Visual Insights: A Practical Guide to Making Sense of Data

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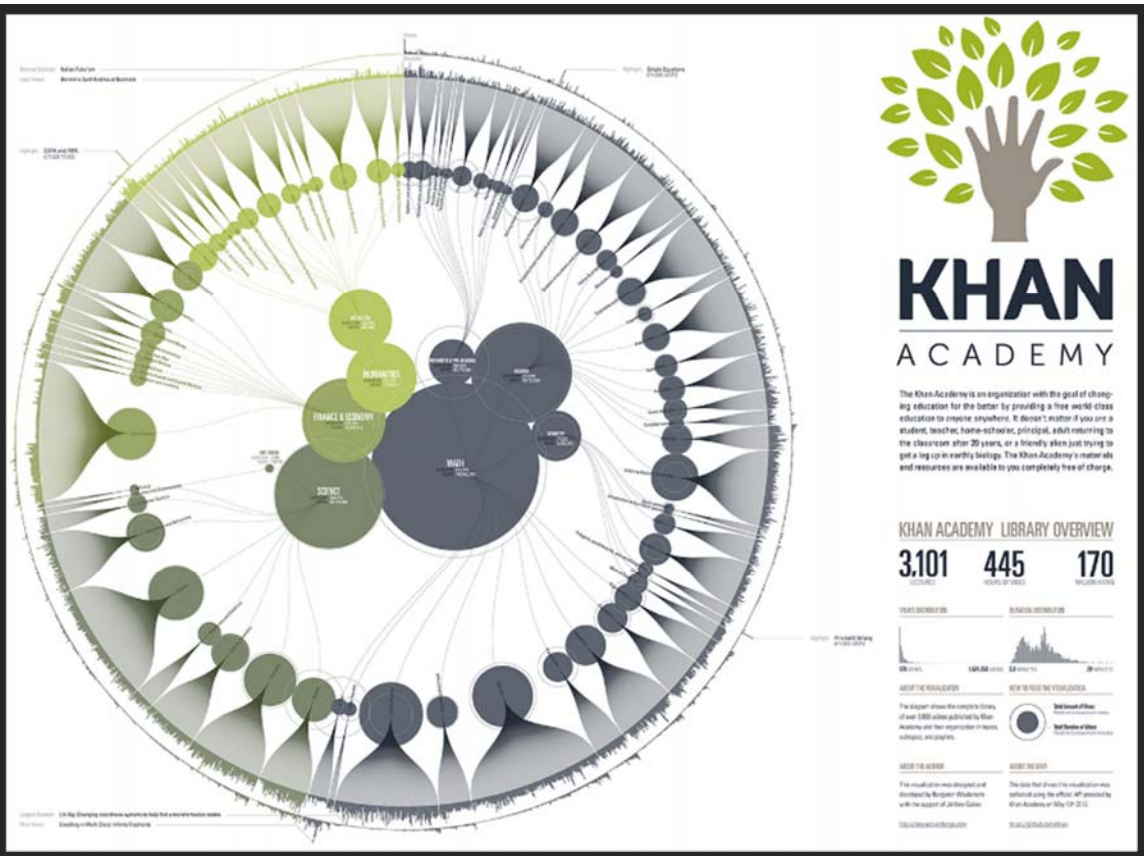
With special thanks to the members of the Cyberinfrastructure for Network Science Center

Keynote for NSF's CS10K initiative to support high school computer science teachers around the country who are teaching or preparing to teach Computer Science Principles (CSP).

December 6, 2013

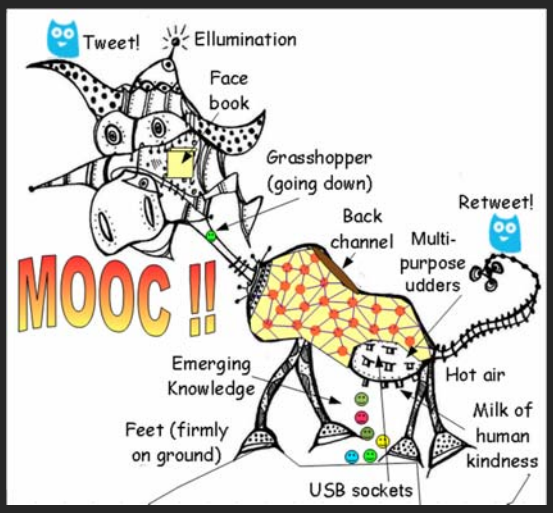


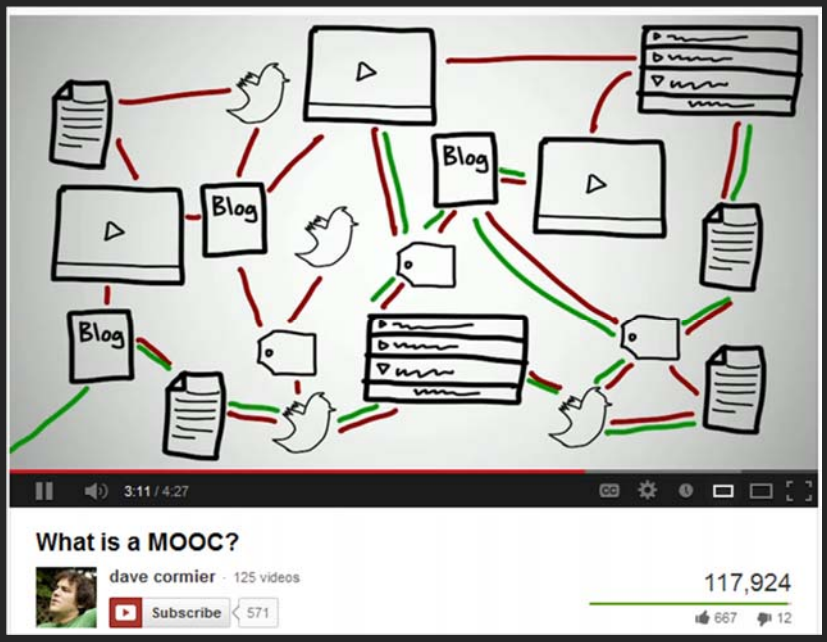
http://scimaps.org/maps/map/khan_academy_library_147 by Benjamin Wiederkehr & Jérôme Cukier

