JOIN US: AAAS LUNCHEON DISCUSSION

VISUALIZATION METAPHORS FOR COMMUNICATING THE STRUCTURE AND DYNAMICS OF SCIENCE
JULIA LAURIN, THOMSON REUTERS AND KATY BÖRNER, INDIANA UNIVERSITY

Please join us and take part in our lunchtime discussion titled "Visualization Metaphors for Communicating the Structure and Dynamics of Science" hosted by Julia Laurin, Thomson Reuters and Katy Börner, Indiana University.

Date: Sunday, February 15, 2015

Time: 12 PM to 1 PM (PST)

Location: San Jose Convention Center
AAAS Conference Room: Glen Ellen
150 West San Carlos Street
San Jose, CA 95113

This luncheon will provide an opportunity for those who produce and work with maps of science to discuss the challenges of visualizing non-spatial scientific activity and investigate concrete ways for scholars and industry to advance understanding and engagement with maps of science. Brief talks by leading experts and brainstorming will be used to identify: What visual metaphors have been successful for representing trends, emerging research areas, or bursts of activity, etc.? Are there best practices for representing non-spatial information? How can the different teams producing maps of science collectively enhance the legibility and utility of science maps?
Agenda

Welcome by Julia and Katy

Setting the Stage:
Visual Languages: Industry Pull
by Julia Laurin, Thomson Reuters
Visualization Frameworks: Academic Push
by Katy Börner, Indiana University

Invited Talk:
Visualizing Knowledge Spaces: Cartographic Perspectives
by Dr. André Skupin, Geography, San Diego State University

Discussion
Visual Languages: Industry Pull
by Julia Laurin, Thomson Reuters
Visualizing Across Domains: Lessons Learned

- Intellectual Property: Thomson Data Analyzer
  - Support multiple approaches to data

- Life Sciences: Cortellis Data Fusion
  - User-driven and use case driven

- Scholarly Research: Web of Science
  - Balancing transparency and usability
Graph Analytics: Answering the Big Questions

Mission: *Research and develop solutions which support graph data, analytics and machine learning at big data scales*  

How do we provide research funders with **areas of research on the verge of developing** into new fields and worthy of deeper funding?  

How do we provide scientific researchers with a **topic hierarchy for research discovery which remains current w/rt recently published articles**?  

How do we provide university administrators with **aggregation tools that effectively disambiguate entities** like people and organizations?  

- graph community detection and prediction
- graph-based topic generation and clustering
- graph-based pattern matching
Getting from Table to Graph

37,225,696 publications
602,346,147 total citations
Mapping Science Requires *a lot of Choices*

- Insight needed
- Types of analysis
- Levels of analysis
- Data scale types
- Visualization types
- Graphic symbol types
- Level of interactivity
Uncharted Territory – Together

- Visual perception and cognition
- Power of big computing
- Sheer complexity of data
- Interactive and 3D gamification
Visualization Frameworks: Academic Push
by Katy Börner, Indiana University
De-Facto Standardization of Science Basemaps
How to Classify Different Visualizations?

By

• User insight needs?
• User task types?

• Data to be visualized?
• Data transformation?

• Visualization technique?
• Visual mapping transformation?
• Interaction techniques?

How to support the design of effective visualizations by experts and citizen scientists?
# Study

## Levels

<table>
<thead>
<tr>
<th>LEVELS</th>
<th>MICRO: Individual Level</th>
<th>MESO: Local Level</th>
<th>MACRO: Global Level</th>
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<tbody>
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## Types

<table>
<thead>
<tr>
<th>TYPES</th>
<th>Statistical Analysis</th>
<th>WHEN: Temporal Analysis</th>
<th>WHERE: Geospatial Analysis</th>
<th>WHAT: Topical Analysis</th>
<th>WITH WHOM: Network Analysis</th>
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<tbody>
<tr>
<td>page 44</td>
<td>Knowledge Cartography</td>
<td>Productivity of Russian life sciences research teams</td>
<td>Victorian poetry in Europe</td>
<td>Evolving journal networks in nanotechnology</td>
<td>Electronic and new media art networks</td>
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<td>world-wide scholarly collaboration networks</td>
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</table>

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Workflow Design

Acquire
User Needs Acquisition, page 40
Data Acquisition, page 42

Interpret
Validation and Interpretation, page 72

Analyze & Visualize
Statistical Studies, page 44
Statistical Visualization Types, page 46
Temporal Studies—“When”, page 48
Temporal Visualization Types, page 50
Geospatial Studies—“Where”, page 52
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Studying Dynamics, page 64

Deploy
Human-Computer Interface, page 70
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Types relevant for the design of effective visualizations

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<th>Insight Need Types</th>
<th>Data Scale Types</th>
<th>Visualization Types</th>
<th>Graphic Symbol Types</th>
<th>Graphic Variable Types</th>
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# Types relevant for the design of effective visualizations

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See page 30
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 depend on node attributes or node similarity. **Tree graphs**: hierarchies, taxonomies, genealogies. **Networks**: social networks, migration flows.
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### Graphic Variable Types Versus Graphic Symbol Types

