Science from Above

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The Problem:
Being Lost in (Knowledge) Space

15th Century: One person can make major contributions to many areas of science

Mankind’s Knowledge

use

contribute

Amount of knowledge on brain can manage

Human Brain

Leonardo Da Vinci (1452-1519)
20th Century: One person can make major contributions to a few areas of science

Mankind's Knowledge

\[ \text{use} \quad \text{Human Brain} \]

\[ \text{contribute} \]

Amount of knowledge on brain can manage

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Albert Einstein (1879-1955)

21st Century: One person can make major contributions to a specific area of science

Mankind's Knowledge

\[ \text{use} \quad \text{Human Brain} \]

\[ \text{contribute} \]

Amount of knowledge on brain can manage
21st Century: One person can make major contributions to a specific area of science

Mankind’s Knowledge

Amount of knowledge on brain can manage

use

contribute

Human Brains

Domain Expert

Manager

Humanity’s Knowledge
Growth of Scientific Knowledge, 1665 to 2006
**2005 World Population**

The population map uses a quarter degree box resolution. Boxes with zero people are given in white. Darker shades of red indicate higher population counts per box using a logarithmic interpolation. The highest density boxes appear in Mumbai, with 11,687,850 people in the quarter degree block, Calcutta (10,816,010), and Shanghai (8,628,088).

**2003 Scientific Productivity**

Shown is where science is performed today. Each circle indicates a geographic location at which scholarly papers are published. The larger the circle the more papers are produced. Boston, MA, London, England, and New York, NY are the top three paper production areas. Note the strong resemblance with the Night on Earth and the IP Ownership maps and the striking differences to the world population map.
2007 IP Address Ownership
This map shows IP address ownership by location. Each owner is represented by a circle and the area size of the circle corresponds to the number of IP addresses owned. The largest circle denotes MIT’s holdings of an entire class A subnet, which equates to 16,581,375 IP addresses. The countries that own the most IP addresses are US (560 million), Japan (130 million), Great Britain (47 million).
Mapping Science Exhibit – 10 Iterations in 10 years

http://scimaps.org/

The Power of Maps (2005)

Science Maps for Economic Decision Makers (2008)


Science Maps for Science Policy Makers (2009)

Science Forecasts (2007)

Science Maps for Scholars (2010)

Science Maps as Visual Interfaces to Digital Libraries (2011)

Science Maps for Kids (2012)

Science Forecasts (2013)

How to Lie with Science Maps (2014)

Exhibit has been shown in 49 venues on four continents.
The Power of Maps

Four Early Maps of Our World
VERSUS
Six Early Maps of Science

(1st Iteration of Places & Spaces Exhibit - 2005)
How would a map of science look?

What metaphors would work best?
The Structure of Science

The Power of Reference Systems

Four Existing Reference Systems
VERSUS
Six Potential Reference Systems of Science

(2nd Iteration of Places & Spaces Exhibit - 2006)
How would a reference system for all of science look?

What dimensions would it have?
Impact

US Patent Hierarchy

Prior Art
Synthetic Resins or Natural Rubber
Ion-exchange Polymer or Process of Preparation
Process of Regenerating
Membrane or Process of Preparing
Previously Formed Solid Ion-exchange Polymer Available For
Polymer Characterized By Defined Size or Shape Other Than Bead
Chemically Treated Solid Polymer
Solid Polymer Derived From Ethylenically Unsaturated Reactant
Solid Polymer Derived From At Least One 1,2-epoxy Containing
Solid Polymer Derived From Aldehyde or Derivative
From Ethylenically Unsaturated Reactant Only
From Aldehyde or Derivative

Process of Treating Scrap or Waste Product
Process of Treating Scrap or Waste Product Containing At Least
Treating Rubber (or Rubberlike Materials) or Polymer Derived
Treating Polymer Derived From A Monomer Containing At Least
Treating Polymer Derived From Hydrocarbon Monomers Only
Treating Polysiloxane
Treating Polyester
Treating With Alcohol
Treating Polyurethane, Polyurea (excluding Urea-formaldehyde)
Treating With Alcohol or Amine
Treating Polycarbonate

Cellular Products or Processes of Preparing
Cellular Product Derived From Two or More Solid Polymers or Frs
At Least One Polymer Is Derived From Reactant Containing Two
At Least One Polymer Is Derived From An Aldehyde or Derivative
At Least One Polymer Is Derived From A Common Reactant

Science can be thought of as consisting of themes and paradigms. Themes are areas of current research, while paradigms comprise the dominant tool sets and existing knowledge that are used for today’s researchers. This map shows 777 major paradigms in science and their relationships with each other. Each paradigm is represented by a node, and the lines connecting the nodes indicate the relationships between them. The map was created using a recursive algorithm to connect the 777 paradigms, and the connections are color-coded to represent different types of relationships. The colors are based on the underlying scientific disciplines and fields, such as physics, chemistry, biology, and medicine. The map allows for a visual representation of the structure of science and its relationships, and it can be used to explore the connections between different fields of study.
The Power of Forecasts

Four Existing Forecasts
VERSUS
Six Potential Science ‘Weather’ Forecasts

Can one forecast science?
What ‘science forecast language’ will work?