MOOCs

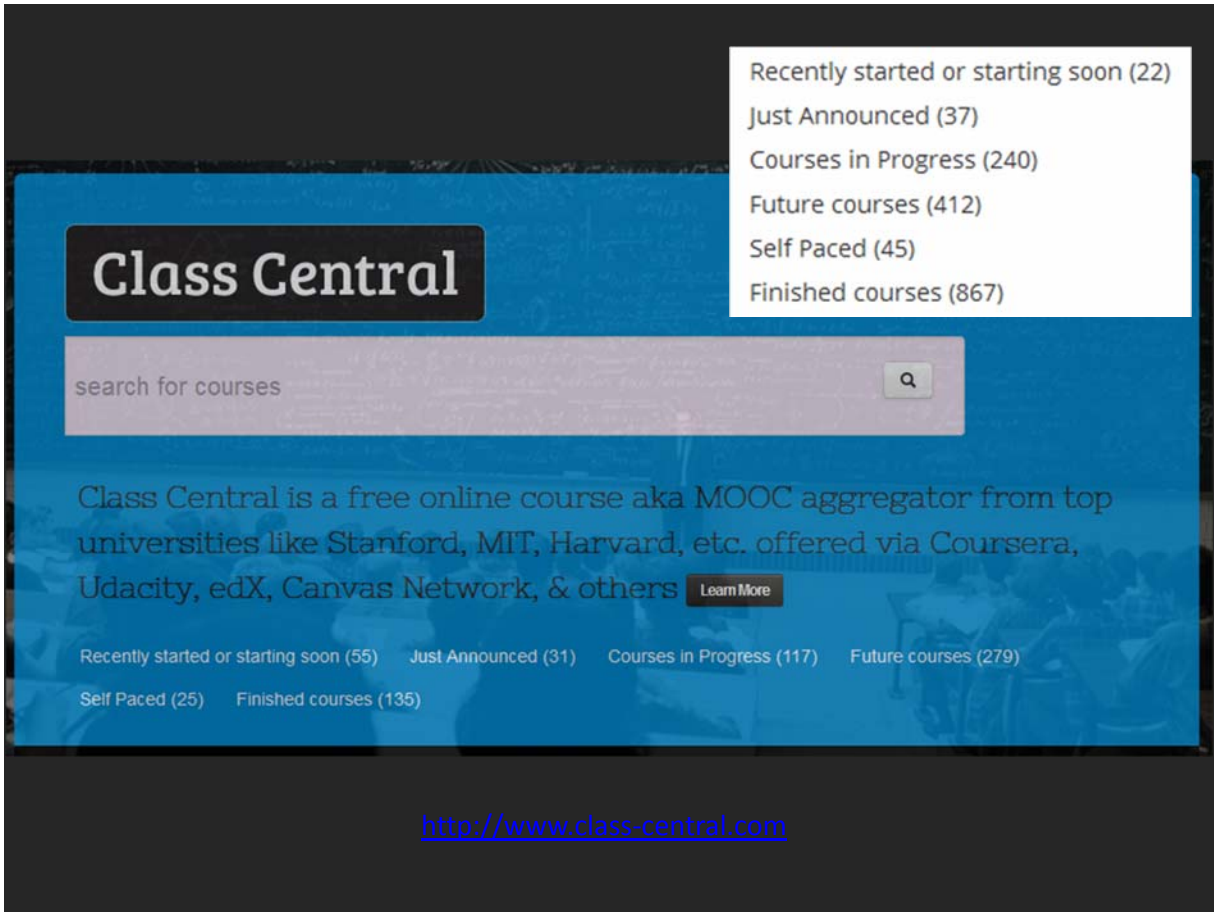
In 2012, Google hosted three massive open online courses (MOOCs) collectively reaching over 400,000 registrants.

By the end of 2013 more than 250 courses will be run using the Google, Coursera, Udacity, EdX, and other platforms.