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<td>y</td>
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<td>z</td>
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<thead>
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<th>Temporal</th>
<th>Qualitative</th>
<th>Geometric Symbols</th>
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| Size     | Quantitative | ![Size symbols] |
| Shape    | Qualitative  | ![Shape symbols] |
| Rotation | Quantitative | ![Rotation symbols] |
| Curvature| Quantitative | ![Curvature symbols] |
| Angle    | Quantitative | ![Angle symbols] |
| Closure  | Quantitative | ![Closure symbols] |

| Value    | Quantitative | ![Value symbols] |
| Hue      | Qualitative  | ![Hue symbols] |
| Saturation| Quantitative | ![Saturation symbols] |

See page 36
Atlas of Knowledge: Anyone Can Map
by Katy Börner
To be published by MIT Press on March 13, 2015
Pre-Order Now

13 x 11, 250 pp.
580 illus.
978-0-262-02881-3
Download informational flyer

Introduction

In an age of information overload, the ability to make sense of vast amounts of data and to render insightful visualizations is as important as the ability to read and write. The Atlas of Knowledge explains and exemplifies the power of visualizations not only to help locate us in physical space but also to help us understand the extent and structure of our collective knowledge, to identify bursts of activity, pathways of ideas, and borders that beg to be crossed.

Drawing on 15 years of research and tool development, the Atlas introduces a theoretical visualization framework meant to empower anyone to systematically render data into insights. It aims to teach "timeless" knowledge that

http://scimaps.org/atlas2
Overview

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

The course can be taken for three Indiana University credits as part of the Online Data Science Program, as part of the Information and Library Science M.S. program, and as part of the online Data Science M.S. Program offered by the School of Informatics and Computing. Students seeking enrollment information should contact Rhonda Spencer at 812-855-2018, ilsmain@indiana.edu or datasci@indiana.edu.

Among other topics, the course covers:

- Data analysis algorithms that enable extraction of patterns and trends in data
- Major temporal, geospatial, topical, and network visualization techniques
- Discussions of systems that drive research and development.

http://ivmooc.cns.iu.edu
Invited Talk:
Visualizing Knowledge Spaces: Cartographic Perspectives
by Dr. André Skupin, Geography, San Diego State University
What is Visualization?
Cartographic Lesson I: “Space – The Final Frontier”
Cartographic Lesson II: “It’s all been done before!”
The Power of Spatial Concepts
Gallery of Base Maps
Visualization for Impact: Partners, Cultures, Values
“Visualization is a data-driven representation aimed at amplifying cognition, frequently supported by computation and interactivity.”
**Knowledge Visualization**

See: http://scimaps.org/

**Spaces of Visualization**

- **Geographic Space**
  - Discrete objects
  - Continuous fields

- **Vector Space**
  - Entities
  - Properties

- **Network Space**
  - Nodes
  - Links

- **Knowledge Space**
  - Domains
  - Actors
  - Concepts
  - Artifacts
**It’s all been done before**

- Data → Symbols → Understanding
- Scale & Abstraction
- Semantic Zooming
- Base Map Creation
- Base Map Use
- Thematic Overlays
- Truth in Mapping

**Data → Symbols → Understanding**

*visual | graphic | semiotic* variables

- for static maps
  - Bertin (1967/1983)
    - seven variables
      - *Position*
      - Size
      - Value
      - Texture
      - Hue
      - Orientation
      - Shape
### Visual | Graphic | Semiotic Variables

- for static maps
  - Bertin+
    - eight variables
      - size
      - value
      - saturation
      - pattern texture
      - pattern arrangement
      - hue
      - orientation
      - shape

- quantitative data
  - size
  - value
  - saturation
  - pattern texture

- qualitative data
  - pattern arrangement
  - hue
  - orientation
  - shape
Data → Symbols → Understanding

visual | graphic | semiotic variables

- for static maps
  - Bertin+
    - quantitative data
      - size
      - value
      - saturation
      - pattern texture
  - qualitative data
    - pattern arrangement
    - hue
    - orientation
    - shape

- for animated maps
  - duration
  - rate of change
  - order
  - display date
  - frequency
  - synchronization

Scale & Abstraction

From: Zondervan (1901)
Allgemeine Karten kunde, Leipzig:
B. G. Teubner. (Original source: Sydow-Wagners Methodischer Schulatlas)
From Raw Data to Relevant Insight

Power of Concepts: Author as Discrete Object


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Visualization for Impact:
Partners, Cultures, Values

- Impactful Visualization
  - Inspire [domain experts]
  - Connect [across disciplines]
  - Understand [domain patterns]

- Power of Diversity
  - Partners
  - Institutions
  - Disciplines
  - Cultures
  - Technologies
  - Values
Right knowledge focuses on domain-specific knowledge management and analytics solutions. We enable domain communities to discover, manage, and operationalize the knowledge inherent among vast and ever-growing data, ranging from term ontologies to large collections of text, context, pedo- and multidatabases. The domains in which we operate include higher education, healthcare, biomedicine, law, and finance.

Knowledge Management
Set your organization's knowledge tree: with ontology-driven solutions for capturing, interpreting, and unifying multi-disciplinary domain knowledge. Learn more...

Knowledge Analytics
Advanced computational and visual solutions for turning large document collections into actionable insights, engaging users in real-time. Learn more...

Knowledge Engineering
Uniquely multi-structural approaches for leveraging the knowledge hidden in unstructured data, research data, and problems in support of domain understanding and decision-making. Learn more...