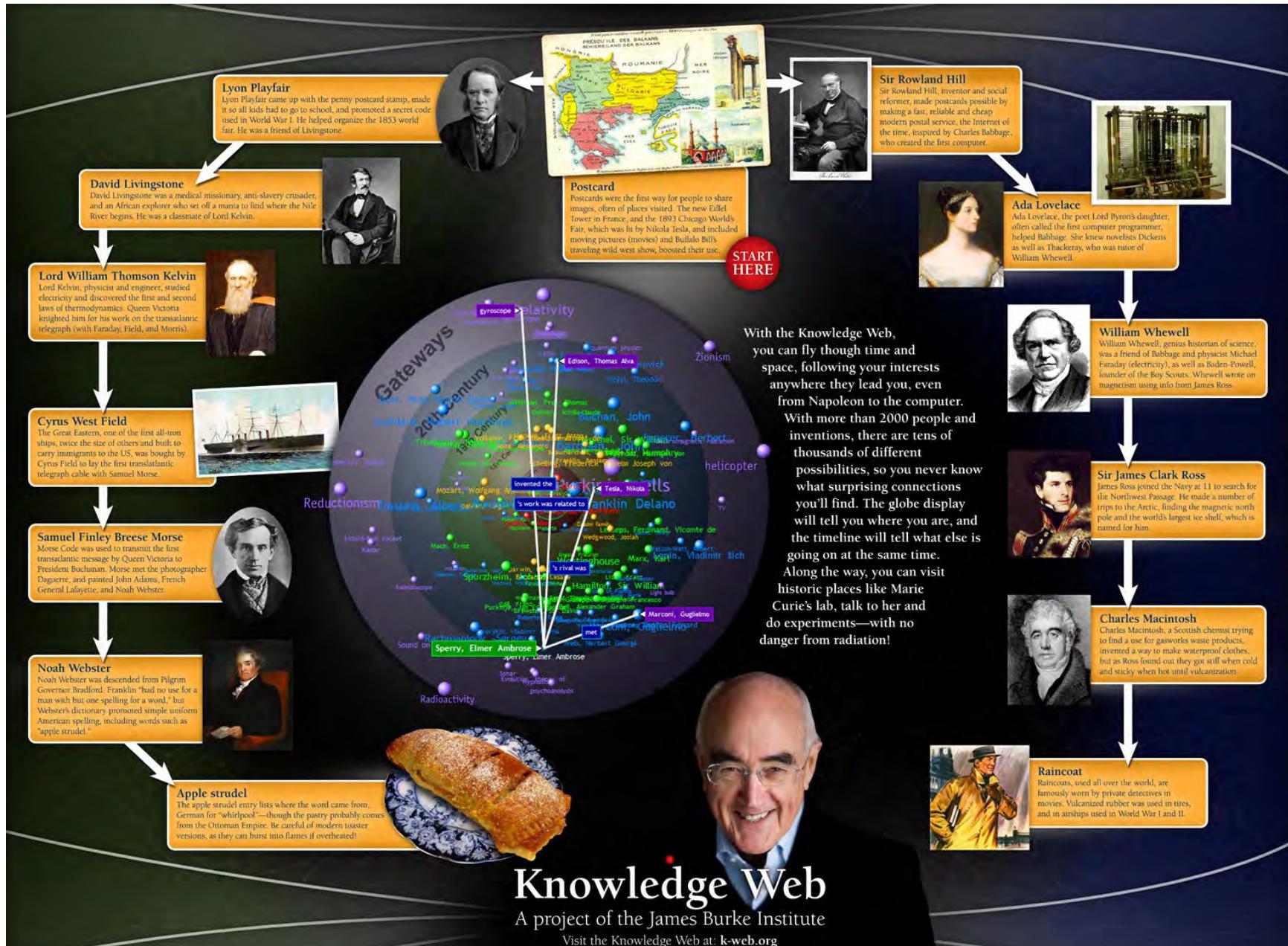
learn stories that bring the art to life!

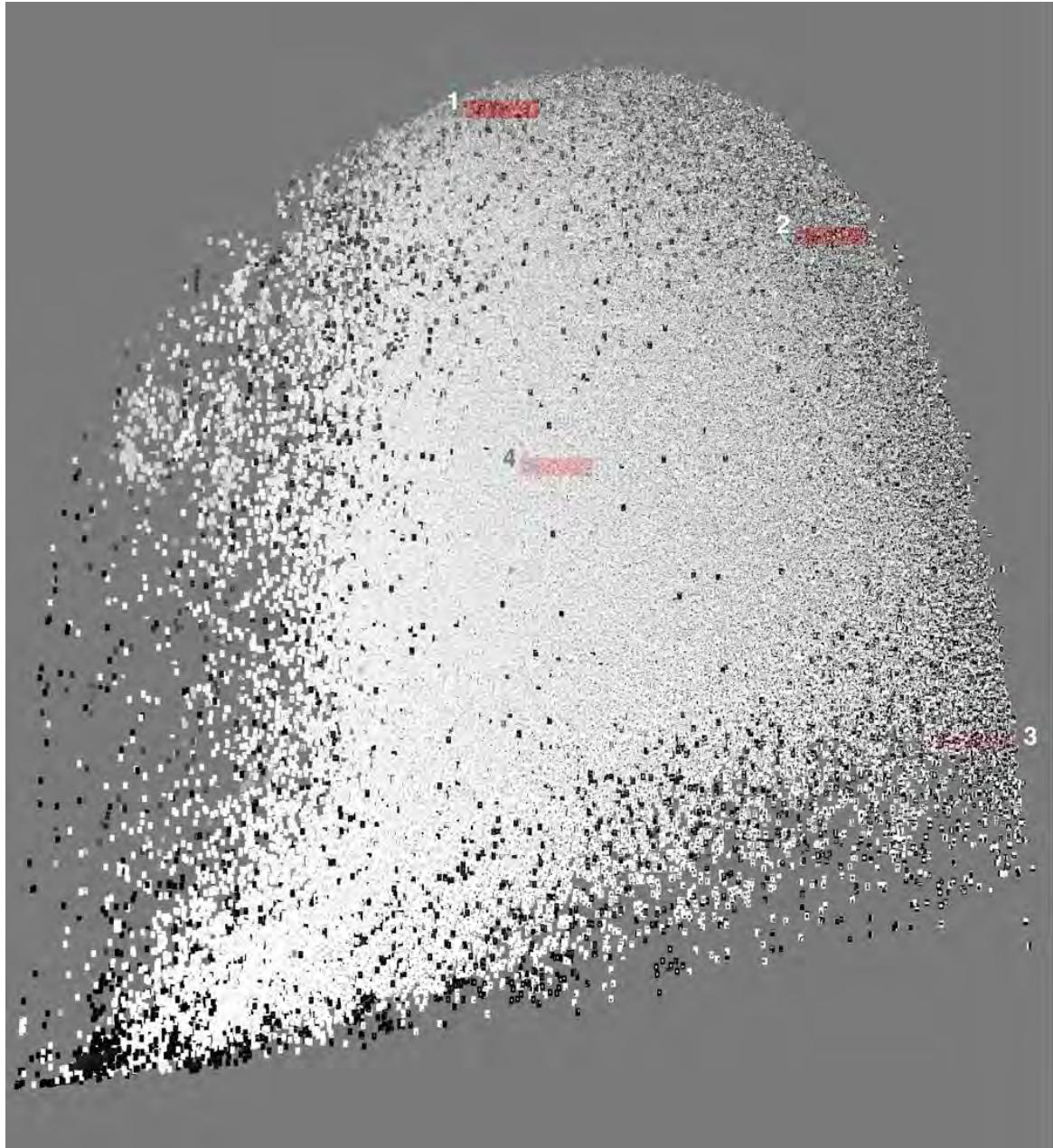
Information **Wheelchair accessible**
Elevator **Coat check** **Water fountain**
Escalator **Dining** **Restrooms**
First aid **Changing tables**



VIII.4 Left vs. Right Political Spectrum - David McCandless and Stefanie Posavec - 2009







MANGA UNIVERSE

883 Series

62,172 Chapters

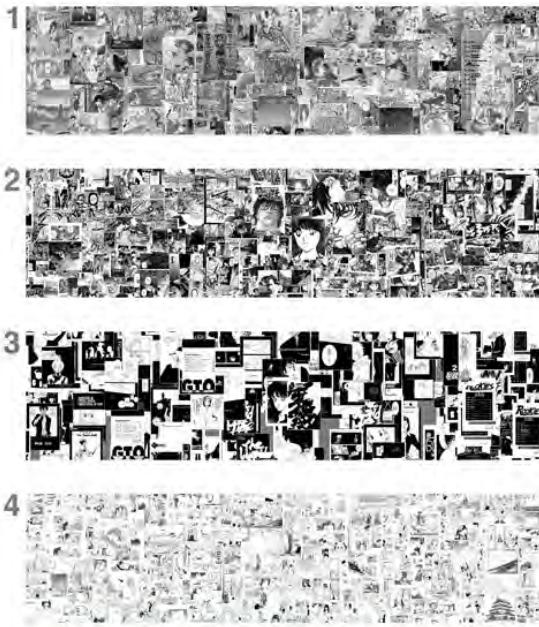
1,074,790 Pages

The digitization of cultural artifacts and the rise of social media create unprecedented opportunities for the study of visual culture. But how can we explore patterns and relationships between sets of photographs, designs, or videos—which may number in hundreds of thousands, millions, or billions? In 2007, we set up the Software Studies Initiative (www.softwarestudies.com) at University of California, San Diego (UCSD) and California Institute for Telecommunications and Information (Calit2) to address these challenges.

In fall 2009, we downloaded all pages of 883 different manga series from CloudManga.com, the most popular web site for “acanthions,” which refer to manga publications that are digitized and translated by fans. The resulting data set contains 1,074,790 manga pages. Each page is in the form of a JPEG image; average image resolution is 350 x 1150 pixels. The complete image set is 100 GB.

The map on the left shows the complete set of over one million pages organized according to contrast (mangaatla.atlas) and amount of detail and texture (vertical axis).

The pages in the lower left of the map consist of a small number of Tef areas, with minimum detail and no texture. The pages situated in the top part have lots of detail and texture. Pages with the lowest contrast are on the extreme left; pages with highest contrast are on the extreme right.



In between the four graphical extremes corresponding to the left, right, top, and bottom edges of the page “atlas” are one practically infinite graphic variations. The density of this map suggests that the concept of style as it is normally used may become problematic when we consider very large cultural data sets. The concept assumes that we can partition a set of works into small meaningful categories. However, when we consider a large set of variations, such categories become problematic and attempt to divide this space into discrete stylistic categories will be arbitrary. It is important to keep in mind that this map only shows graphic variations along two dimensions—mapping other visual characteristics such as composition or representation or characters and their faces might split the cloud into distinct clusters.

This map also shows which graphical choices are more commonly used by manga artists (the central part of the cloud of pages) and which appear much more rarely (bottom and left parts). If you are a beginning manga artist and want to establish a unique style, this map can help you to do so in either bottom or left parts of the map, which so far have not been explored by other artists. To see other visualizations and read papers about the CloudManga.org project, visit www.academicales.com.

Credits: Lev Manovich, Jay Chow.

Can we teach ourselves to react in a certain way?

To show that reflexes can be learned, Ivan Petrovich (also known as Pavlov) rang a bell and then fed his dog. He noted that the dog salivated when it saw the food. He repeated this, and then when he rang the bell without food, the dog salivated automatically. This means that Pavlov had taught his dog a new reflex. Maybe this means that people can learn new reflexes too, and for instance teach themselves not to be scared in the dark anymore.

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

Can we make a copy of ourselves?

In 1996, 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 orchid or a genetically engineered animal — for instance, sheep have been engineered to produce human insulin. Someone might want to replace lost or deceased family pets, or repopulate 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?

Ham, a chimp, was not the first animal to travel into space, but he was the first with a mission. He had received training before going on board to how to push a button as quickly as possible. (If he did well, he could eat his banana.) Ham 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 on 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 Turtle around 1831 from the Galápagos Islands and brought her with him to England. For 100 years or so, Harriet was thought to be a male turtle and was called Harry. At the time of Darwin's visit, Harriet would have been as big as a dinner plate. She 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 wash every morning, and was on a vegetarian celery-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. Andre Geim 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 this 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, roars, sighs, and high-pitched squeals that may last up to 10 minutes or longer.

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

NEUROSCIENCE
PSYCHOLOGY

MOLECULAR BIOLOGY

PHYSICS AND ASTRONOMY

BIOLOGICAL SCIENCES

BIOCHEMISTRY
CHEMISTRY
MATHEMATICS SCIENCE
PHYSICS

NEUROSCIENCE:
BIOLOGICAL SCIENCES

BIOLOGICAL SCIENCES:
EARTH SCIENCE
PHYSICS

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?

"The fundamental interconnectedness of all things"

An exploration of related themes from different disciplinary perspectives.

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.

PHYSICS

ENGINEERING

IMMUNOLOGY
PHARMACOLOGY
MICROBIOLOGY

CHEMISTRY

MATERIALS SCIENCE

IMMUNOLOGY
PHARMACOLOGY
MICROBIOLOGY

Why do things fall down?

Sir 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 LeBaron Spencer was an engineer. At his work, there was a magnetron, a machine that produces microwaves. Microwaves are invisible electric 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 pharmacologist. He was not very good at cleaning up: his laboratory was quite messy. One day in 1928, as 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 the drink was made from. It was a cold night, cold enough for water to freeze into ice.

Over night, the drink turned to ice, trapping the wooden stirrer: the popsicle was created. Ice lollies are made of frozen liquid, often water and fruit juice.

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

What are ice lollies made of?

In 1905, a popular drink was a soda prepared by stirring powder into water. One day, an 11 year old boy called Frank Epperson prepared a drink with a stirrer 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 wooden stirrer: the popsicle was created. Ice lollies are made of frozen liquid, often water and fruit juice.

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 smallpox into the boy, but the boy did not get ill: he had been vaccinated.

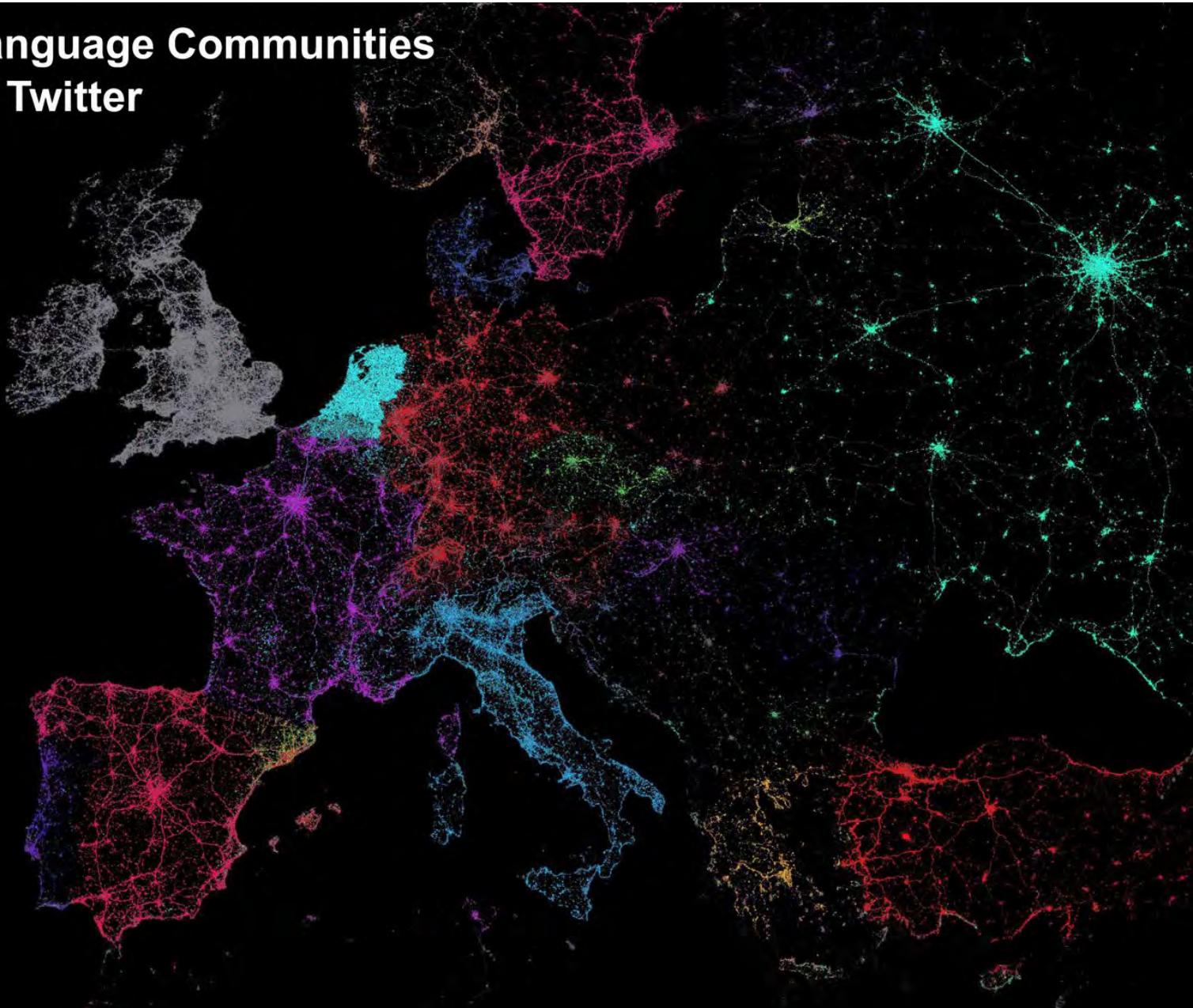
Nowadays, vaccination protects people from many diseases. It is usually done with a syringe containing a small amount of substance similar to the disease: our bodies learn from this how to recognize and fight the disease.