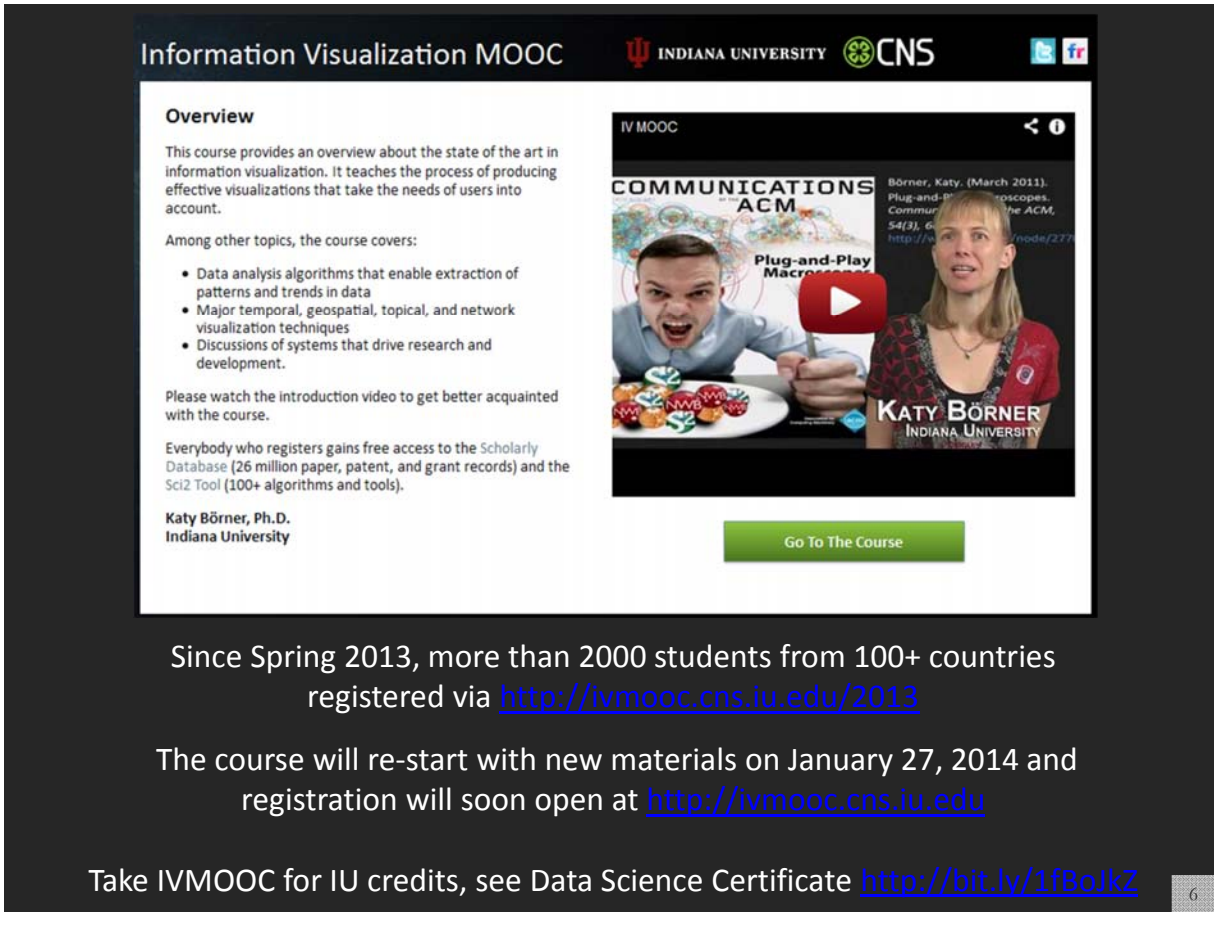




http://www.youtube.com/watch?feature=player_embedded&v=eW3gMGocZQc#at=128



http://www.class-central.com

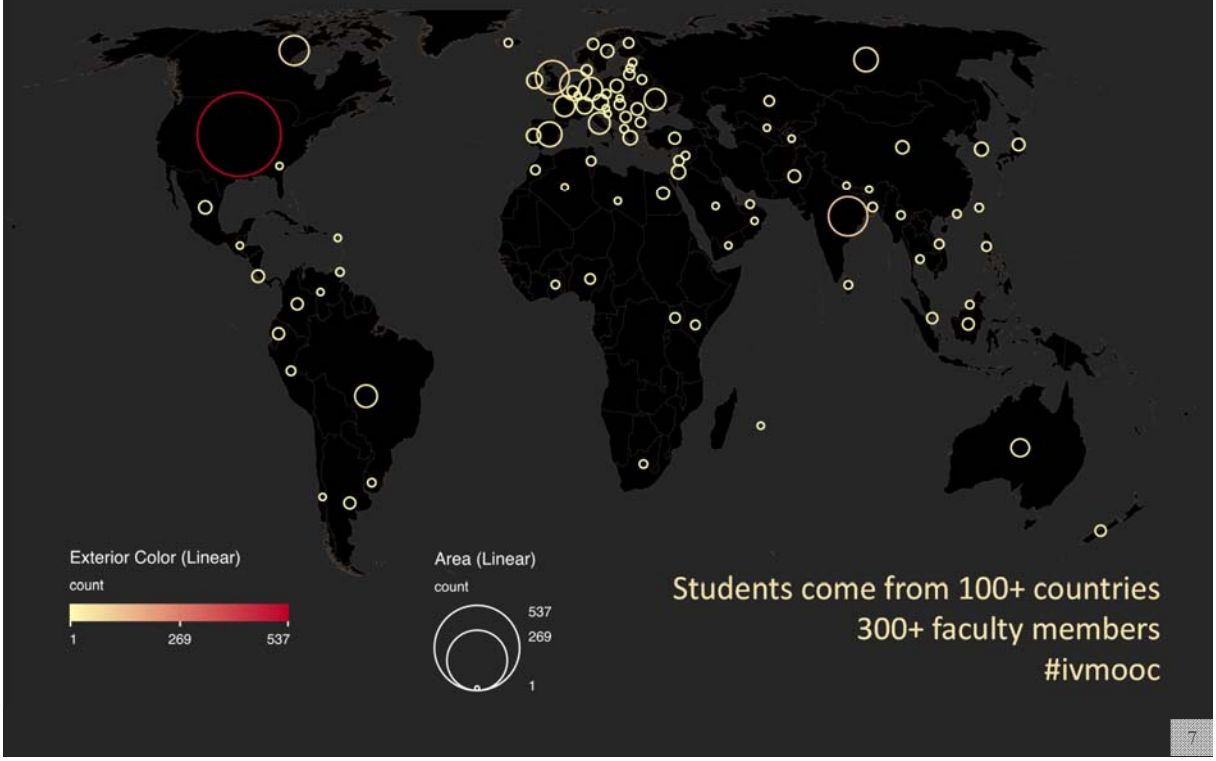


Since Spring 2013, more than 2000 students from 100+ countries registered via http://ivmooc.cns.iu.edu/2013

The course will re-start with new materials on January 27, 2014 and registration will soon open at http://ivmooc.cns.iu.edu

Take IVMOOC for IU credits, see Data Science Certificate http://bit.ly/1fBoJkZ

The Information Visualization MOOC
ivmooc.cns.iu.edu



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Instructors

Katy Börner – Theory Parts
Instructor, Professor at SLIS

David E. Polley – Hands-on Parts
CNS Staff, Research Assistant with MIS/MLS
Teaches & Tests Sci2 Tool

Scott B. Weingart – Client Work
Assistant Instructor, SLIS PhD student

Course Schedule

Course started on January 22, 2013

- **Session 1** – Workflow design and visualization framework
- **Session 2** – "When:" Temporal Data
- **Session 3** – "Where:" Geospatial Data
- **Session 4** – "What:" Topical Data

Mid-Term

Students work in teams with clients.

- **Session 5** – "With Whom:" Trees
- **Session 6** – "With Whom:" Networks
- **Session 7** – Dynamic Visualizations and Deployment

Final Exam

Grading

All students are asked to create a personal profile to support working in teams.

Final grade is based on Midterm (**30%**), Final (**40%**), Client Project (**30%**).

