Plug and Play Macroscopes: Empowering Anyone To Convert Data Into Insights

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School of Informatics and Computing and Indiana University Network Science Institute
Indiana University, USA

RKII Room 7111, NHLBI Division of Cardiovascular Sciences
Rockledge Two, 6701 Rockledge Drive, Bethesda, MD

February 11, 2016

Map of Scientific Collaborations from 2005-2009

### Type of Analysis vs. Level of Analysis

<table>
<thead>
<tr>
<th></th>
<th>Micro/Individual (1-100 records)</th>
<th>Meso/Local (101–100,000 records)</th>
<th>Macro/Global (100,000 &lt; records)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statistical Analysis/Profiling</strong></td>
<td>Individual person and their expertise profiles</td>
<td>Larger labs, centers, universities, research domains, or states</td>
<td>All of NSF, all of USA, all of science.</td>
</tr>
<tr>
<td><strong>Temporal Analysis (When?)</strong></td>
<td>Funding portfolio of one individual</td>
<td>Mapping topic bursts in 20-years of PNAS</td>
<td>113 Years of Physics Research</td>
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<tr>
<td><strong>Geospatial Analysis (Where?)</strong></td>
<td>Career trajectory of one individual</td>
<td>Mapping a states intellectual landscape</td>
<td>PNAS publications</td>
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<tr>
<td><strong>Topical Analysis (What?)</strong></td>
<td>Base knowledge from which one grant draws.</td>
<td>Knowledge flows in Chemistry research</td>
<td>VxOrd/Topic maps of NIH funding</td>
</tr>
<tr>
<td><strong>Network Analysis (With Whom?)</strong></td>
<td>NSF Co-PI network of one individual</td>
<td>Co-author network</td>
<td>NIH’s core competency</td>
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</tbody>
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### Mapping Indiana’s Intellectual Space

Identify
- Pockets of innovation
- Pathways from ideas to products
- Interplay of industry and academia
Research Collaborations by the Chinese Academy of Sciences
Huang, Duhon, Hardy & Börner

VIVO Researcher Networking System
http://vivo-netsc.ons.ii.edu/vivo12/vis/map-of-science/Person74
VIVO Researcher Networking System
http://vivo-netsci.cns.iu.edu/vivo12/vis/map-of-science/Person74

Individual Co-PI Network
Ke & Börner. 2006.
Mapping the Evolution of Co-Authorship Networks
Ke, Visvanath & Börner. 2004. Won 1st prize at the IEEE InfoVis Contest.
Mapping Transdisciplinary Tobacco Use Research Centers Publications

Compare R01 investigator-based funding with TTURC Center awards in terms of number of publications and evolving co-author networks.


Supported by NIH/NCI Contract HHSN261200800812

NIH RePORTER: Existing Interface

http://projectreporter.nih.gov
CIShell/Sci2 World and Science Visualizations of NIH RePORTER Data

NIH RePORTER: NIH Map

http://nihmaps.org
NIH Twitter Network

Illuminated Diagram: Searchable World and Science Maps, [http://cns.iu.edu/interactive_displays.html](http://cns.iu.edu/interactive_displays.html)
Science Maps in "Expedition Zukunft" science train visited 62 cities in 7 months. Opening on April 23rd, 2009 by German Chancellor Merkel
Places & Spaces Exhibit at the David J. Sencer CDC Museum, Atlanta, GA
January 25-June 17, 2016

Seeing for Action - Using Maps and Graphs to Protect the Public’s Health.

CDC Opening Event: Maps of Health Tutorial and Symposium
February 4-5, 2016
MACROSCOPES FOR INTERACTING WITH SCIENCE

http://scimaps.org/iteration/11


Background and Goals
The Places & Spaces Mapping Science exhibit was created to communicate human activity and scientific progress on a globe that enable the close inspection of large-scale maps in public conferences; (2) novel, interactive macroscopes tools that let

Themes for the upcoming iterations/years are:
- 11th Iteration (2016): Macroscopes for Interacting With Science
- 12th Iteration (2016): Macroscopes for Making Sense of Science
- 13th Iteration (2017): Macroscopes for Forecasting Science
- 14th Iteration (2018): Macroscopes for Economic Decision Makers
Information Visualization Framework
&
IVMOOC
Needs-Driven Workflow Design

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

Data → READ → ANALYZE → VISUALIZE → DEPLOY

Validation Interpretation

Visually encode data
Overlay data
Select visualiz. type

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

#### Insight Need Types
- categorize/cluster
- order/rank/sort
- distributions (also outliers, gaps)
- comparisons
- trends (process and time)
- geospatial
- compositions (also of text)
- correlations/relationships