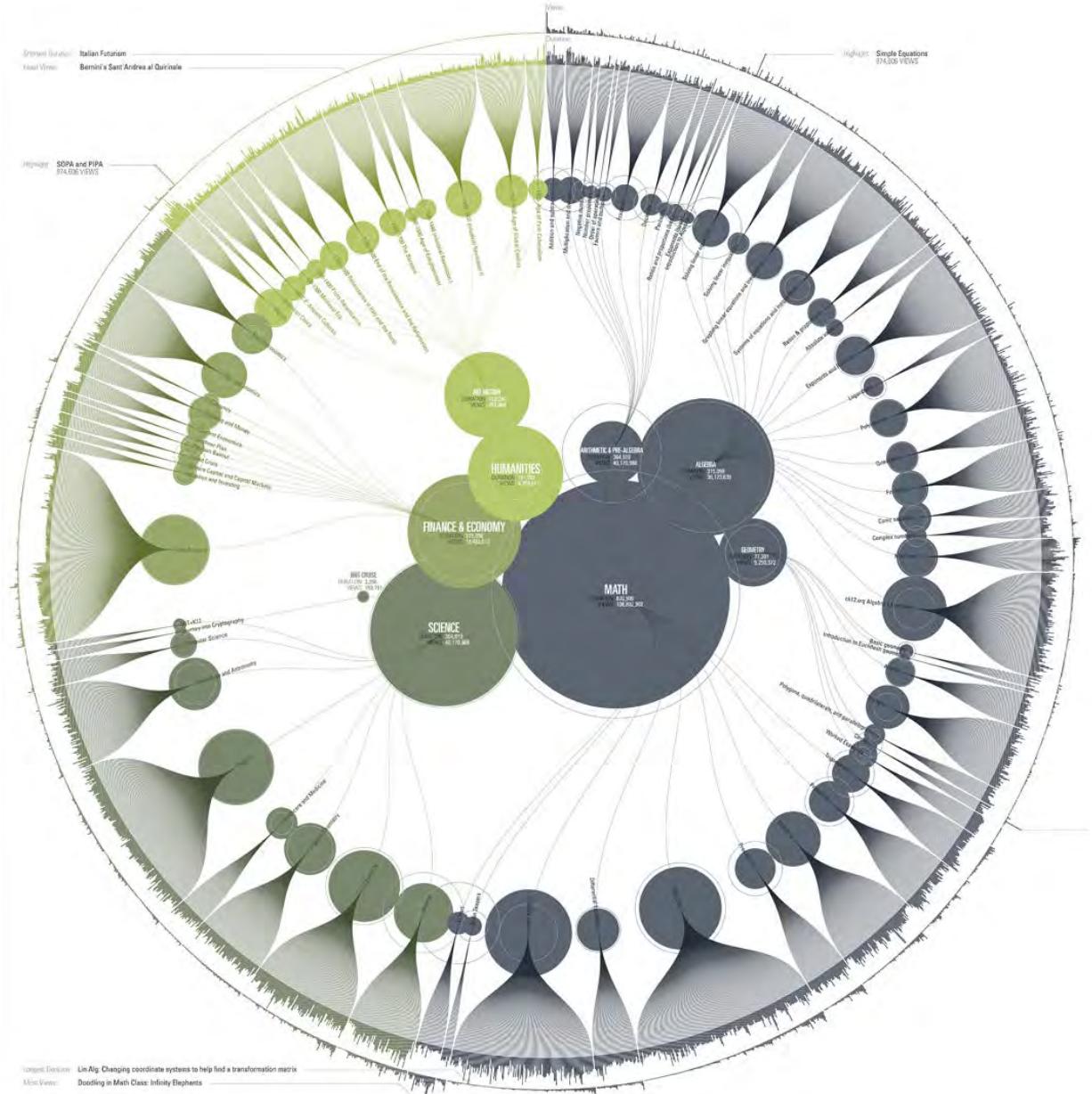
Have you had any vaccinations?



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





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-schooled, 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
LECTURES **445**
HOURS OF VIDEO **170**
MILLION VIEWS



ABOUT THE VISUALIZATION

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

HOW TO READ THE VISUALIZATION

Total Amount of Views (Relative to maximum views)
Total Duration of Videos (Relative to maximum minutes)

ABOUT THE AUTHOR

This visualization was designed and developed by Benjamin Wiederkehr with the support of Jérôme Cukier.

<http://interactivedesigns.com>

ABOUT THE DATA

The data that drives this visualization was collected using the official API provided by Khan Academy on May 13th, 2012.

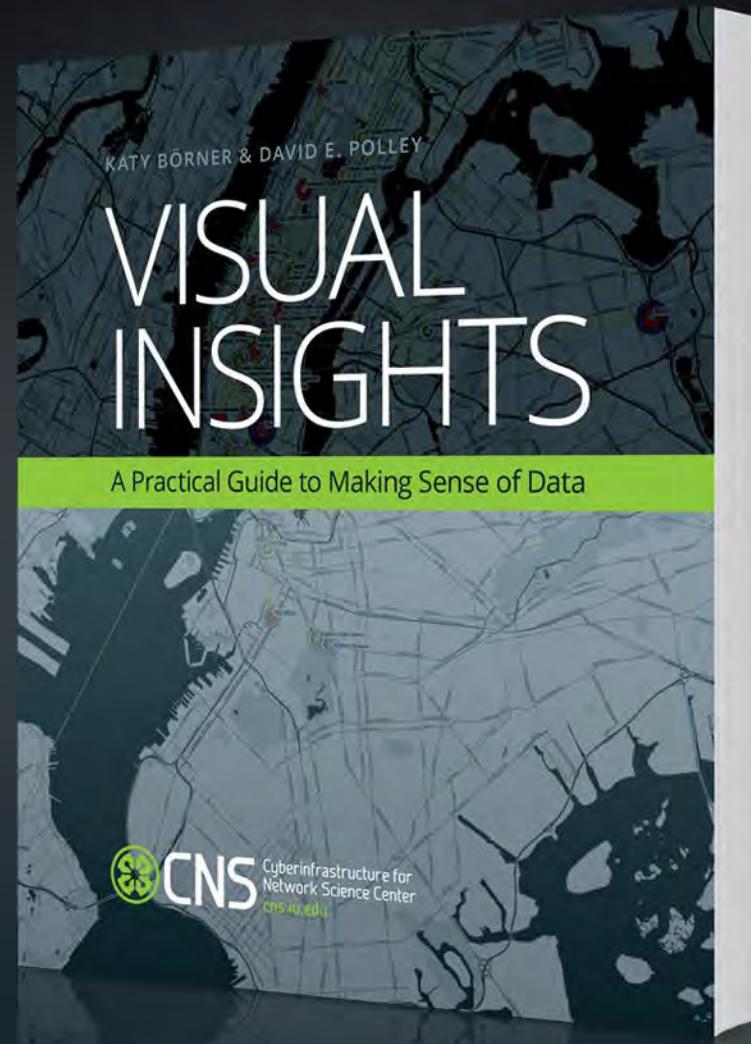
<https://github.com/khan>

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

Iteration IX (2013)

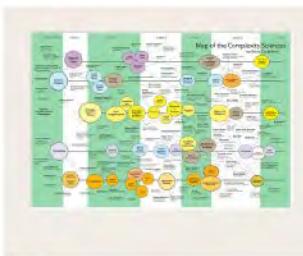
Science Maps Showing Trends and Dynamics



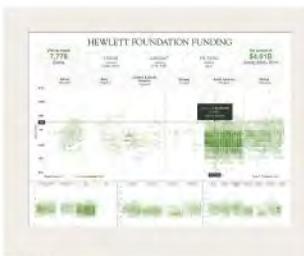
IX.1



IX.3



IX.5



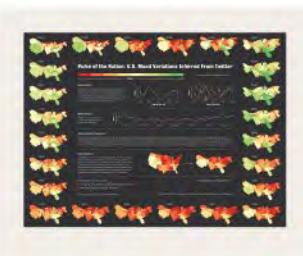
IX.7



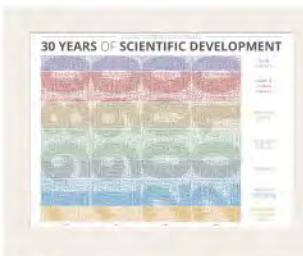
IX.9



IX.2



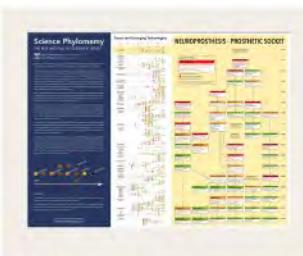
IX.4



IX.6

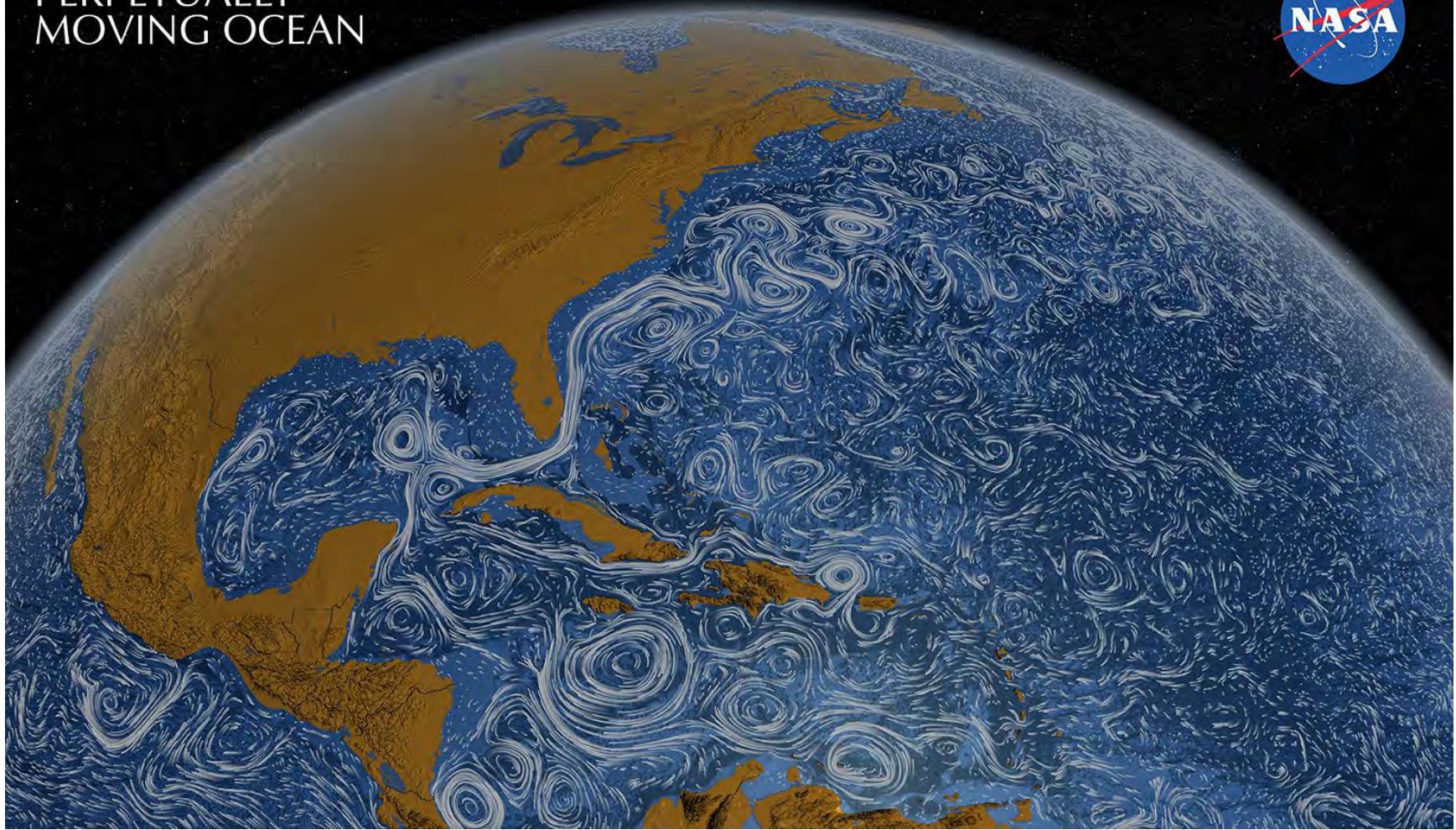


IX.8



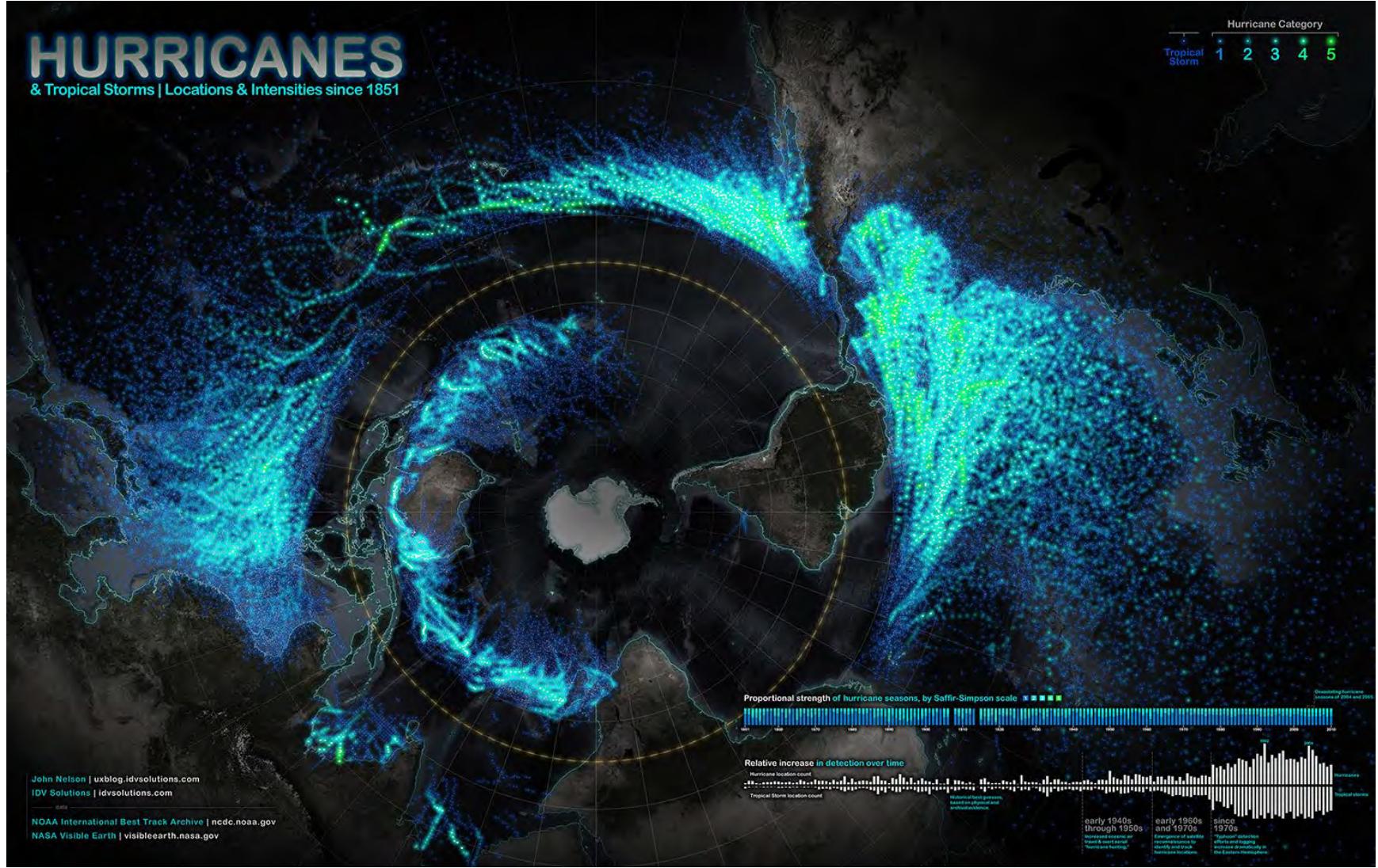
IX.10

NASA VIEWS OUR
PERPETUALLY
MOVING OCEAN



HURRICANES

& Tropical Storms | Locations & Intensities since 1851



STATE OF THE POLAR BEAR

AN EXPLORATION OF CURRENT POPULATION, HABITAT AND THREAT INFORMATION FOR THE WORLD'S POLAR BEARS

EXPLORE:

SUB-POPULATIONS

NATIONS

ECOREGIONS

TREND:

INCREASING DECLINING
STABLE DATA DEFICIENT

19 population units of polar bears, called subpopulations, are recognized throughout the circumpolar Arctic by the Polar Bear Specialist Group (PBSG 2010a).

Genetic studies have shown that polar bears from the various subpopulations are genetically similar (Paetkau et al. 1999), and there is no evidence that any of the groups have been evolutionary separated for significant periods of time. Consequently, the rate of genetic exchange is such that these "units" cannot be considered as real populations in an evolutionary sense.

REFERENCES

O'bbrick, M., G.W. Thiemann, E. Peacock, and T. DeBruyn, eds. 2010. Proceedings of the 15th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 29 June-3 July 2009, Copenhagen, Denmark. Gland, Switzerland: IUCN.