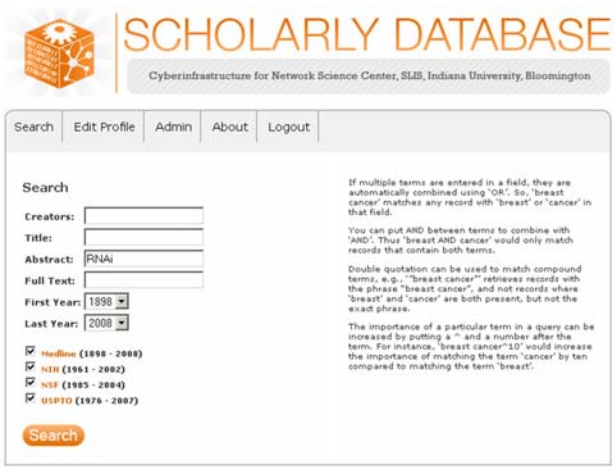
- Weekly self-assessments are not graded.
- Homework is graded automatically.
- Midterm and Final test materials from theory and hands-on sessions are graded automatically.
- Client work is peer-reviewed via online forum.

All students that receive more than **80%** of all available points get an official certificate/badge.

Scholarly Database at Indiana University

http://sdb.wiki.cns.iu.edu

Supports federated search of 26 million publication, patent, clinical trials, and grant records. Results can be downloaded as data dump and (evolving) co-author, paper-citation networks.



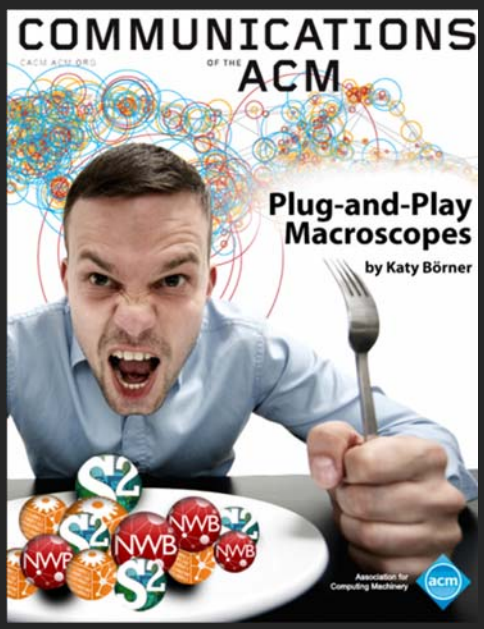
Register for free access at http://sdb.cns.iu.edu

Plug-and-Play Macroscopes
cishell.org

NetworkWorkbench
A Workbench for Network Scientists
cyberinfrastructure for NETWORK SCIENCE CENTER
CIShell Powered

Sci² Tool
A Tool for Science of Science Research & Practice
cyberinfrastructure for NETWORK SCIENCE CENTER
CIShell Powered

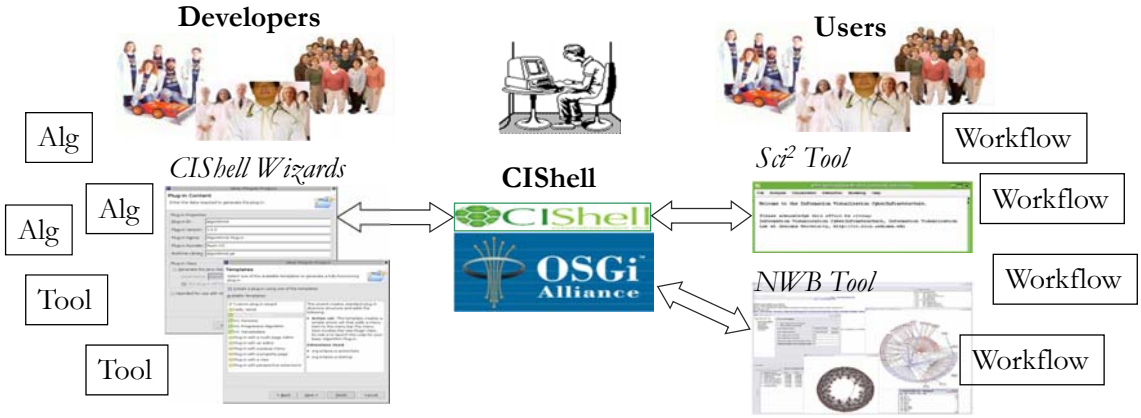
EpiC
cyberinfrastructure for NETWORK SCIENCE CENTER
CIShell Powered



Börner, Katy. (March 2011). Plug-and-Play Macroscopes. *Communications of the ACM, 54(3), 60-69.* http://www.scivee.tv/node/27704

OSGi & Cyberinfrastructure Shell (CIShell)

- CIShell (http://cishell.org) is an open source software specification for the integration and utilization of datasets, algorithms, and tools
- It extends the Open Services Gateway Initiative (OSGi) (http://osgi.org), a standardized, modularized service platform
- CIShell provides "sockets" into which algorithms, tools, and datasets can be plugged using a wizard-driven process



Unit Structure

The course and each unit has three components:

Theory: Videos and Slides
Self-Assessment (not graded)

Hands-on: Videos and Slides & Wiki pages with workflows
Homework (not graded)

Client Work: Using Drupal Forum (graded)

Theory Unit Structure

Each theory unit comprises:

- Examples of best visualizations
- Visualization goals
- Key terminology
- General visualization types and their names

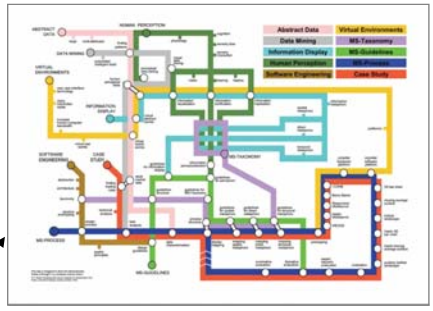
- Workflow design
  - Read data
  - Analyze
  - Visualize