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

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

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

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

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

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### Basic Task Types

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<td>compare</td>
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<td>compare and contrast</td>
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<td>time</td>
<td>process and time</td>
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<td>location</td>
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<td>generate maps</td>
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<td>quantity</td>
<td>part-to-whole</td>
<td>proportions</td>
<td>form and structure</td>
<td>see parts of whole, analysis/text</td>
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<td>association</td>
<td>correlate</td>
<td>correlation</td>
<td>relationships, hierarchy</td>
<td>relations between data points</td>
<td></td>
<td></td>
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</table>
## Visualization Framework

### Insight Need Types
- categorize/cluster
- order/rank/sort
- distributions (also outliers, gaps)
- comparisons
- trends (process and time)
- geospatial
- compositions (also of text)
- correlations/relationships

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

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

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

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

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

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### Visualization Types (Reference Systems)

1. **Charts**: No reference system—e.g., Wordle.com, pie charts
2. **Tables**: Categorical axes that can be selected, reordered; cells can be color coded and might contain proportional symbols. Special kind of graph.
3. **Graphs**: Quantitative or qualitative (categorical) axes. Timelines, bar graphs, scatter plots.
4. **Geospatial maps**: Use latitude and longitude reference system. World or city maps.
5. **Network graphs**: Node position might depends on node attributes or node similarity. **Tree graphs**: hierarchies, taxonomies, genealogies. **Networks**: social networks, migration flows.
IVMOOC App – More than 60 visualizations

The “IVMOOC Flashcards” app can be downloaded from Google Play and Apple iOS stores.

Visualization Framework

<table>
<thead>
<tr>
<th>Insight Need Types</th>
<th>Data Scale Types</th>
<th>Visualization Types</th>
<th>Graphic Symbol Types</th>
<th>Graphic Variable Types</th>
<th>Interaction Types</th>
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</thead>
<tbody>
<tr>
<td>page 26</td>
<td>page 28</td>
<td>page 30</td>
<td>page 32</td>
<td>page 14</td>
<td>page 26</td>
</tr>
<tr>
<td>categorical/cluster</td>
<td>nominal</td>
<td>table</td>
<td>geometric symbols</td>
<td>spatial</td>
<td>overview</td>
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<tr>
<td>order/rank/sort</td>
<td>ordinal</td>
<td>chart</td>
<td>point</td>
<td>position</td>
<td>zoom</td>
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<tr>
<td>distributions</td>
<td>interval</td>
<td>graph</td>
<td>line</td>
<td>retrieval</td>
<td>search and locate</td>
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<tr>
<td>outliers, gaps</td>
<td>ratio</td>
<td>map</td>
<td>area</td>
<td>form</td>
<td>filter</td>
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<td>surface</td>
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<td>(process and time)</td>
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<td>linguistic symbols</td>
<td>motion</td>
<td>extract</td>
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<tr>
<td>geospatial</td>
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<td></td>
<td>text</td>
<td></td>
<td>link and brush</td>
</tr>
<tr>
<td>compositions</td>
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<td>punctuation marks</td>
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<td>projection</td>
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<tr>
<td>(also of text)</td>
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<td>pictorial symbols</td>
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<td>correlations</td>
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<td>statistical glyphs</td>
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</tbody>
</table>

See page 24

Course Schedule

Part 1: Theory and Hands-On
- Session 1 – Workflow Design and Visualization Framework
- Session 2 – “When:” Temporal Data
- Session 3 – “Where:” Geospatial Data
- Session 4 – “What:” Topical Data

Mid-Term
- Session 5 – “With Whom:” Trees
- Session 6 – “With Whom:” Networks
- Session 7 – Dynamic Visualizations and Deployment

Final Exam

Part 2: Students work in teams on client projects.

Final grade is based on Class Participation (10%), Midterm (30%), Final Exam (30%), and Client Project(30%).
Load **One** File and Run **Many** Analyses and Visualizations

<table>
<thead>
<tr>
<th>Times Cited</th>
<th>Publication Year</th>
<th>City of Publisher</th>
<th>Country</th>
<th>Journal Title (Full)</th>
<th>Title</th>
<th>Subject Category</th>
<th>Authors</th>
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<tr>
<td>12</td>
<td>2011</td>
<td>NEW YORK</td>
<td>USA</td>
<td>COMMUNICATIONS OF THE ACM</td>
<td>Plug-and-Play Macrosopes</td>
<td>Computer Science</td>
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<td>18</td>
<td>2010</td>
<td>MALDEN</td>
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<td>CTS-CLINICAL AND TRANSLATIONAL SCIENCE</td>
<td>Advancing the Science of Team Science</td>
<td>Research &amp; Experimental Medicine</td>
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Co-author and many other bi-modal networks.
This conference is co-funded by the NSF Science of Science and Innovation Policy (SciSIP) program. It brings together international experts and practitioners that develop and apply mathematical, statistical, and computational models to increase our understanding of the structure and dynamics of science, technology and innovation, see details at http://modsti.cns.iu.edu.

References


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

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