Paetkau, D., S.C. Amstrup, E.W. Born, W. Calvert, A.E. Derocher, G.W. Garner, F. Messier, I. Stirling, M.K. Taylor, O. Wiig, and C. Strobeck. 1999. "Genetic Structure of the World's Polar Bear Populations." *Molecular Ecology* 8 (10): 1571-1584.

LANCASTER SOUND

Study Date: 1998
EST. POPULATION: 2,541
PBSG STATUS: Data Deficient
RISK OF DECLINE: High

TREND
 DECREASING POPULATION

STATE OF THE POLAR BEAR

AN EXPLORATION OF CURRENT POPULATION, HABITAT AND THREAT INFORMATION FOR THE WORLD'S POLAR BEARS

NORTHERN BEAUFORT SEA

Country of Jurisdiction: Canada

ESTIMATED POPULATION:

1,000

SURVEY TYPE: Mark-Recapture Study

RESEARCH INSTITUTE: Environment Canada

YEAR: 2011

TREND:

STABLE

STATUS:

Not Reduced

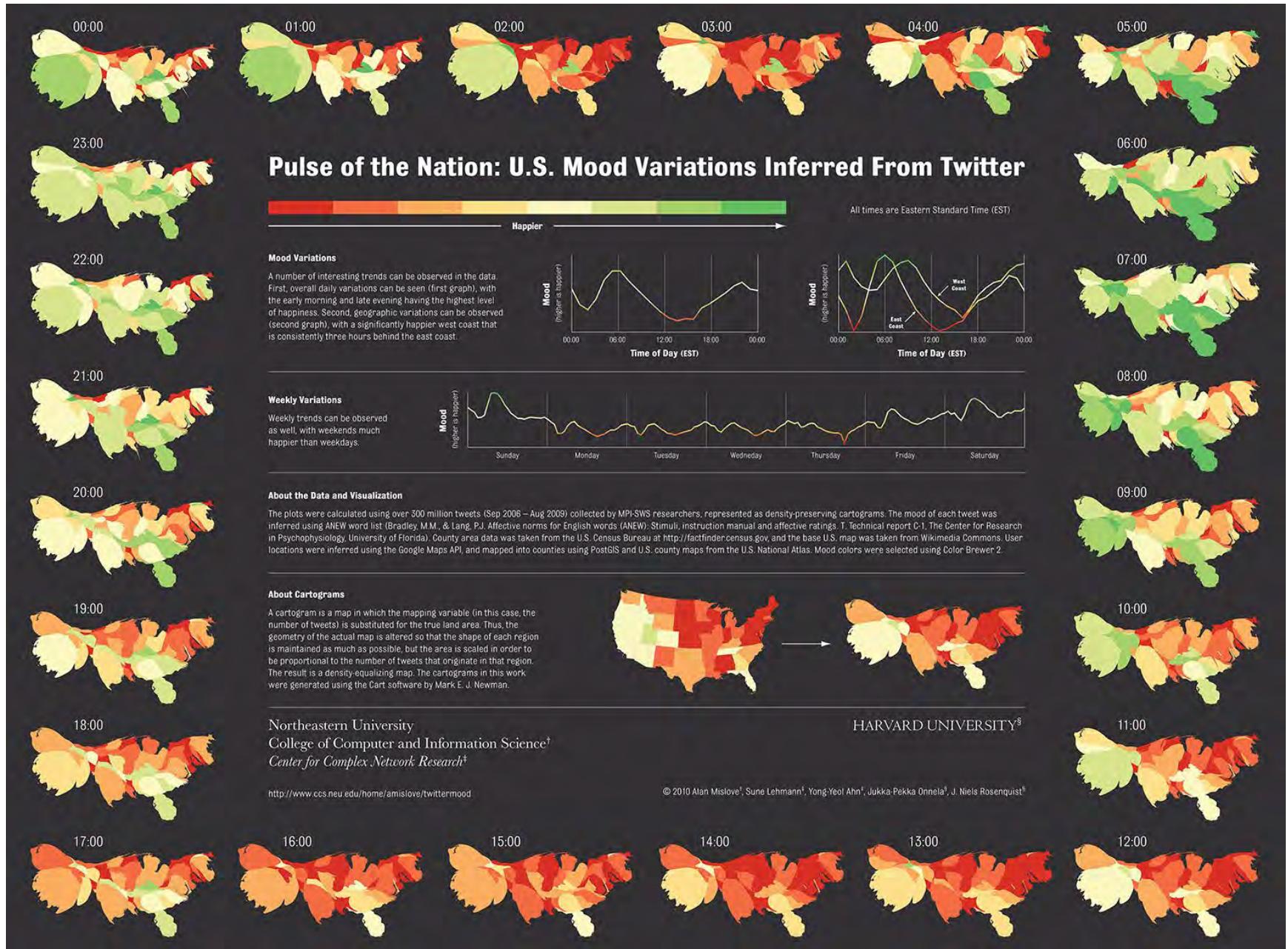
RISK OF DECLINE:

Data Deficient

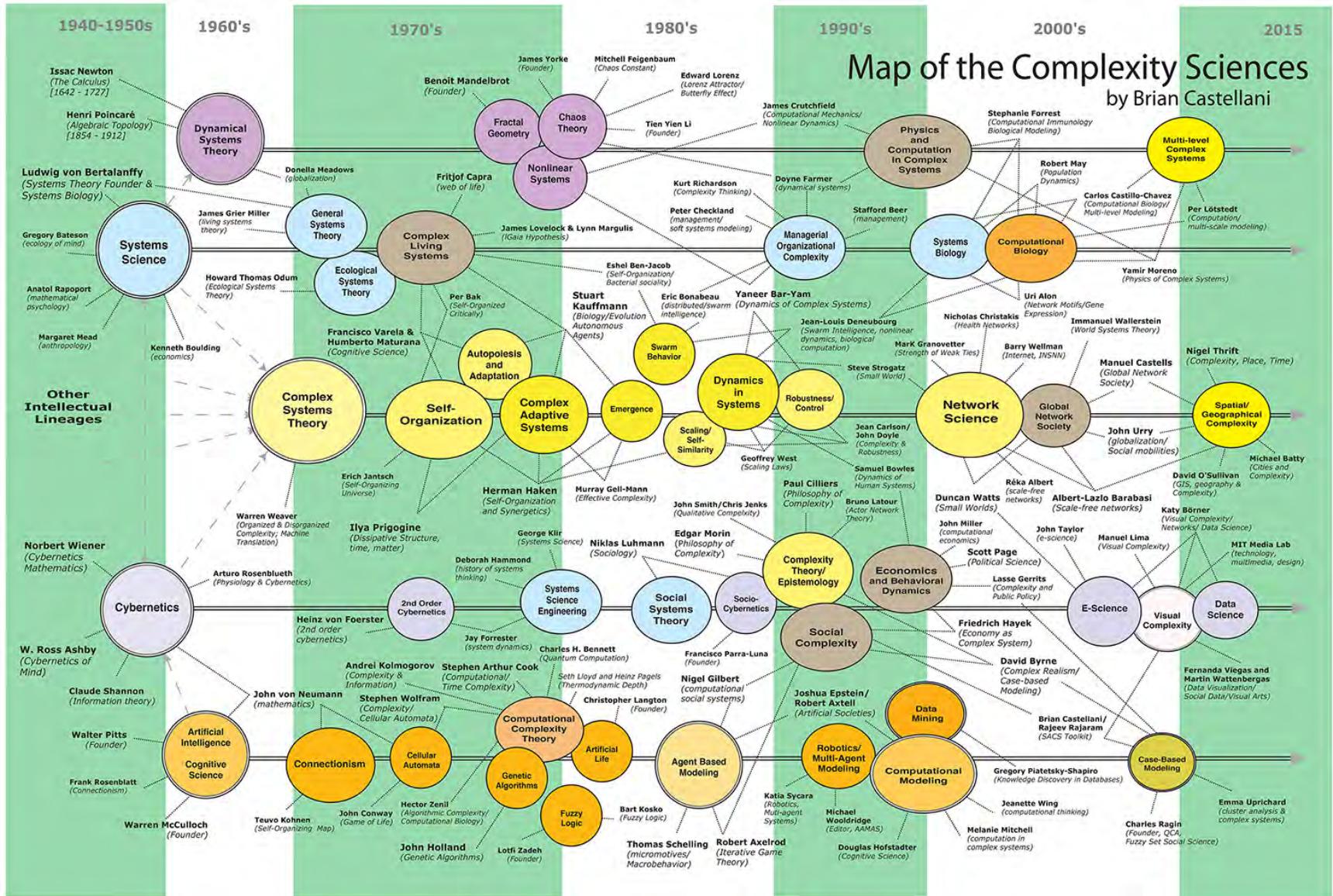
EXPLORER

HABITAT

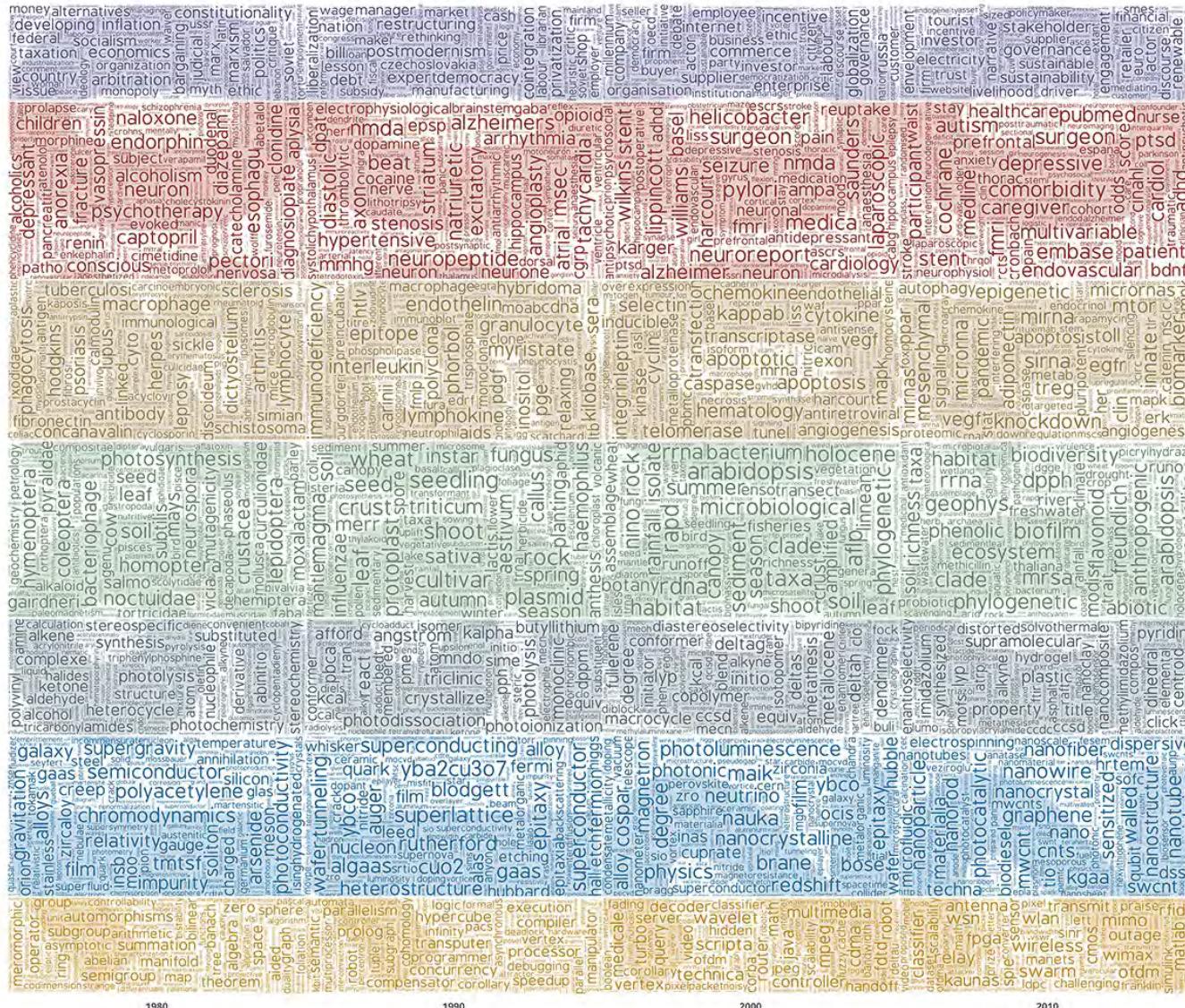
MAP



Map of the Complexity Sciences by Brian Castellani



30 YEARS OF SCIENTIFIC DEVELOPMENT



HEWLETT FOUNDATION FUNDING

We've made
7,778
grants

YEARS
viewing
(2000-2013)

AMOUNT
viewing
(\$1K - \$1B)

FILTERS
viewing
(ALL)

for a total of
\$4.01B
during 2000 - 2013



IX.7 The Hewlett Foundation Grant Visualizer

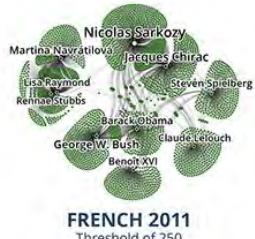
Dino Citraro, Kim Rees, Jacob O'Brien, Brett Johnson, Andrew Winterman, and Andrew Witherspoon - 2013

Who Really Matters in the World

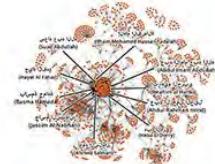
LEADERSHIP NETWORKS IN DIFFERENT-LANGUAGE WIKIPEDIAS



CHINESE 2011
Threshold of 30



FRENCH 2011
Threshold of 250



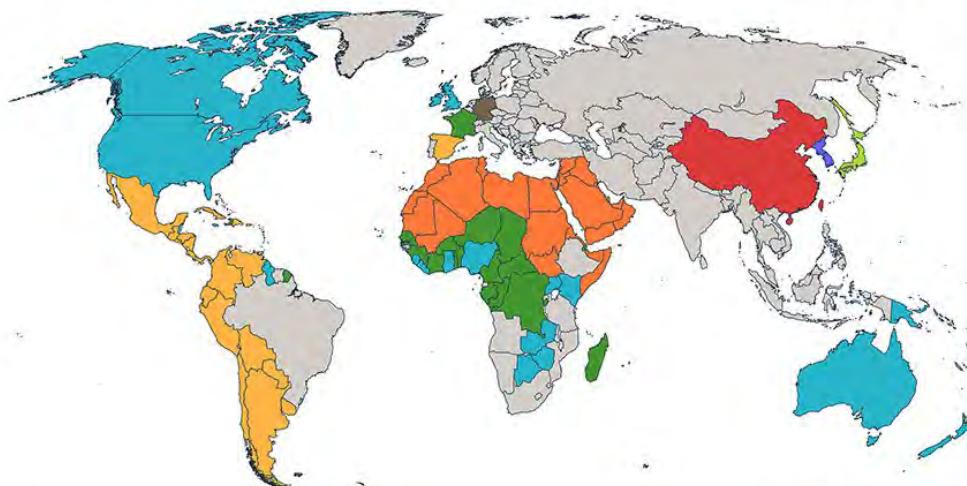
ARABIC 2011
Threshold of 10



KOREAN 2011
Threshold of 10



ENGLISH 2003
Threshold of 10



Shown are the networks of living people and their friendship, business, and animosity links retrieved from eight different-language Wikipedias. Network nodes, geospatial regions in which the languages are spoken, and the tabular listing of the number of living people in 2011 are color-coded. The networks show living people interconnection for eight different languages. Because the size of the complete networks was too large, different thresholds were applied (see numbers on map). Native language names and English translations are listed for key people nodes. Different networks have rather different global and local structures revealing the (dis)connectedness of politicians, musicians, athletes, and others. The lower five figures showcase the evolution of the English network between 2003-2011. For example, the U.S. President Barack Obama node becomes dominant when he is elected in 2009 and shows a major increase in importance in 2011, providing a near real-time window into current history and culture through the lens of Wikipedians.

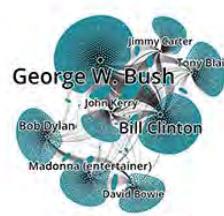
Largest node:
3240 links

Median node:
1553 links

Smallest node:
1 link



ENGLISH 2005
Threshold of 30



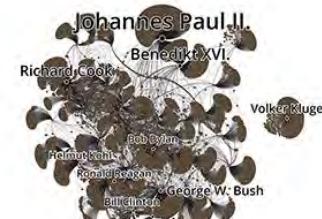
ENGLISH 2007
Threshold of 300

Color	Language, Year	# of Living People Articles	# of Articles	Ratio
Blue	English, 2003	3,409	109,000	3.13%
Dark Blue	English, 2005	38,996	464,000	8.40%
Medium Blue	English, 2007	193,058	1,600,000	12.07%
Cyan	English, 2009	348,552	2,700,000	12.91%
Light Blue	English, 2011	467,340	3,500,000	13.35%
Brown	German, 2011	194,043	1,200,000	16.2%
Green	French, 2011	126,053	1,100,000	11.5%
Light Green	Japanese, 2011	102,082	742,000	13.8%
Orange	Spanish, 2011	41,827	728,000	5.7%
Red	Chinese, 2011	23,963	339,000	7.1%
Purple	Korean, 2011	5,379	158,000	3.4%
Yellow	Arabic, 2011	15,921	171,744	9.27%

ENGLISH 2009
Threshold of 500



ENGLISH 2009
Threshold of 500



GERMAN 2011
Threshold of 150



JAPANESE 2011
Threshold of 150



SPANISH 2011
Threshold of 50



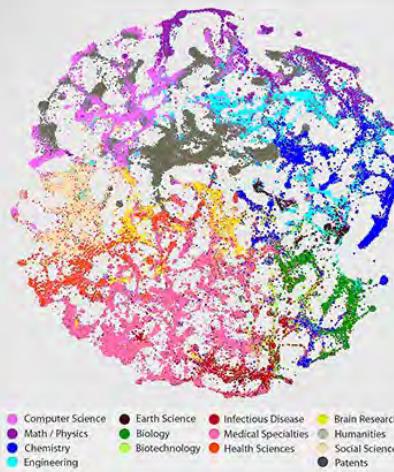
ENGLISH 2011
Threshold of 500

IDENTIFYING EMERGING TOPICS IN SCIENCE AND TECHNOLOGY

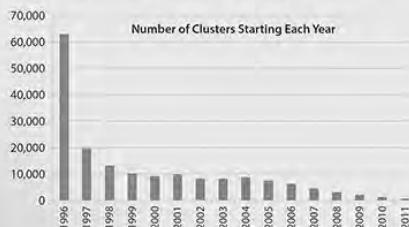
(finding the needles in the haystack)

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.