- Discussion of specific algorithms

Different Question Types

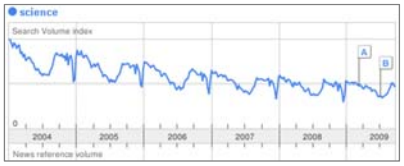
Terabytes of data

Descriptive & Predictive Models



Find your way

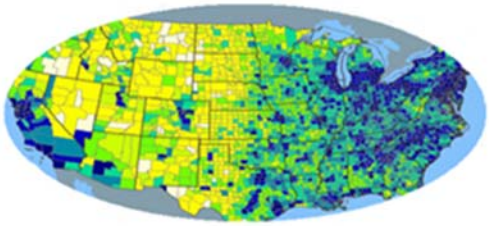
Find collaborators, friends



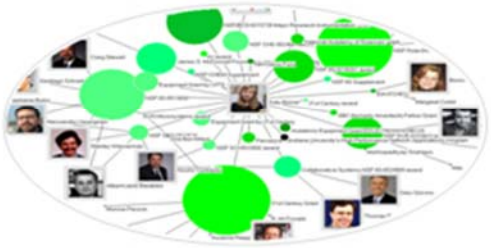
Identify trends

Different Levels of Abstraction/Analysis

Macro/Global
Population Level



Meso/Local
Group Level



Micro
Individual Level

Type of Analysis vs. Level of Analysis

	Micro/Individual (1-100 records)	***Meso/Local (101–10,000 records)***	***Macro/Global (10,000 < records)***
Statistical Analysis/Profiling	Individual person and their expertise profiles	Larger labs, centers, universities, research domains, or states	All of NSF, all of USA, all of science.
Temporal Analysis (When)	Funding portfolio of one individual	Mapping topic bursts in 20 years of *PNAS*	113 years of physics research
Geospatial Analysis (Where)	Career trajectory of one individual	Mapping a state's intellectual landscape	*PNAS* publications
Topical Analysis (What)	Base knowledge from which one grant draws.	Knowledge flows in chemistry research	VxOrd/Topic maps of NIH funding
Network Analysis (With Whom?)	NSF Co-PI network of one individual	Co-author network	NIH's core competency

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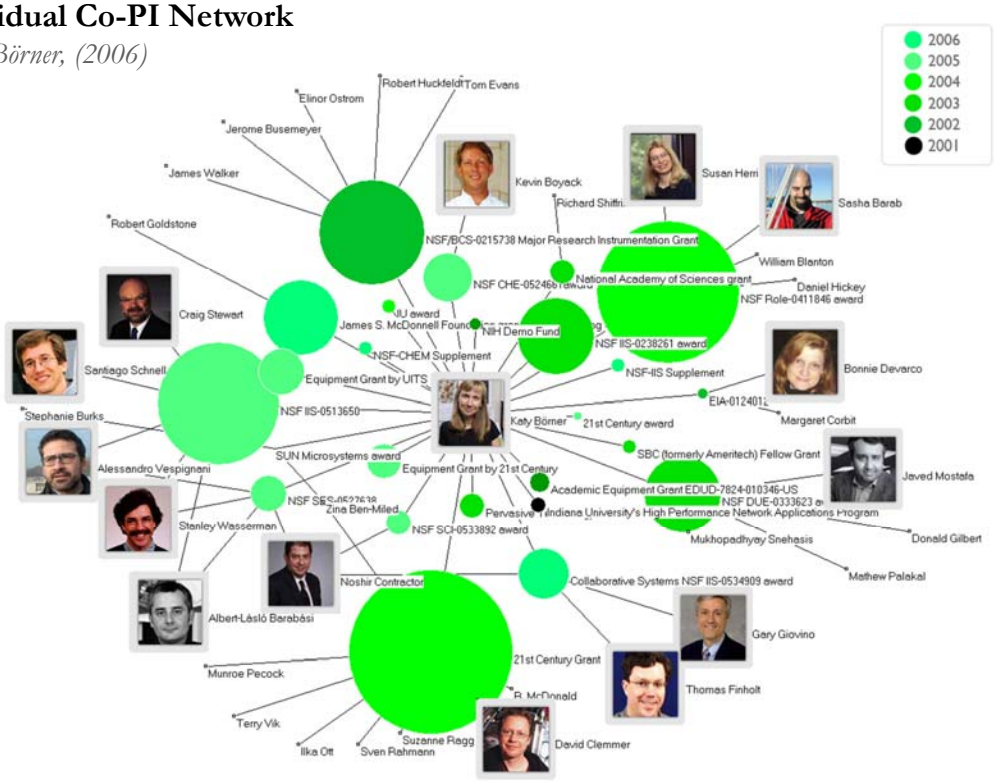
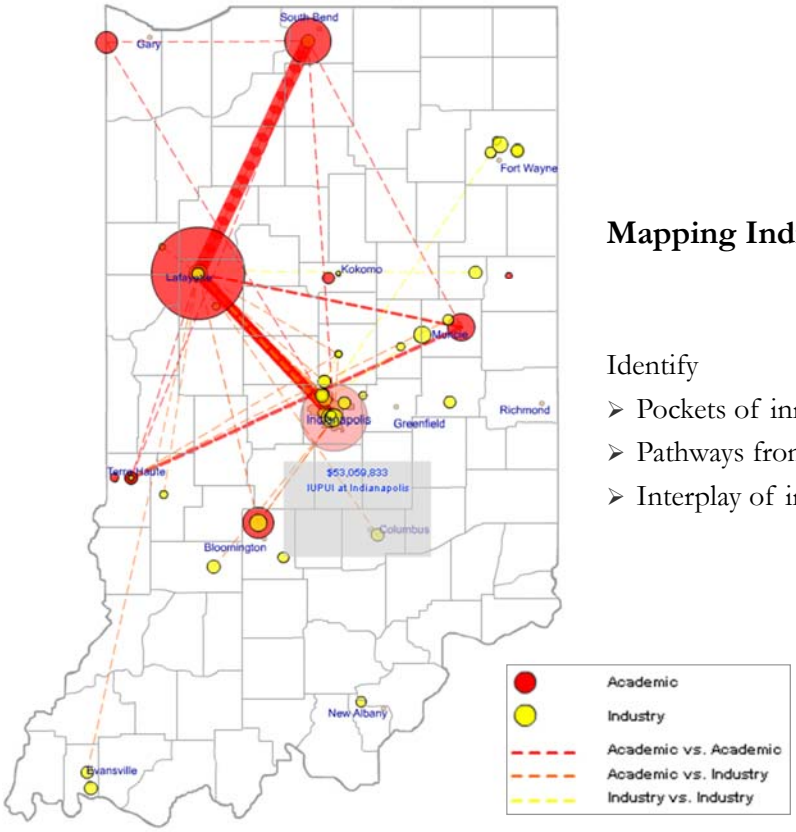
Individual Co-PI Network