(3rd Iteration of Places & Spaces Exhibit - 2007)
Science Maps for Economic Decision Making

Four Existing Maps VERSUS Six Science Maps

(4th Iteration of Places & Spaces Exhibit - 2008)
What insight needs to economic decision makers have?

What data views are most useful?
Science Maps for Science Policy Makers

Call For Maps for 5th Iteration of Exhibit

Submit initial entry: January 9th, 2009
Notification to mapmakers: January 31st, 2009
Submit final entries: March 31, 2009
5th Iteration ready for display: April 30, 2009


Visit [http://scimaps.org/host](http://scimaps.org/host) for info on how to host exhibit.
Additional Elements of the Exhibit

Illuminated Diagram Display

Hands-on Science Maps for Kids

Worldprocessor Globes

**Illuminated Diagram Display**

**Questions:**
- Who is doing research on what topic and where?
- What is the ‘footprint’ of interdisciplinary research fields?
- What impact have scientists?

**Contributions:**
- Interactive, high resolution interface to access and make sense of data about scholarly activity.

Large-scale, high resolution prints illuminated via projector or screen.

Interactive touch panel.
Nanotechnology

This overlay shows the distribution of nanotechnology within the paradigms of science. The majority of current work in nanotechnology takes places in physics, chemistry, and materials science, at the upper right portion of the map. However, an increasing amount of nanotechnology is being applied in the biological and medical sciences, at the lower right.

All Topics

Nanotechnology

Sustainability

Biology & Chemistry

Francis H. C. CRICK

Albert EINSTEIN

Michael E. FISHER

Susan T. FISKE

Our energy

through the
Paradigms

The science behind our
long-term hopes

The interface between
these two vital fields

Co-discoverer of DNA’s
double helix

Understood physics with
relativity theories

Models and proofs
towards materials of
matter

Converging perspectives
and intermediates

We zoom slowly through adjoining paradigms, lighting up the places in the world that study each topic. You may select a subset of the topics that deal with these three intersecting objects by touching it.

A single person’s spreading influence is shown as a series of footsteps. First, we highlight primary topics and places relating to that person’s papers—papers that are still highly cited today. The second highlights everything that cites that original work. Note that this first-generation impact extends far more topics than did the original work. The third highlights papers that cite the second, and the fourth lights science that cites the third.
Hands-on Science Maps for Kids

All maps of science are on sale via
http://scimaps.org/ordermaps/
Science Puzzle Map for Kids by Fileve Palmer, Julie Smith, Edisha Hardy and Katy Börner, Indiana University, 2006. (Base map taken from Illuminated Diagram display by Kevin Boyack, Richard Klavans, and W. Bradford Paley.)
Activities:
Solve the puzzle.
Navigate to 'Earth Science'.
Identify major inventions.
Place major inventors.
Find your dream job on the map.
Why is mathematics important?

There are seven main fields of science. They are:
- Social Science
- Mathematics
- Psychology
- Physics
- Chemistry
- Medicine
- Earth Science

Earth scientists study the weather, plants and trees, marine life, insects, and much more.

I like insects. They are interesting to look at and study.

Color earth science green.
Color in the insect.

There are many types of insects in the world. Bees, butterflies, and beetles are just a few.

I want to be an entomologist when I grow up. Then I can study insects all the time.
Winners @ AMSE
JoHanna Sanders, age 12, a picture of someone enjoying nature and a theme that science is all around us.
Sascha Richey, age 8, drew a picture of her mother and explained why her mother is her favorite scientist.

Where to go from here?
Contact the map makers via the exhibit curators:
Katy Börner (katy@indiana.edu) and Elisha Hardy (efhardy@indiana.edu)

Computational Scientometrics:
Studying Science by Scientific Means

- Places & Spaces: Mapping Science exhibit, see also http://scimaps.org.
Cyberinfrastructures for a Science of Science

Scholarly Database of 18 million scholarly records
https://sdb.slis.indiana.edu

Information Visualization Cyberinfrastructure
http://iv.slis.indiana.edu

Network Workbench Tool and Community Wiki
*NEW* Scientometrics plugins
http://nwb.slis.indiana.edu

Epidemics Cyberinfrastructure
http://epic.slis.indiana.edu/

http://sci.slis.indiana.edu
The End.