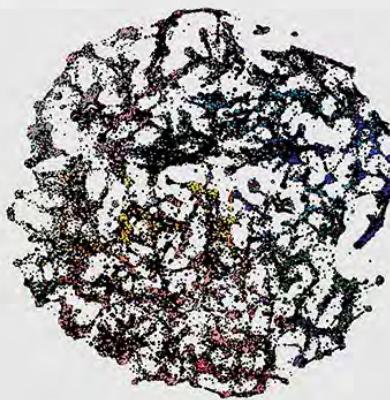
Step 1: Map All of Science and Technology



The map above was created using a combination of direct citation and text mining. First, 20 million articles from Scopus were clustered using direct citation links and the new modularity-based clustering methodology from Waltman & van Eck at Leiden University. Second, 3 million patents from the USPTO were clustered using the same direct citation method. Third, a BM25 text similarity was computed between all clusters, whether articles or patents. Using this text similarity, clusters were positioned relative to each other in the map above. Each of the 149,611 article clusters is colored based on the journals that comprise the cluster. The 27,114 patent clusters are colored gray.



Step 2:
Burn Off the Straw

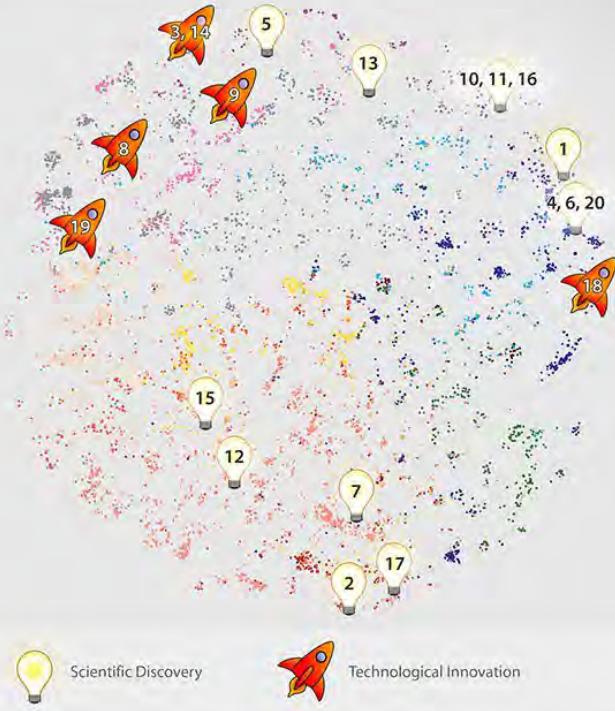


Most of the clusters in the direct citation map are very old (71%), having started a decade or more ago. Another 25% are in their prime, starting between 2002-2007. Emerging topics are, by definition, very new. In the map above, all clusters starting in 2007 or earlier have been blackened, or burned off. The 4% of clusters retaining their original color are those that began in 2008 or later and are still active.

To determine which of these clusters are most emergent, we further filter these clusters to those whose articles are also in new clusters in our co-citation model of science (not shown). Clusters are then ranked using a growth index. The locations of the top-20 emerging clusters for the year 2010 based on the growth index are shown in the map to the right. Emerging clusters can continue to be emergent in additional years if their growth characteristics are strong enough.

Interestingly, some emerging topics are based on scientific discoveries while others spring from technological innovation. Scientific discoveries are those where a new or unexpected finding is made or fundamental knowledge is gained. Technological innovations are those where existing science or technology is used to create new devices or capabilities that serve specific purposes. For the top-20 emerging areas in 2010, roughly one third of them (6) are based on technological innovations. The remainder are based on scientific discoveries.

Step 3: Highlight the BRIGHTEST Needles



Top-20 Emerging Topics in 2010

- | | |
|---|---|
| 1 – iron-based superconductors | 11 – zigzag graphene nanoribbons |
| 2 – swine flu (H1N1) pandemic | 12 – cardiovascular events in type 2 diabetes |
| 3 – spectrum sensing in cognitive radio | 13 – transformative optics |
| 4 – graphene nanosheets and nanocomposites | 14 – spectrum allocation in cognitive radio |
| 5 – Horava-Lifshitz quantum gravity | 15 – IDH1 and IDH2 mutations in cancer |
| 6 – graphene oxide nanosheets | 16 – epitaxial graphene |
| 7 – induced pluripotent stem cells | 17 – H1N1 pandemic and seasonal flu |
| 8 – MapReduce framework | 18 – crystallographic validation |
| 9 – signal recovery from compressed sensing | 19 – social tagging |
| 10 – graphene transistors and optical devices | 20 – mechanical properties of graphene |

Science Phylomemy

THE RISE AND FALL OF SCIENTIFIC FIELDS

 David Chavalarias (CAMS/SC-PIF, CNRS - EHESS)
Jean-Philippe Cointet (INRA-Sen/ISC-PIF)

Phylomemies are based on the analysis of the textual content of publications. They describe how the scientific fields evolve and provide a convenient model to investigate science evolution.

The map opposite has been generated by applying the methodology of phylomemy reconstruction to the domain of Future and Emerging Technologies (FET), defined by the FET Open funding scheme (7th Framework Program of the European Union - EU FP7). We considered all the keyword terms given by authors of projects submitted to FET Open in 2010 (>4000 in total) to delineate the vocabulary associated with FET. These terms have been indexed in the titles and abstracts of a representative sample of worldwide literature, dating from 1990 to 2010 (Thomson Web of Science, >32M publications). Using thematic proximity based on co-occurrence, terms were clustered to identify fields of scientific research.

Each scientific field was then represented by a set of terms. Inter-temporal matching between thematic fields results in evolving branches of science that might show several kinds of transformations: fields can gain new terms or lose terms, merge with another field, split or even die—if the underlying scientific community loses its thematic cohesion.

Exemplarily shown on the right are all branches in the domain of FET—from Neuroprosthetics: Prosthetic Socket on top to Active Circuits, Quantum Metrology on bottom. The evolution of the branches, i.e., changes in the number and composition of their scientific fields—is plotted from left to right. A close-up of the Neuroprosthetics: Prosthetic Socket field is given on the far right. Here, time runs top down and each scientific field has a title and associated keywords that are color and size coded by importance.

The main events in this branch are well recounted: the emergence of new terms as well as the branching and merging events correspond to important steps in the development of this science such as seminal papers, first clinical trials, etc. Nomadic concepts that migrate from one scientific field to another can be identified. Notice the increase of the branch width when the discipline starts to have commercial applications.

The study of science phylomemies might pave the way towards prediction of science evolution. Indeed, Chavalarias & Cointet [1] used two biomedical datasets (embryology science and networks) to demonstrate that fields do not emerge, decline, or hybridize at random: the likelihood of observing dynamic events strongly depends on the structural properties of the fields, such as the density index introduced by Callon et al. in 1991 [2]. The probability that a scientific field will decline increases drastically as its density decreases—low density fields are more than twice as likely to decline than high-density ones.

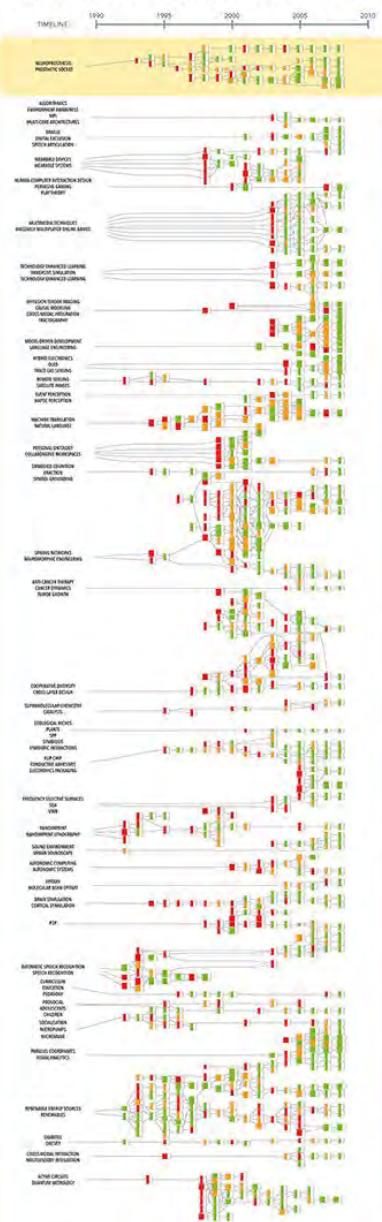


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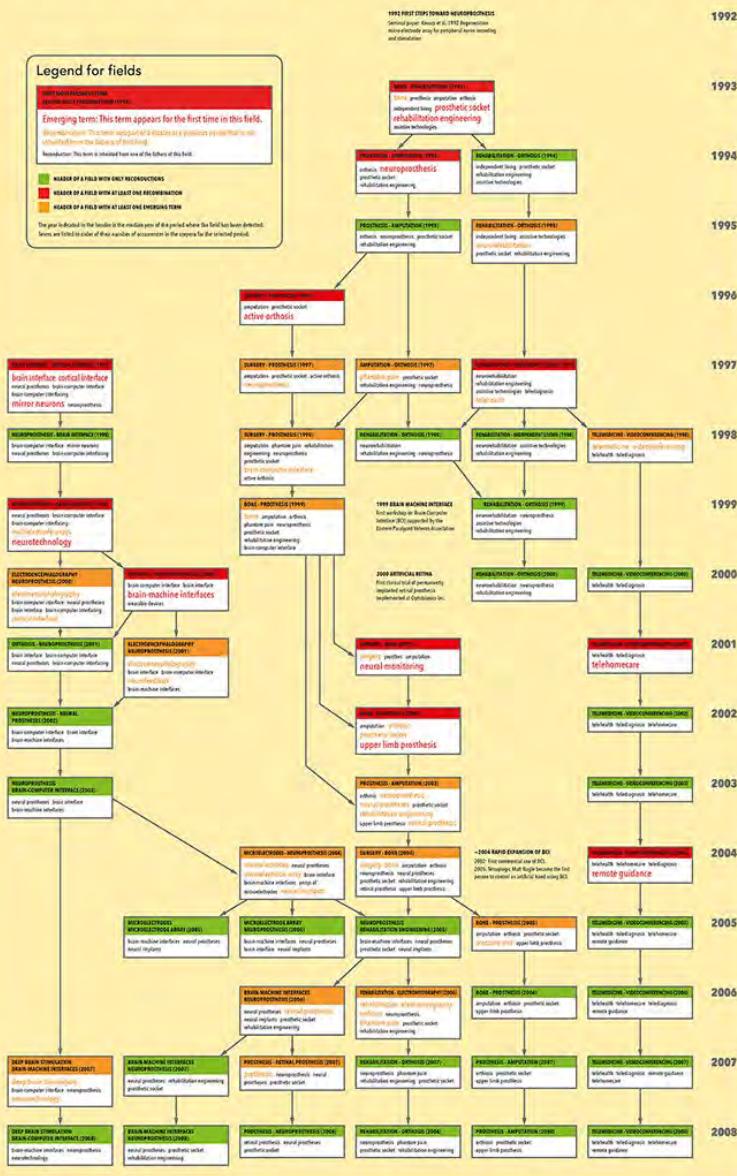
- [1] Chavalarias, David, and Jean-Philippe Cointet. 2013. "Phylometic Patterns in Science Evolution: The Rise and Fall of Scientific Fields." *PLoS ONE* 8:2.
- [2] Callon, Michel, Jean-Pierre Courtial, and Françoise Laville. 1991. "Co-word Analysis as a Tool for Describing the Network of Interaction between Basic and Technological Research: The Case of Polymer Chemistry." *Scientometrics* 22:155–205.

BROWSE THE FULL PHYLOMEMY
fetphylo.sciencemapping.com

Future and Emerging Technologies

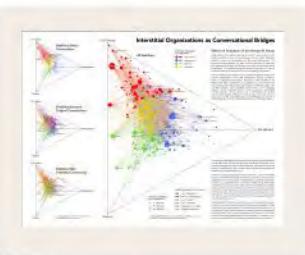
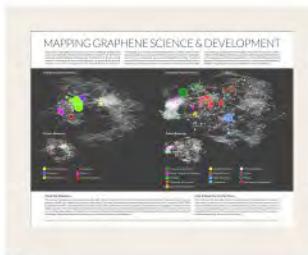
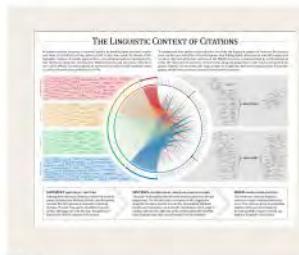
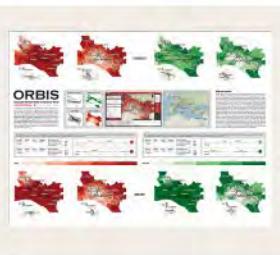
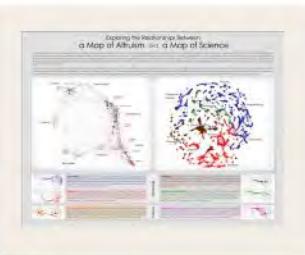
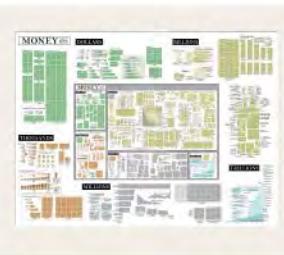