Ke & Börner, (2006)





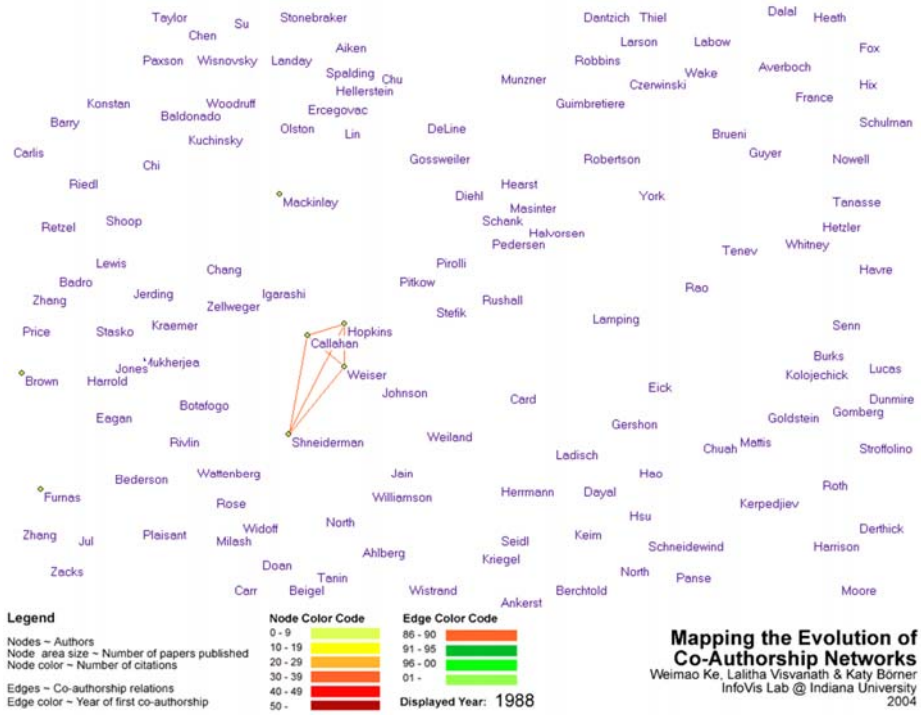
Mapping Indiana's Intellectual Space

Identify

- Pockets of innovation
- Pathways from ideas to products
- Interplay of industry and academia

Mapping the Evolution of Co-Authorship Networks

Ke, Visvanath & Börner, (2004) Won 1st price at the IEEE InfoVis Contest.



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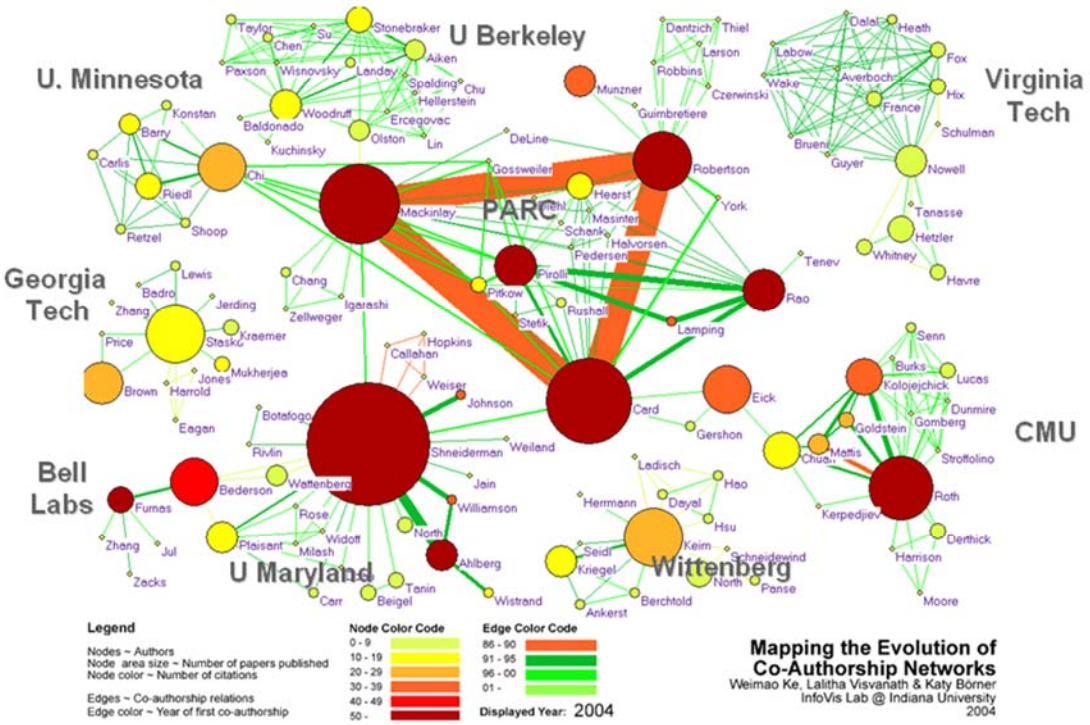
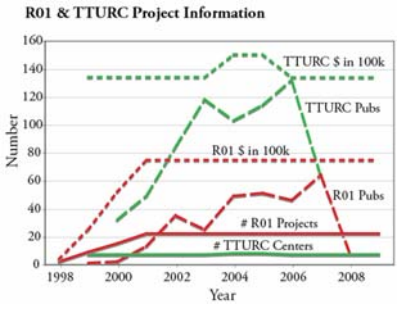


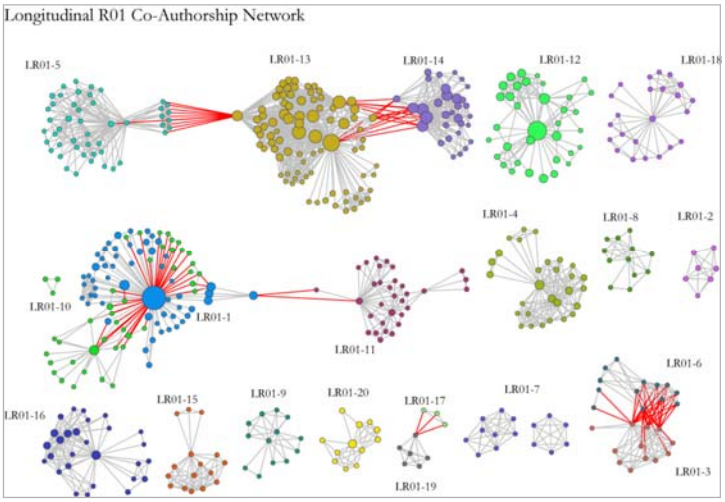
Mapping Transdisciplinary Tobacco Use Research Centers Publications

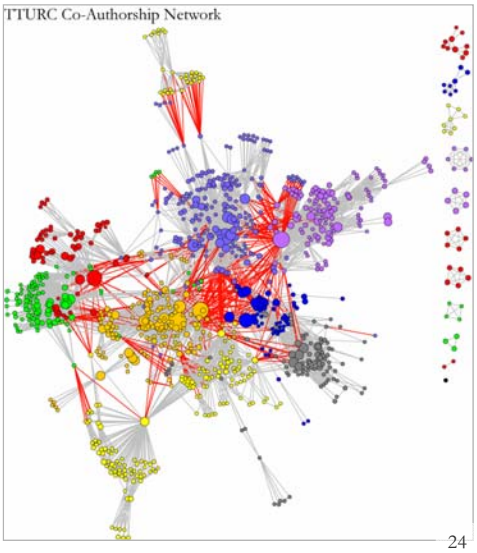
Compare R01 investigator based funding with TTURC Center awards in terms of number of publications and evolving co-author networks.

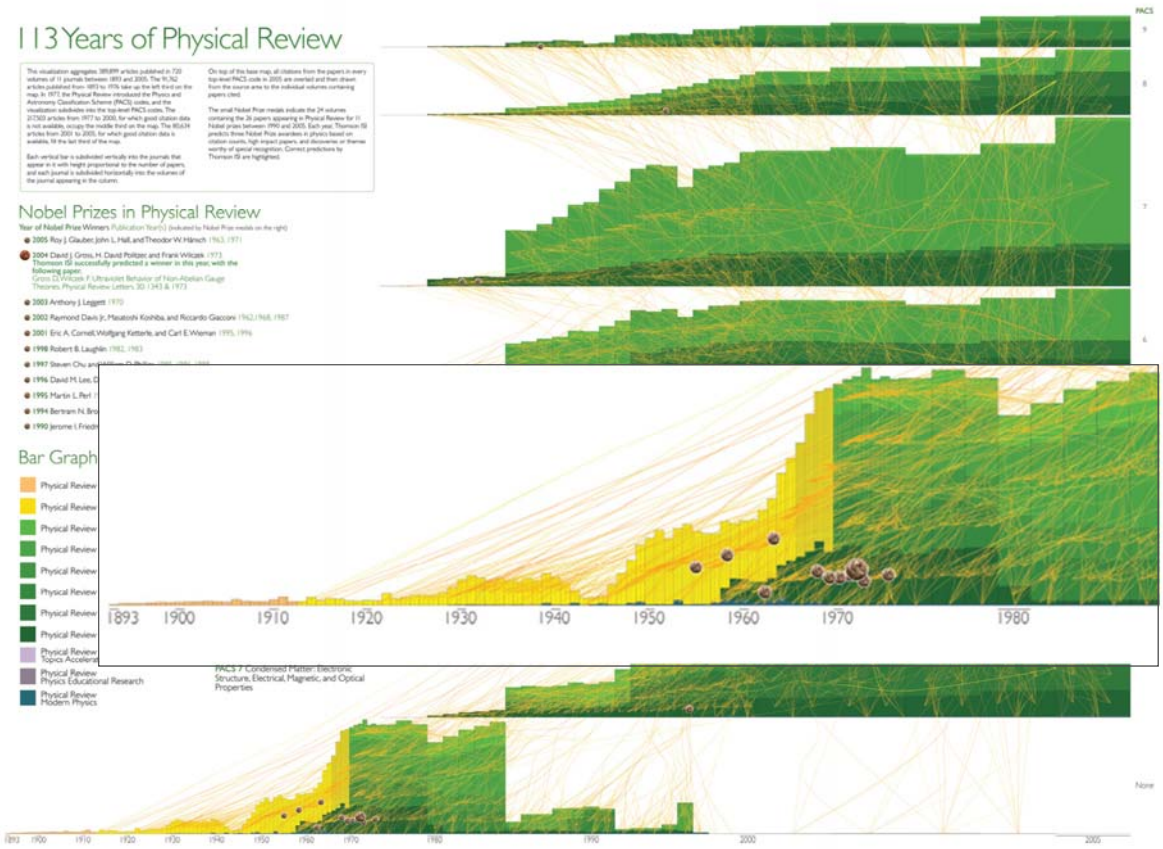
Zoss & Börner, forthcoming.

Supported by NIH/NCI Contract HHSN261200800812









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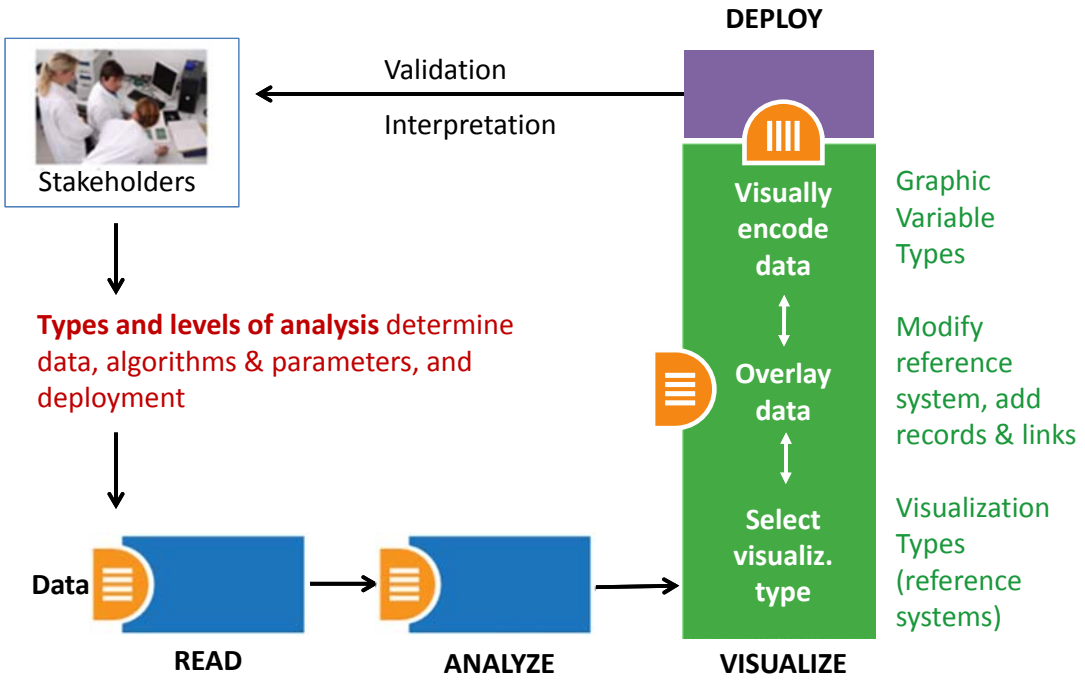
Needs-Driven Workflow Design