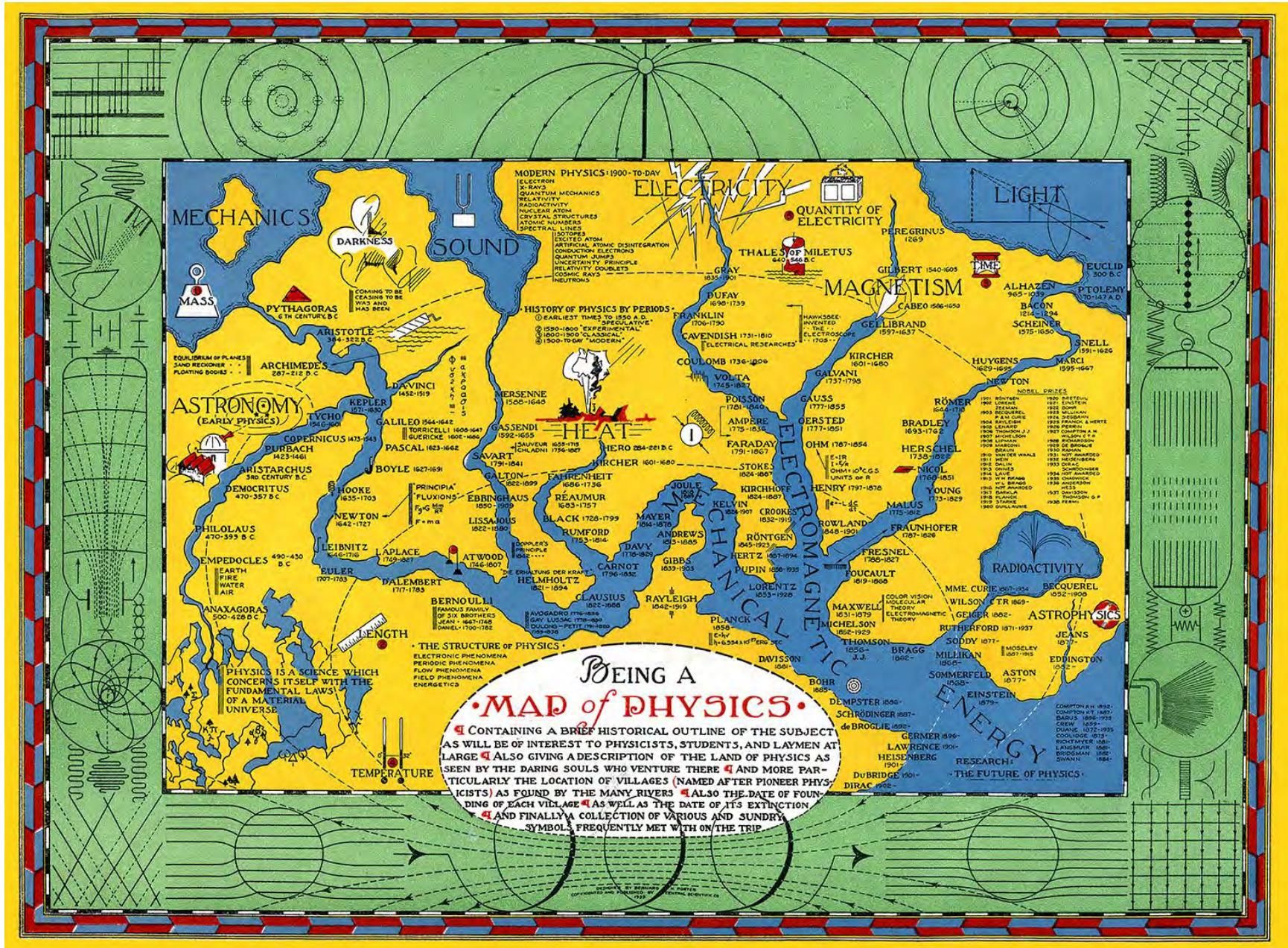
NEUROPROSTHESIS - PROSTHETIC SOCKET



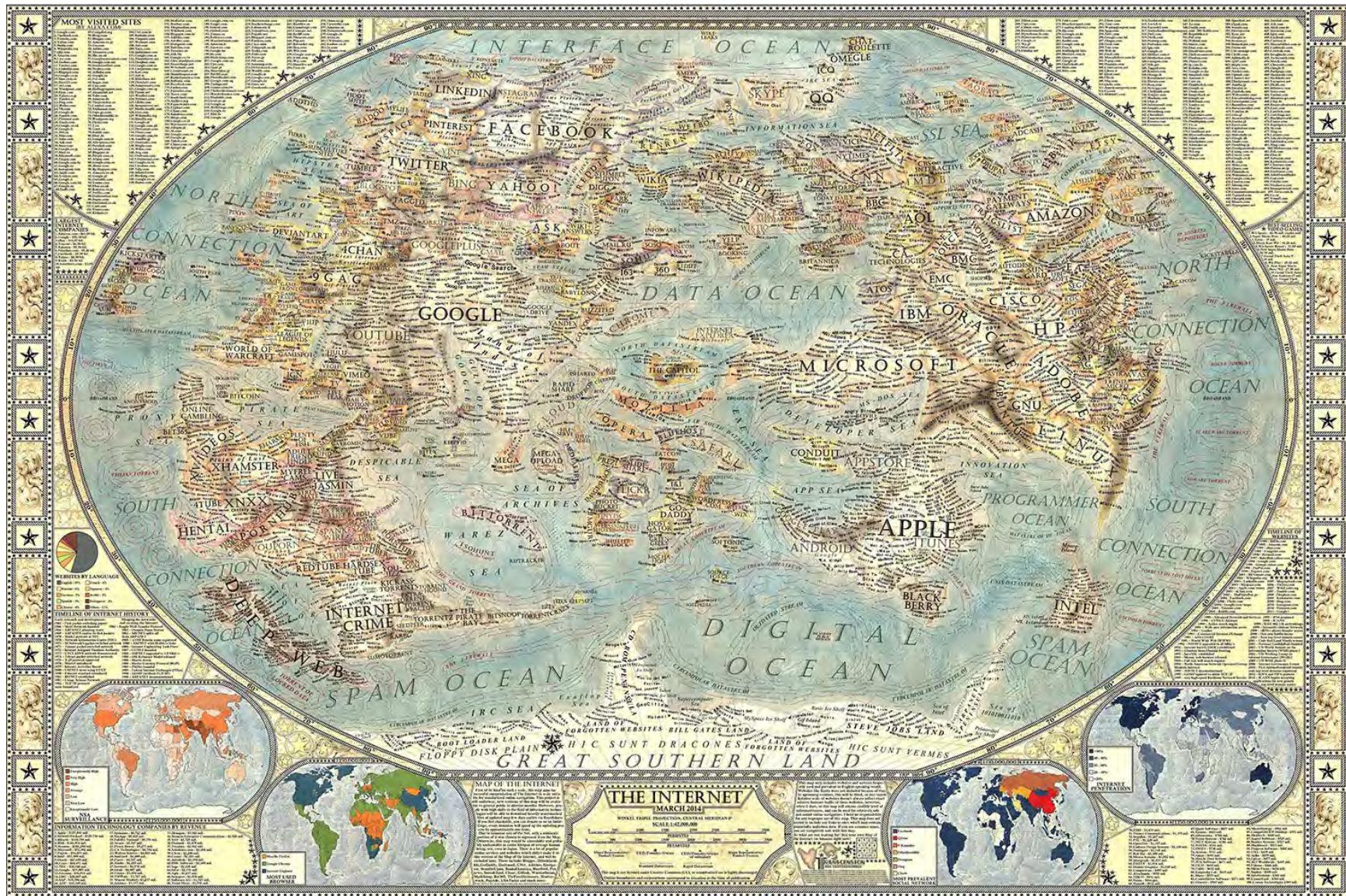
Iteration X (2014)

The Future of Science Mapping

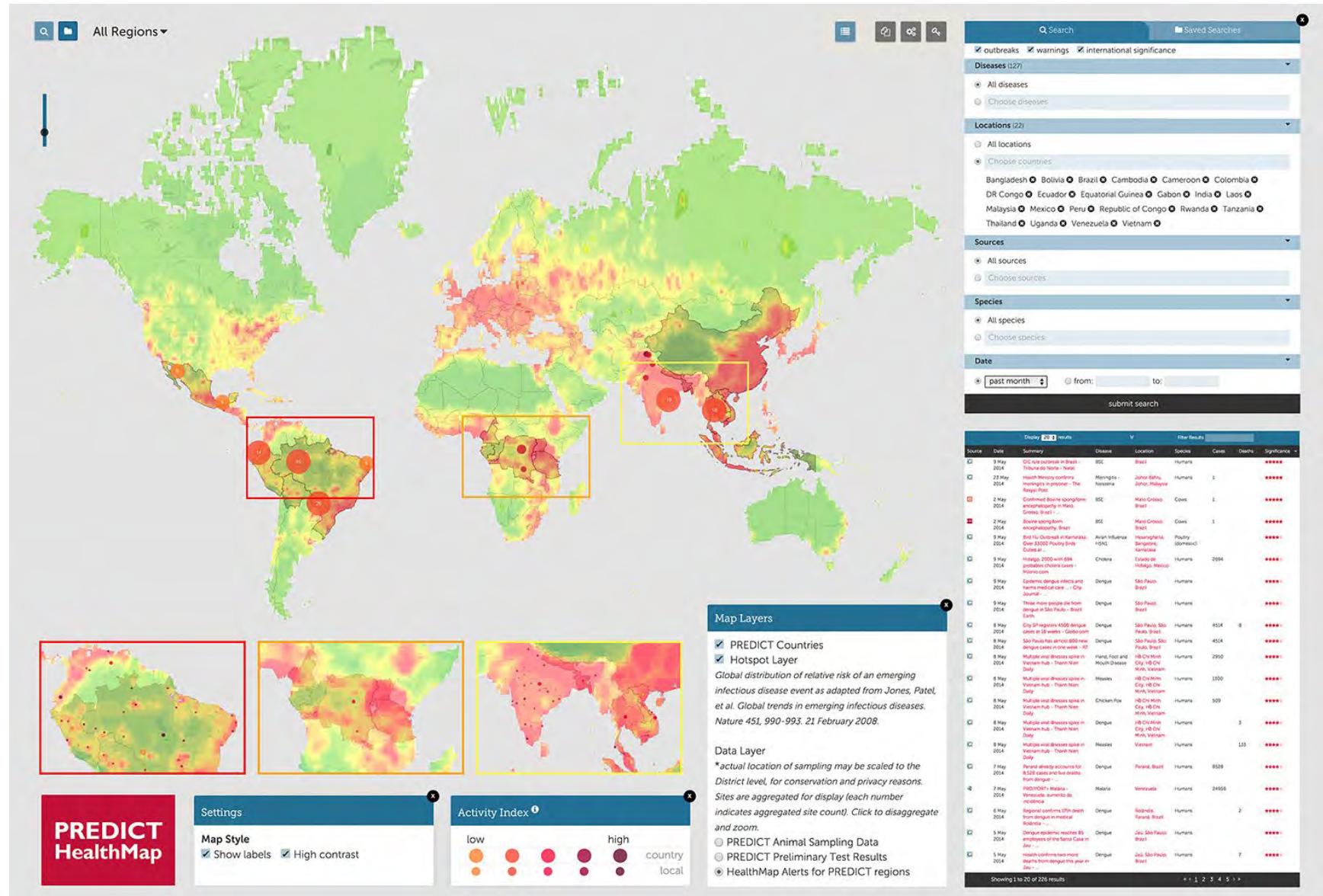




X.1 *Being a Map of Physics* - Bernard H. Porter - 1939



X.2 Map of the Internet - Martin Vargic - 2014



Use the original online tool at healthmap.org/predict





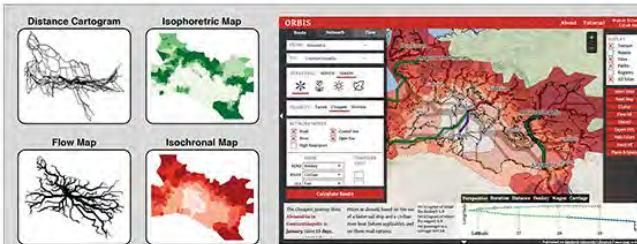
SUMMER



ORBIS

Geospatial Network Model of the Roman World
orbis.stanford.edu STANFORD UNIVERSITY LIBRARIES

Created from archaeological and historical sources for land travel and utilizing computational models to simulate sea travel, ORBIS provides the ability to examine the effects of sea priority, time of year, and other restrictions on the shape of the Roman world. ORBIS utilizes several different methods of information visualization to show individual paths, distance cartograms, isochronic maps, flow maps, and isophoretic maps that show time-reach parts of the empire, isophoretic maps that show the costs to ship goods, and flow maps that indicate the most likely major arteries for that movement. Taken together, ORBIS provides an interactive argument that the nature of space and movement in the Roman world was contingent and often changing.



Why not London?

Historically, the Roman Empire saw two capitals: Rome and Constantinople. While we can see the Roman Empire from this new perspective, it allows us to wonder whether there was something particularly different about Rome or Constantinople that made them "natural" capitals. Here, we look at the difference between the city of Rome and another major world capital from a different historical period: London. The first weakness of a Roman Empire whose capital was London would be the dramatically increased distance from the rest of the empire. London is far from the Mediterranean, so to ship goods on sea rather than on land, we also see that London was not so far from the Mediterranean world during the winter, when heavy seas along the Atlantic coast meant ships could not travel between the Mediterranean and Roman Britain. In the maps and cartograms shown here, the neighborhood of Roman Britain is shaded in grey, and for that reason, much of Roman Britain was economically more accessible than some parts of Roman Italy; while in winter it was one of the most distant places in the empire. This meant that not only was trade disrupted seasonally, but the flow of goods was very different from the flow of people, and this flow also changed depending on the time of year. This lack of stability would make it very difficult to build and maintain power in London, unlike in Rome, Constantinople, or Carthage.

The fastest travel times for a journey from Roma to Londinium in summer and winter are shown here. In July, the journey takes 27 days and covers 2967 km. In January, the fastest journey takes 42 days and covers 2435 km. Both journeys use roads that reduce travel distance but are expensive.

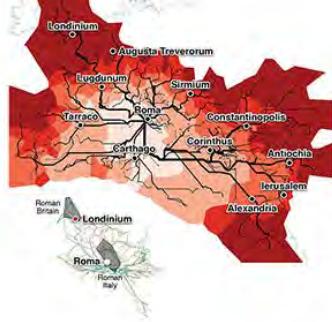


0 ... 7 > 7 ... 14 > 14 ... 21 > 21 ... 28 > 28

The cheapest travel routes from Roma to Londinium in summer and winter are shown here. In July, the journey takes 39 days and covers 5409 km, mostly by sea. In January, the cheapest route takes 90 days and covers 3127 km, mostly by river. Both routes utilize slow but cost effective maritime and river shipping.



0 ... 1 > 1 ... 2.5 > 2.5 ... 5 > 5 ... 10 > 10

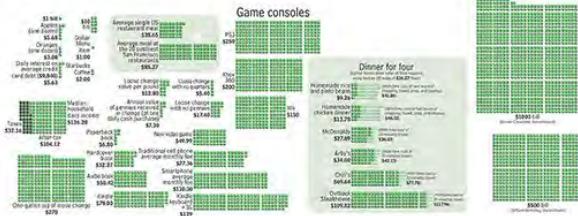
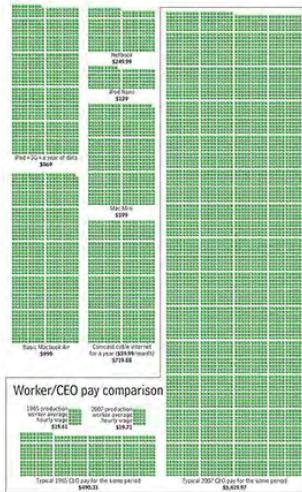


WINTER

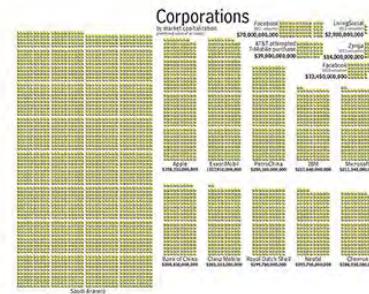
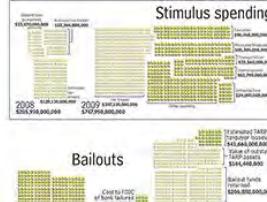




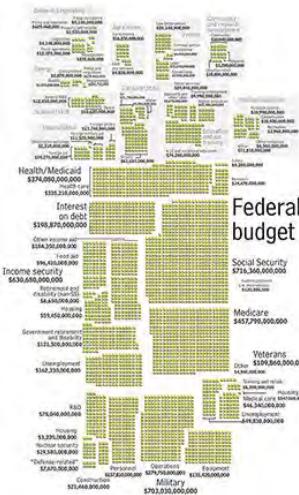
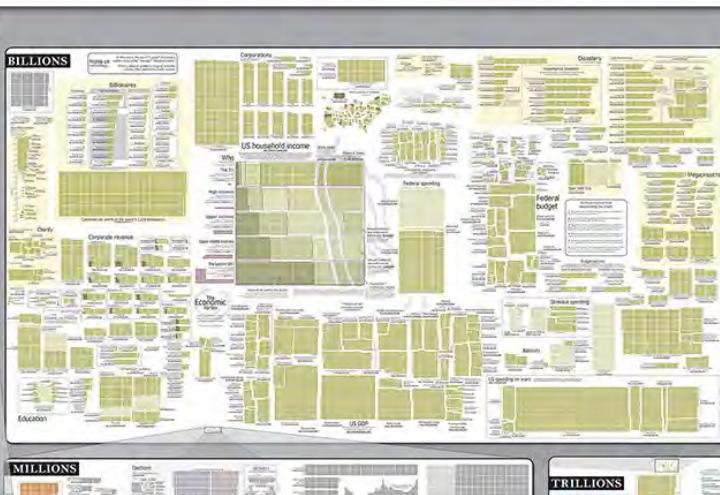
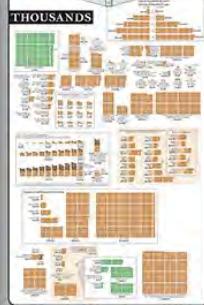
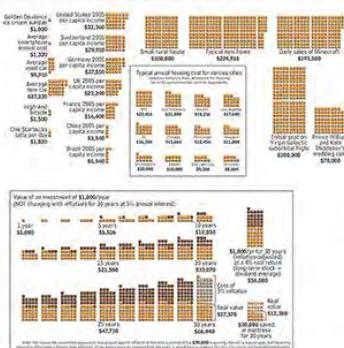
DOLLARS



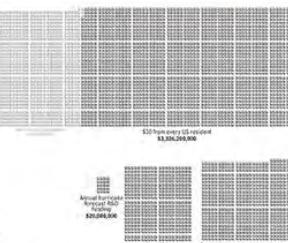
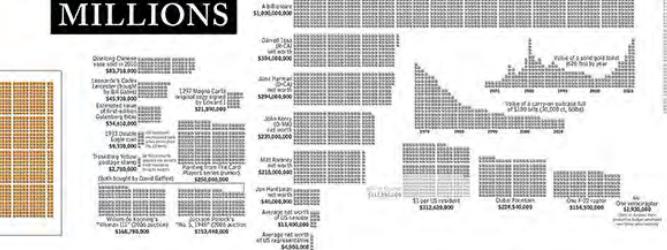
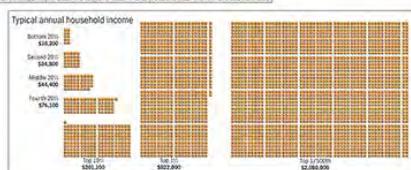
BILLIONS



THOUSANDS

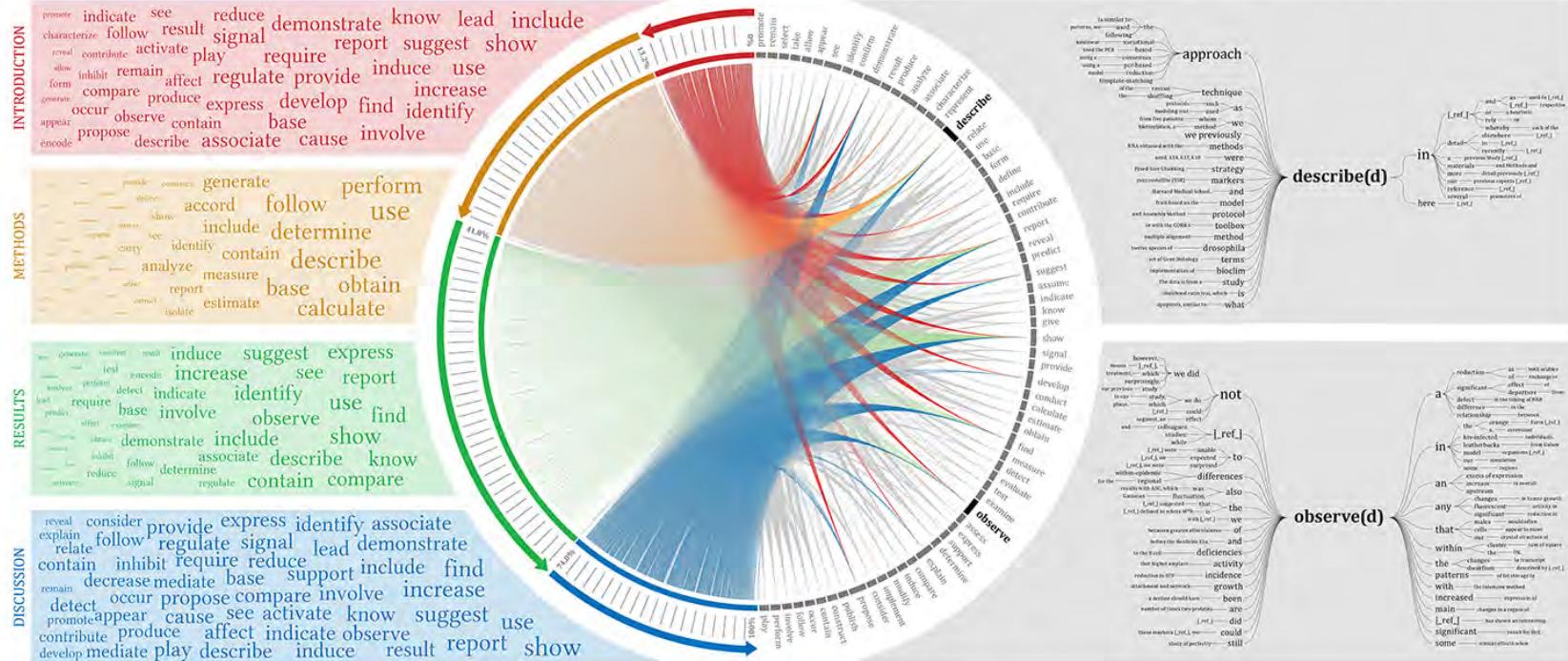


MILLIONS



THE LINGUISTIC CONTEXT OF CITATIONS

In modern science, progress is achieved mainly by building upon previous results and ideas. In scientific writing, authors refer to previous works by means of bibliographic citations. Scientific papers follow a standardized pattern represented by four rhetorical categories: Introduction, Methods, Results and Discussion. This structure, called IMRaD, has been adopted by most journals since the mid-twentieth century, and has become the standard in the 1970s.



DOCUMENT (RHETORICAL STRUCTURE)

Looking at the four main rhetorical sections of scientific papers (Introduction, Methods, Results, and discussion), we show the verbs present in sentences containing citations. The verb frequencies are different in each section: the bigger the verb, the more frequently it is found in the citation contexts of the section.

SENTENCE (DISTRIBUTION OF VERBS ALONG SCIENTIFIC PAPERS)

The circle in the middle links the verbs to their positions in the text progression. The left side of the circle presents the progression along the four main sections in an article: Introduction, Methods, Results, and Discussion, and shows the distribution of verb usage in citation contexts. The right side of the circle presents the list of the most frequent verbs that were extracted from the sentences.

WORD (VERBS IN THEIR CONTEXTS)

The word trees show the linguistic contexts in which verbs and references occur. Two verbs are given as an example together with texts that commonly precede and follow them. Type font size indicates frequency of occurrence.

Using the grants from 23 agencies, this map shows two views of international funding data: A topic map of 50 Research Condition and Disease Classification (RCDC) terms in the top-left and a map of funding profiles for the 23 funding agencies in the lower right.

How does it work?

The RCDC topic map reveals key funding foci and their topical similarity, here indicated by spatial proximity calculated via a multi-dimensional scaling algorithm. That is, more general or crosscutting topics end up in the center, while the more specific themes are located towards the periphery. The area sizes of the circles represent share of grant amounts spent in the respective area by all funders combined.

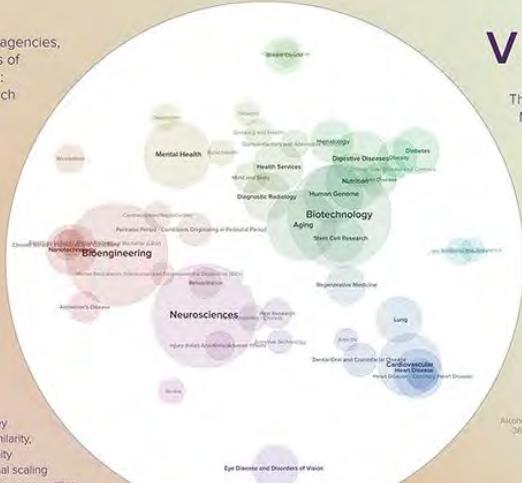
The funder map represents each funding agency by a RCDC topic map, with topics that are funded plotted as size coded circles. Here, the circle area represents the total percentage of funding spent within the category by the respective funder.

A dynamic version of this map is currently being developed. It will allow users to select specific funding data, classification systems, and categories to get answers to specific questions in a visual way. For example, selecting research categories on nanotechnology for different funding agencies makes it possible to see what funding exists in this interdisciplinary field of research across different countries.

The placement of funding agencies matches the placement of the top-50 RCDC topics in the top-left map. For example, funding agencies which fund a lot of Bioengineering are placed on the left side, while funders focussing on Diabetes research are placed in the top right.

Acknowledgements

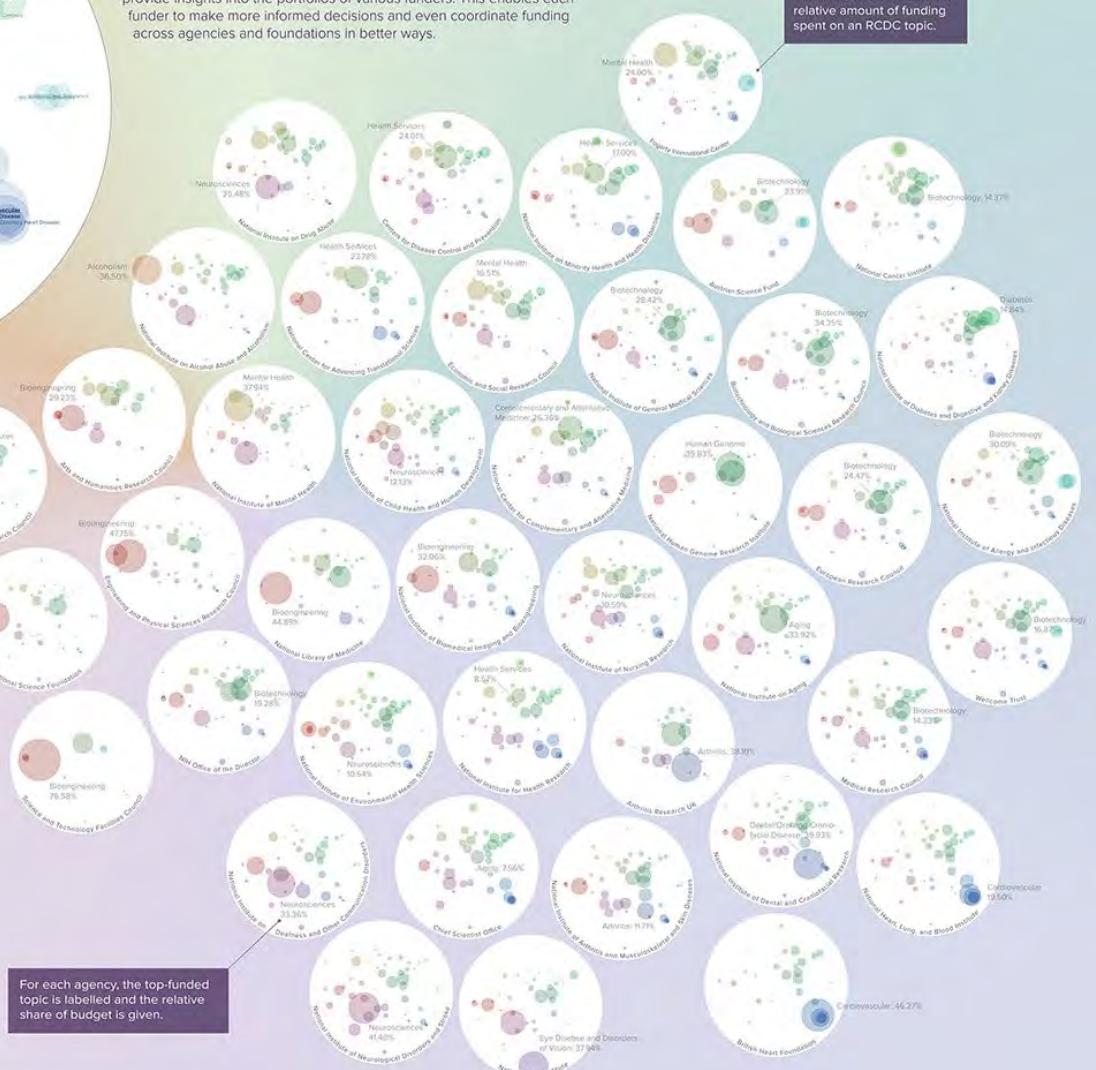
- Research Councils UK data was obtained as public sector information and licensed under the Open Government License v1.0.
- NIH RePORTER data was obtained as public domain information from the National Institutes of Health.
- Europe PubMed Central data was obtained from EMBL-EBI according to the EBI Terms of Use of the EBI Services.
- National Science Foundation data was obtained as public domain information from the National Science Foundation.
- RCDC category data was obtained as public domain information from the National Institutes of Health.



VISUAL FUNDING PORTFOLIOS

The distribution of science funding greatly affects the future of research. Many analyses are done by each funder on their own portfolios, but with science happening on an international scale, robust analytical tools can provide insights into the portfolios of various funders. This enables each funder to make more informed decisions and even coordinate funding across agencies and foundations in better ways.

The circle sizes indicate the relative amount of funding spent on an RCDC topic.



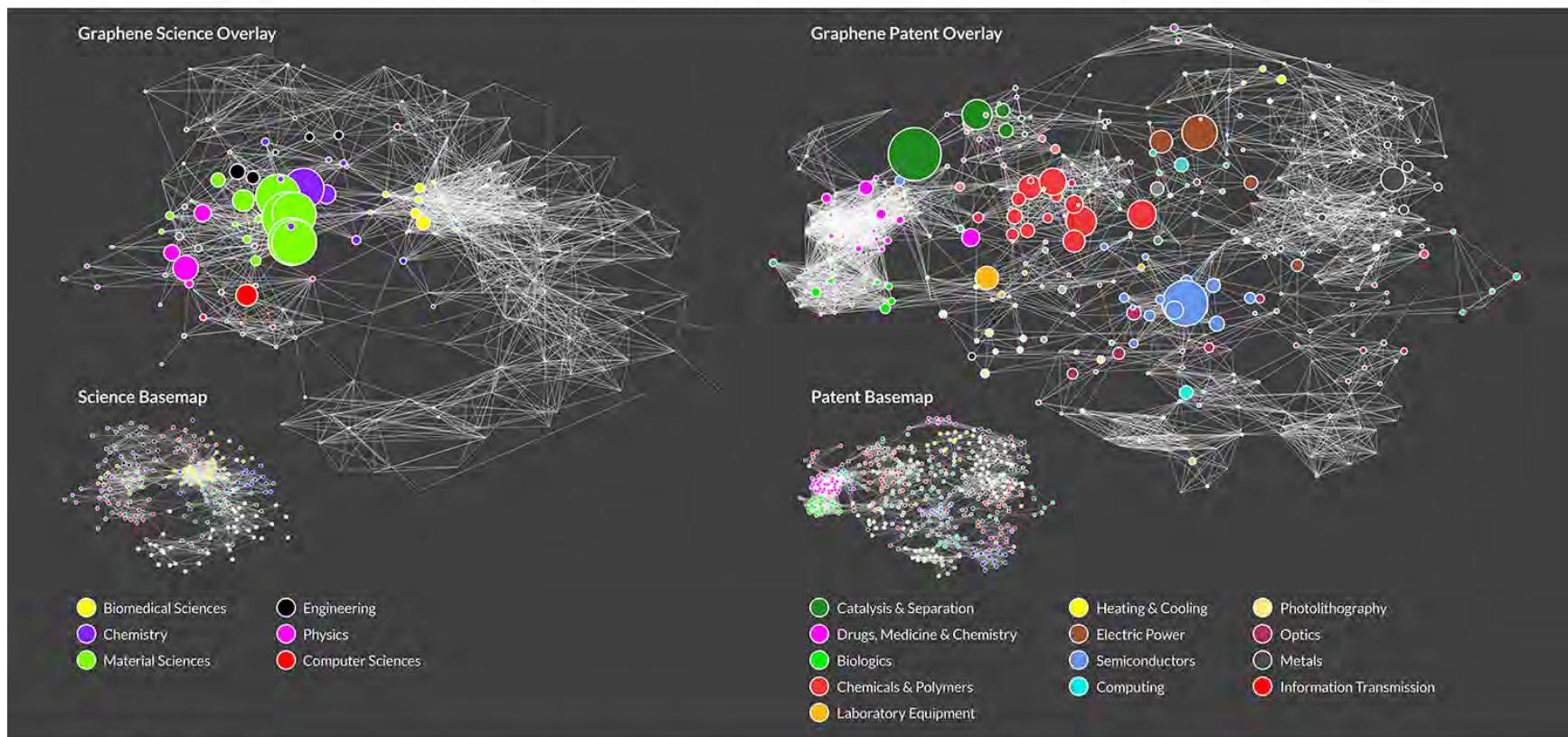
Moritz Stefaner, Mario Diwersy, Christian Herzog
More info at <http://www.uberresearch.com/visual-funding-portfolios>

MAPPING GRAPHENE SCIENCE & DEVELOPMENT

These science and patent overlay maps show the unfolding of graphene discovery and exploitation between 2000 and 2013. Graphene is a new two-dimensional material made out of a single layer of carbon atoms. Its very special features—including great strength yet lightness, and electrical and thermal conductivities—were recognized in the 2010 Nobel Prize in physics.

Interestingly, its research and development follows a “funnel” pattern where scholarly publications are primarily focused in one area of science, and patenting activity is widespread across multiple application areas. Graphene research (left), focuses on material sciences and closely related fields such as engineering and physical chemistry. There is very little activity in other fields

such as biology. Graphene invention (right), on the other hand, covers a wider variety of technologies with focus on catalysis and separation, semiconductor parts and devices, batteries and capacitors, and the chemical properties of graphene. Other inventive activity focuses on a small amount of applications related to computing and pharmaceutical uses such as drug delivery.



About the Basemaps

The science basemap was created using publication citation index data for 2009. It features 222 Web of Science category nodes that are grouped into 18 color-coded macro-science disciplines. The patent basemap was computed by mining patents for the time period 2000-2006. It consists of 466 IPC technology nodes grouped into 35 color-coded macro-patent categories. In each network map, edges are drawn between nodes that have a threshold above the median similarity value. The Kamada & Kawai layout algorithm in Pajek was used to layout the networks in a two-dimensional space—the closer two nodes are the higher the similarity between them. The basemaps show the structure of science and technology landscape respectively and serve as a reference system for data overlays.

How to Read the Overlay Maps

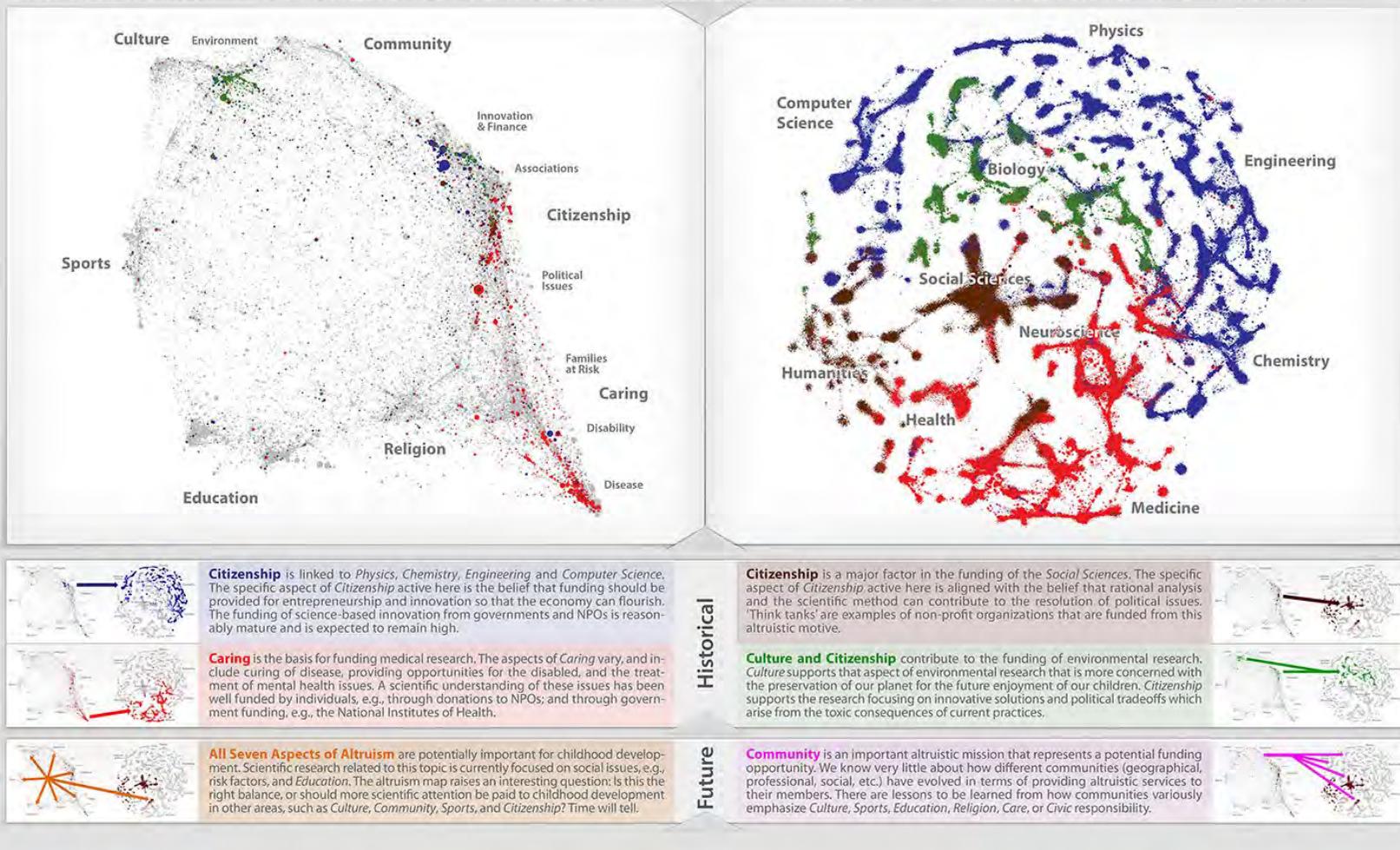
The data overlays show the number and placement of publications and patents that match “graphene” on the respective basemap. Node size indicates the number of matching publications or patents per node. Labels and colors of the six macro-science disciplines and the 13 macro-patent categories that contain matching publications and patents are given below the network maps. There exists no relation between the colors in the two maps.

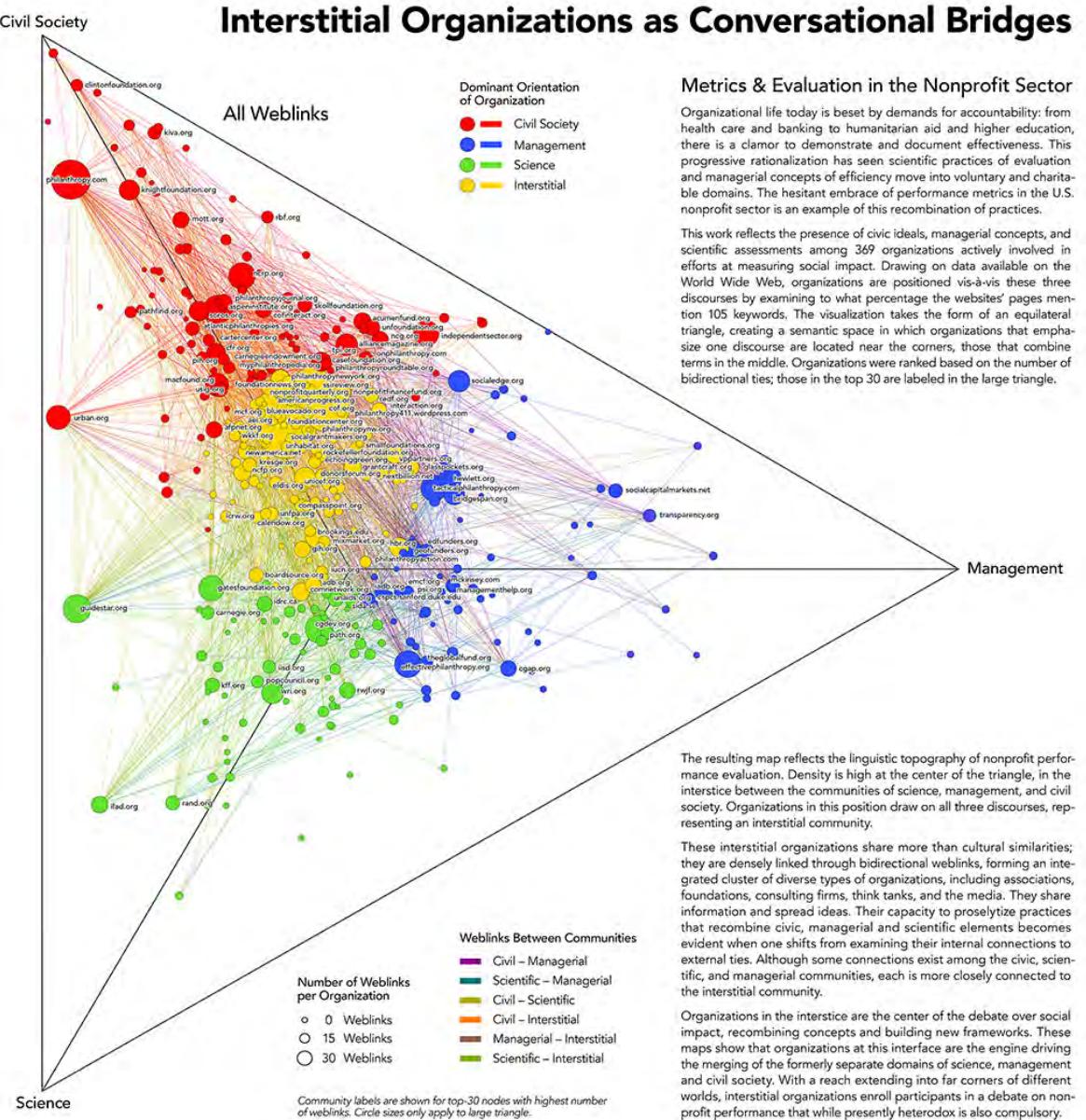
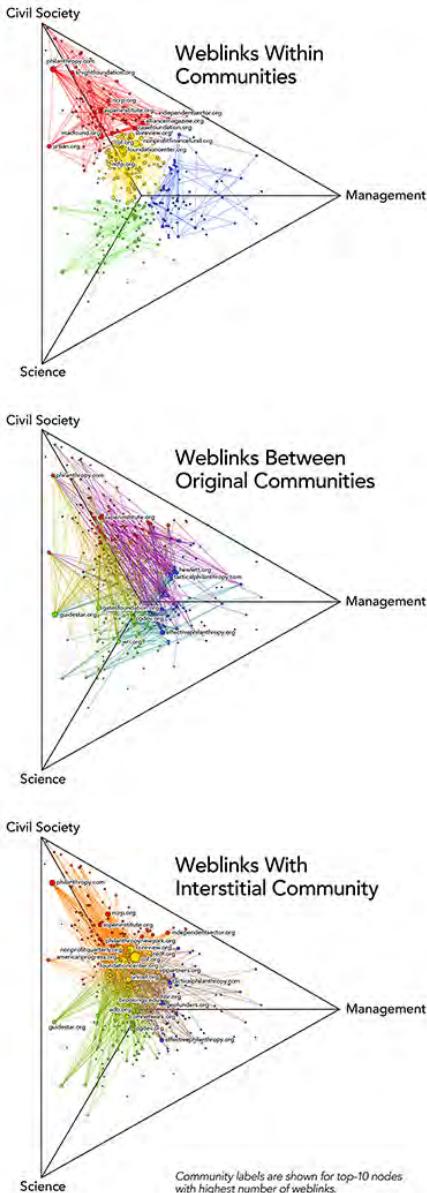
Acknowledgments: This work is based on research undertaken largely at Georgia Tech drawing on support from the U.S. National Science Foundation (NSF) through the Center for Nanotechnology in Society, Arizona State University (Award No. 0531194) and the NSF project “Revealing Innovation Pathways: Hybrid Science Maps for Technology Assessment and Foresight” (Award No. 1054146). Part of this research was also undertaken in collaboration with SPRU, University of Sussex, and the Center for Nanotechnology in Society, University of California Santa Barbara (NSF Awards No. 0758099 and No. 0531184). The observations contained in this work are those of the authors and do not necessarily reflect the views of NSF.

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.





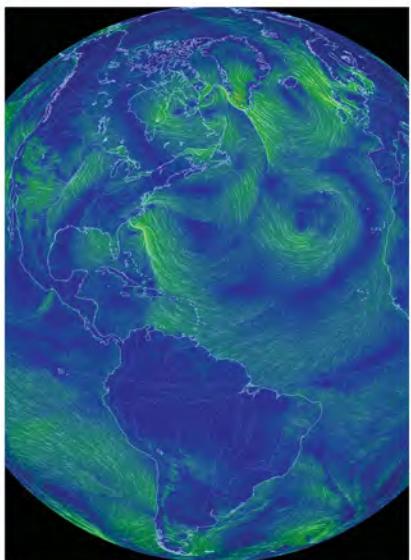
Check out our Zoom Maps online!



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

Iteration XI (2015)

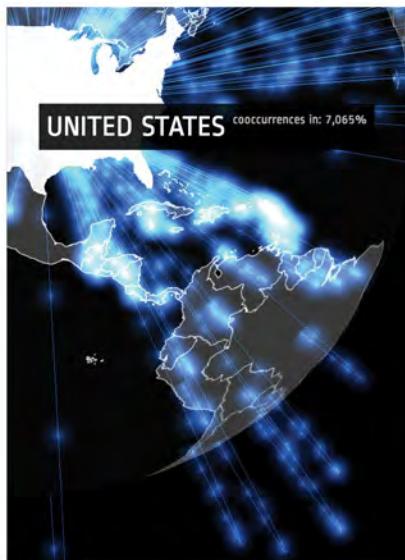
Macroscopes for Interacting with Science



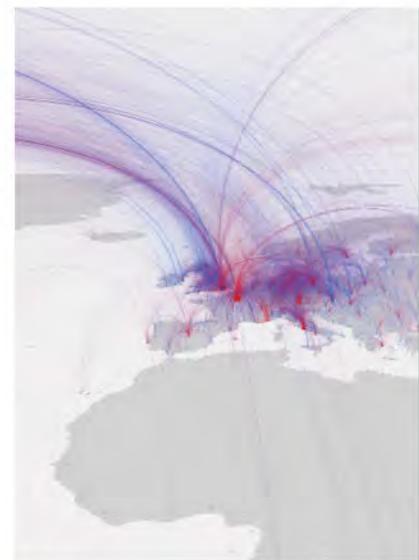
XI.1



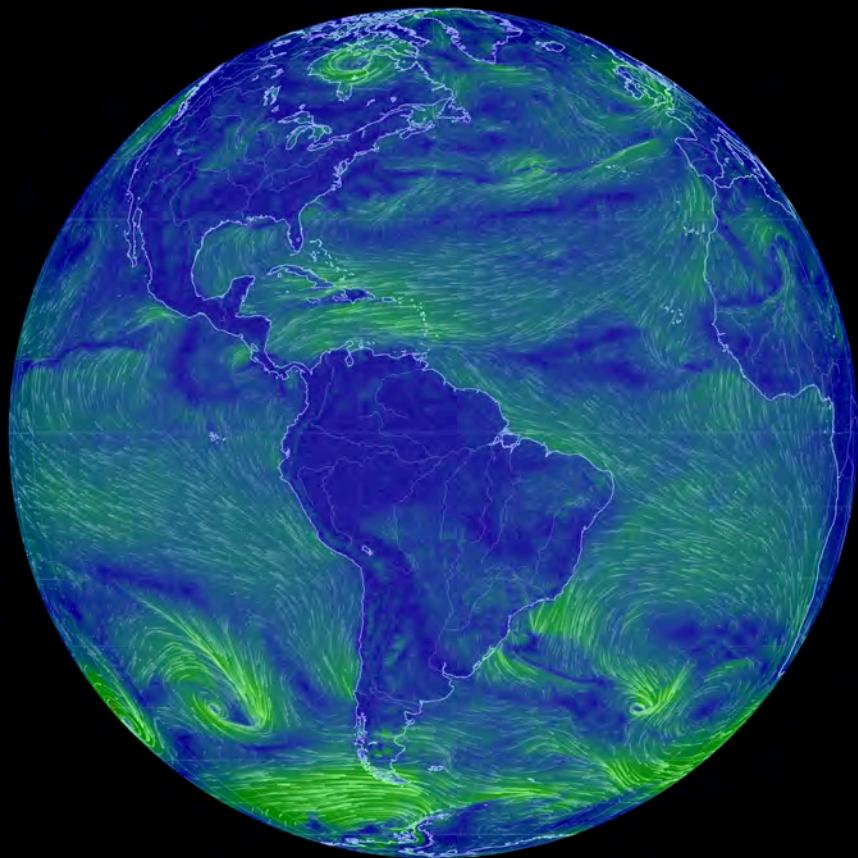
XI.2



XI.3



XI.4

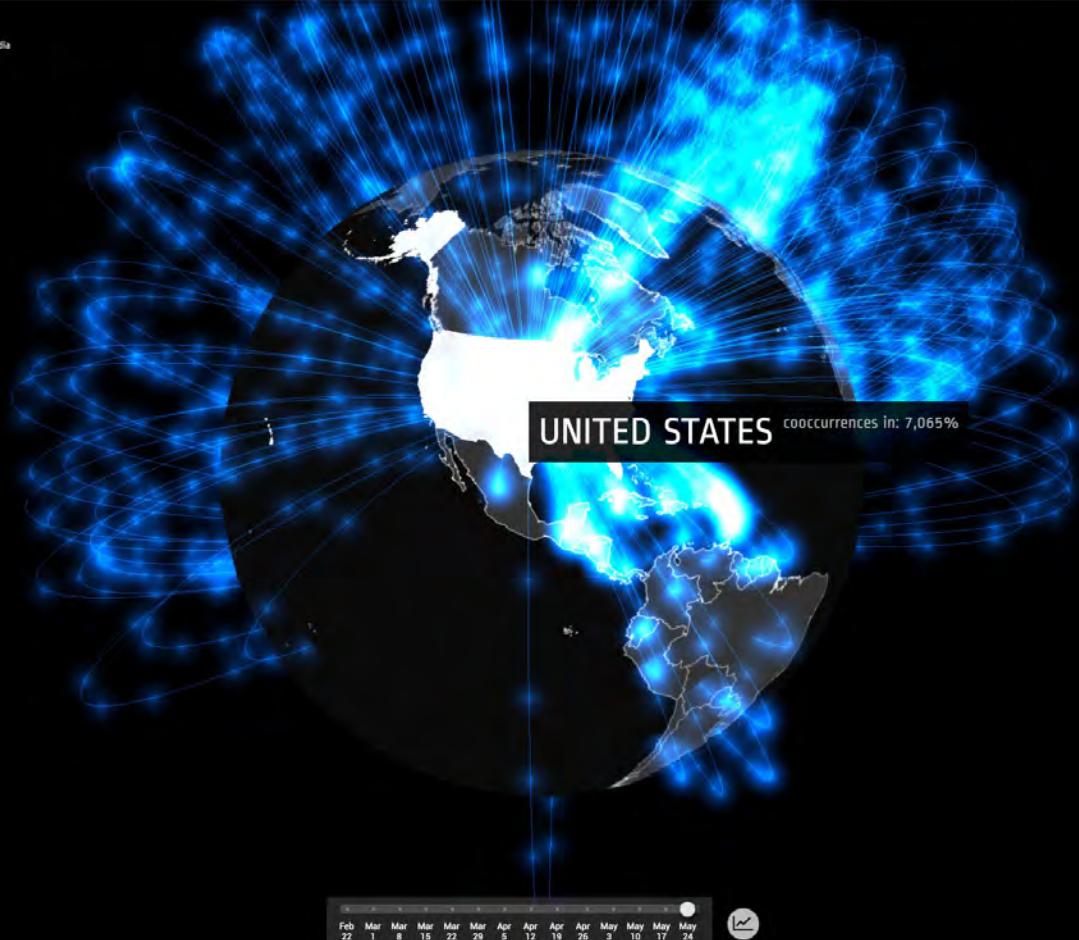


earth ≡



The News Co-occurrence Globe

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



nature video

time: 1954 CE



Iteration XII (2016)

Macroscopes for Making Sense of Science



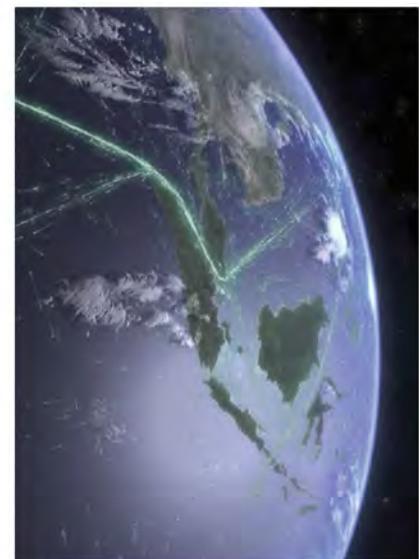
XII.1



XII.2

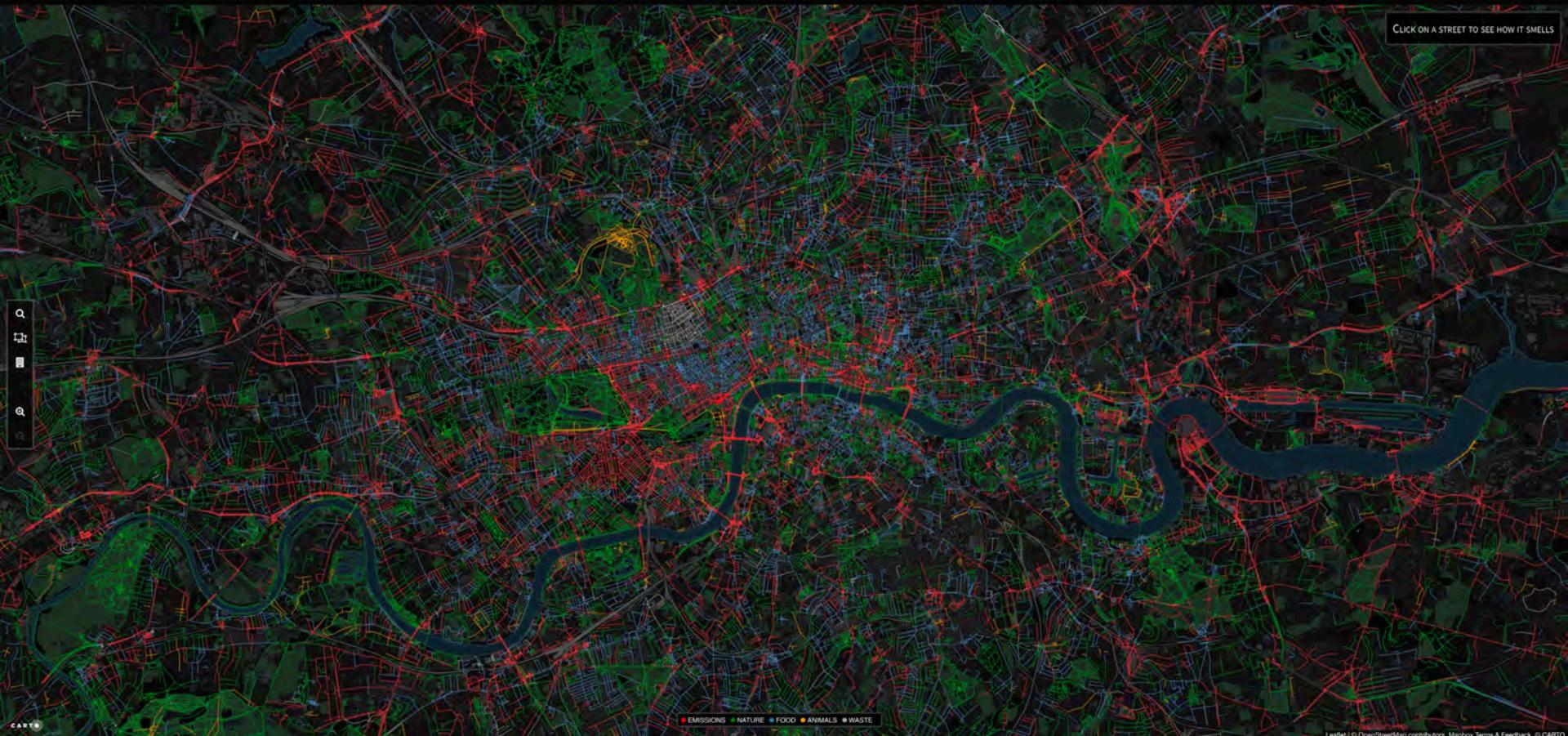


XII.3



XII.4

CLICK ON A STREET TO SEE HOW IT SMELLS



XII.1 *Smelly Maps*—Daniele Quercia, Rossano Schifanella, and Luca Maria Aiello – 2015

Where are books published?

Drag your finger over the timeline to highlight a period of time.
Yellow circles show the location and number of publications
during those years.

Where are potential readers?

Lines flow from publication locations to countries where the
language of publication is spoken in modern times. Each line is
colored according to language, with darker colors representing
the most popular languages in the current selection.

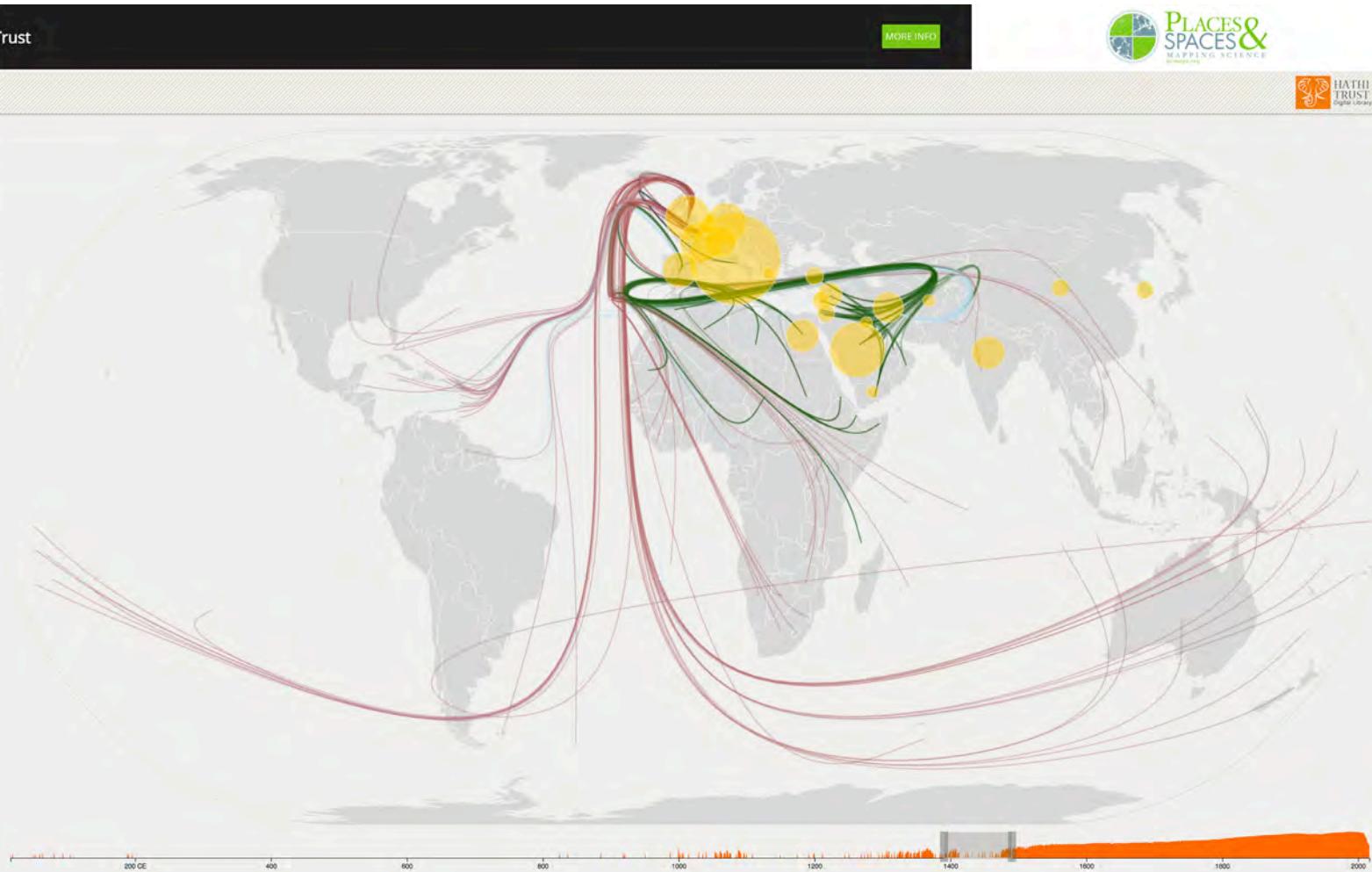
Top Publication Locations

For the years: 1390 - 1490

- Italy
- Saudi Arabia
- England
- Germany
- France
- Show all locations

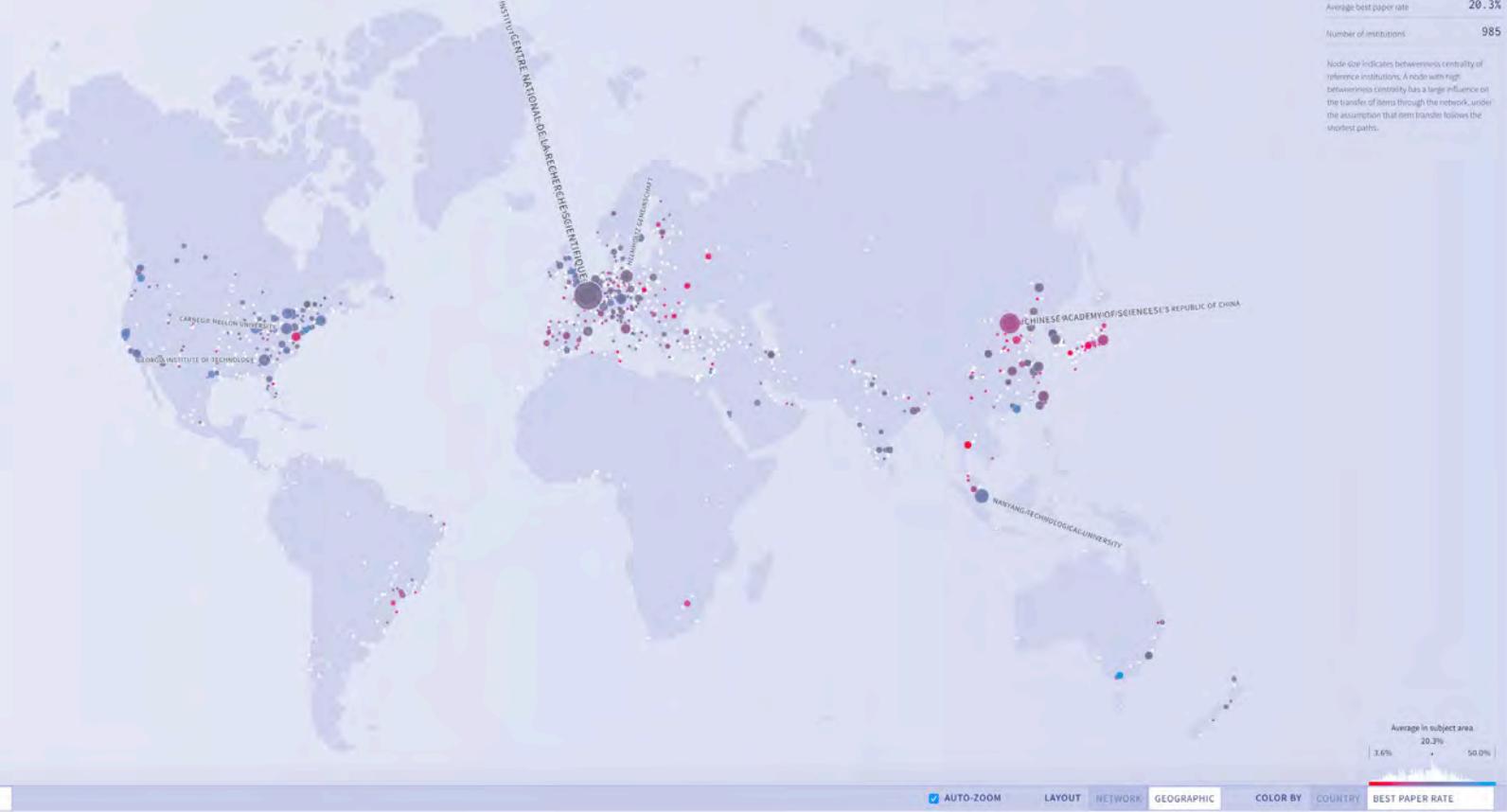
Top languages

- Latin
- Arabic
- English
- Bengali
- Persian
- Other



EXCELLENCE NETWORKS

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SUBJECT AREA Computer Science

MORE INFO

FleetMon

Tracking the Seven Seas

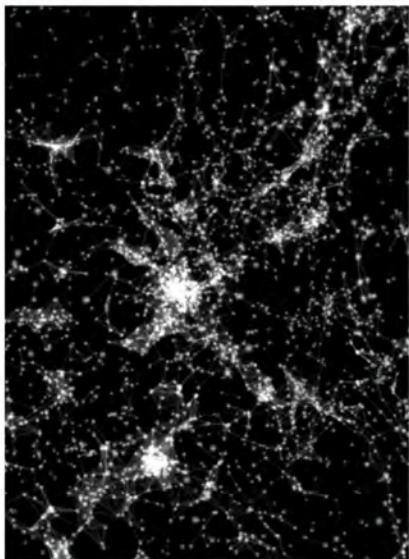
INDIAN OCEAN

Monday, September 10, 2012

01:31

Iteration XIII (2017)

Macroscopes for Playing with Scale



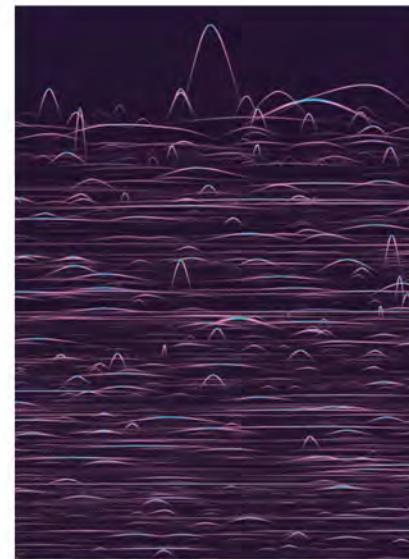
XIII.1



XIII.2



XIII.3



XIII.4

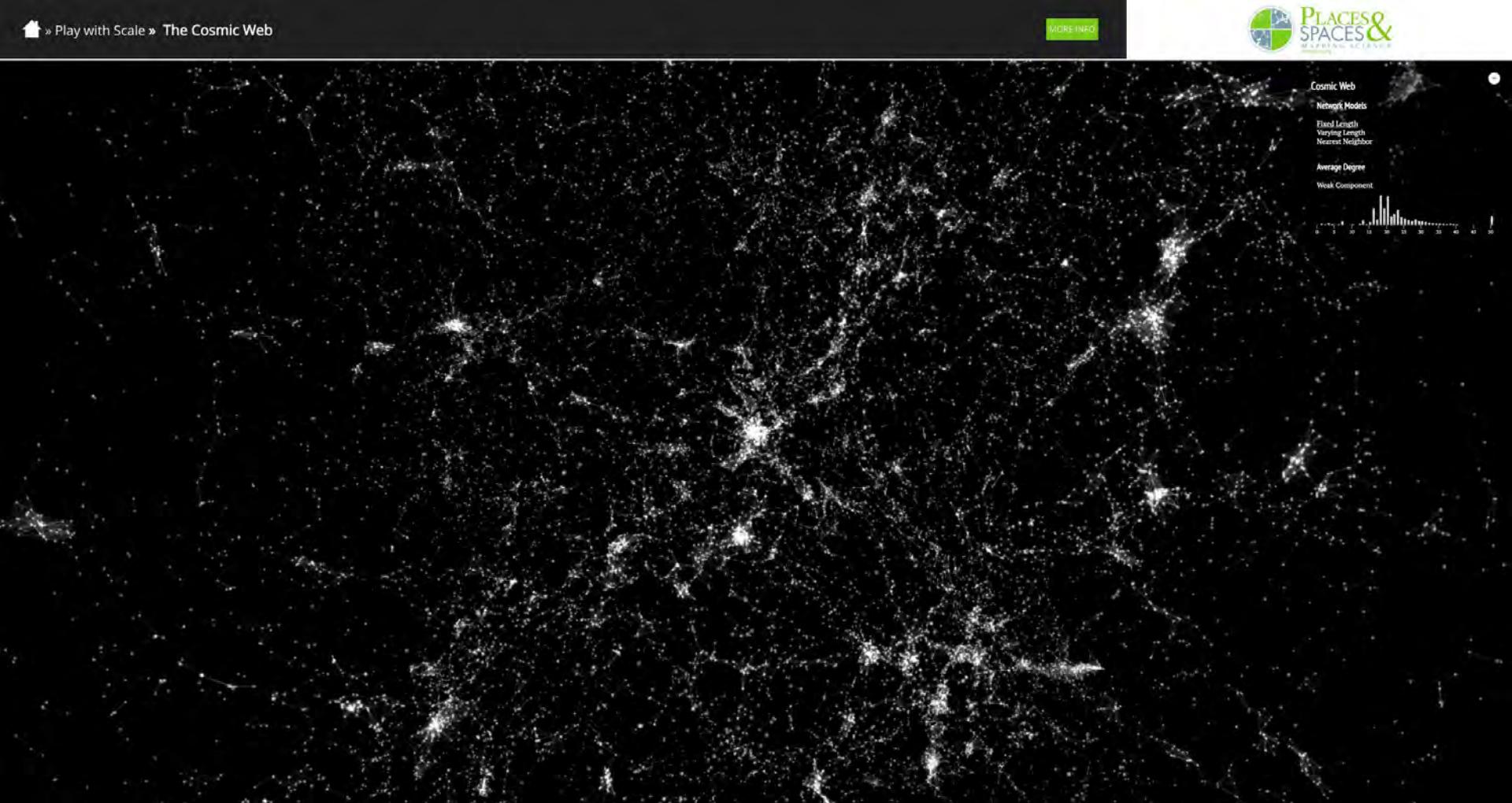
Cosmic Web

Network Models

Fixed Length
Varying Length
Nearest Neighbor

Average Degree
Weak Component

Bar chart



FOUR HUNDRED YEARS

LITERATURE	1575
MUSIC	971
WARS	961
POLITICS	774
CONSTRUCTION	770
INVENTIONS	571
RIOTS	351
WOMEN RIGHTS	258
DISASTERS	225
ART	178
NATIONALITY	171
DISCOVERIES	141
EMPIRES	89
ASSASSINATIONS	50
RELIGION	38





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