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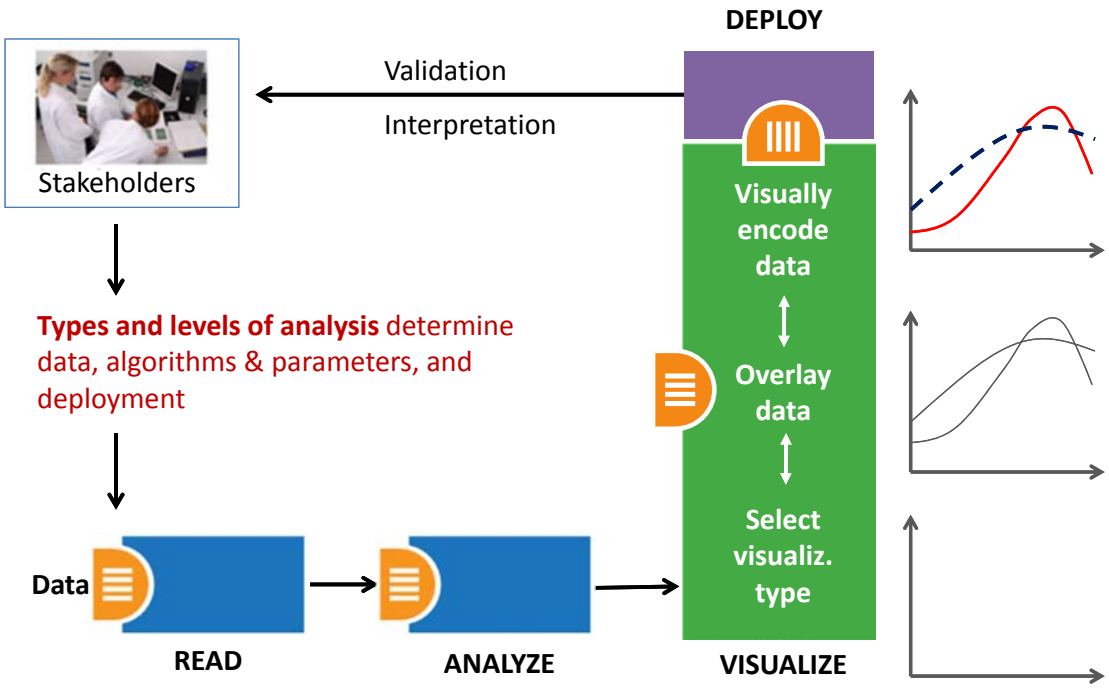

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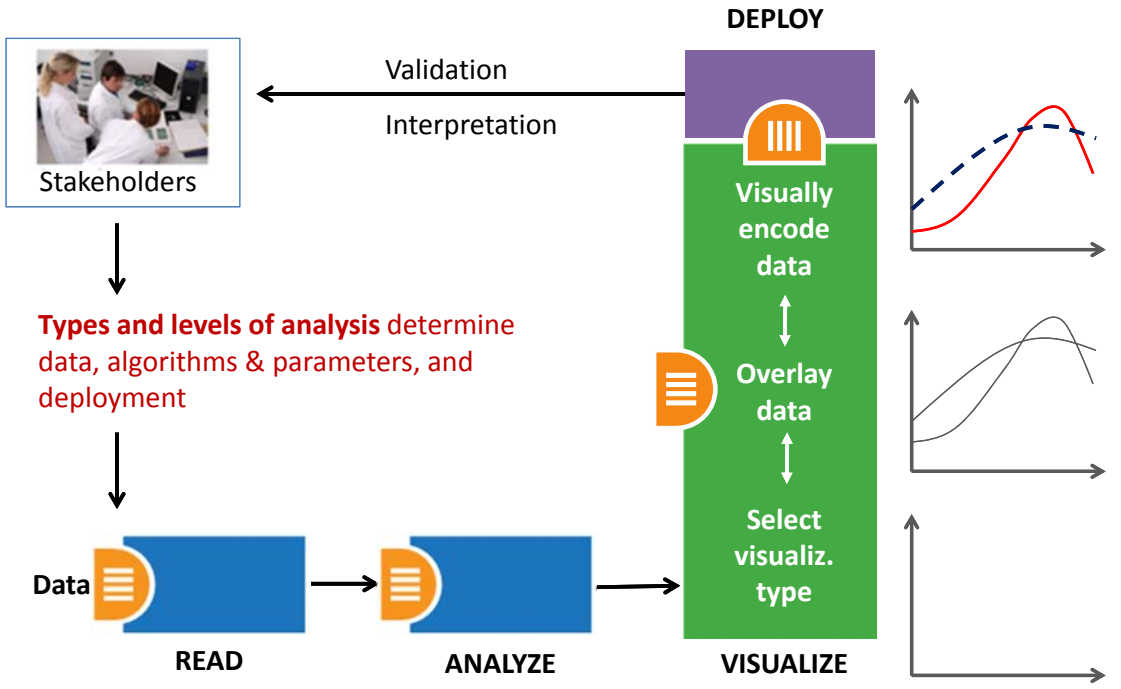

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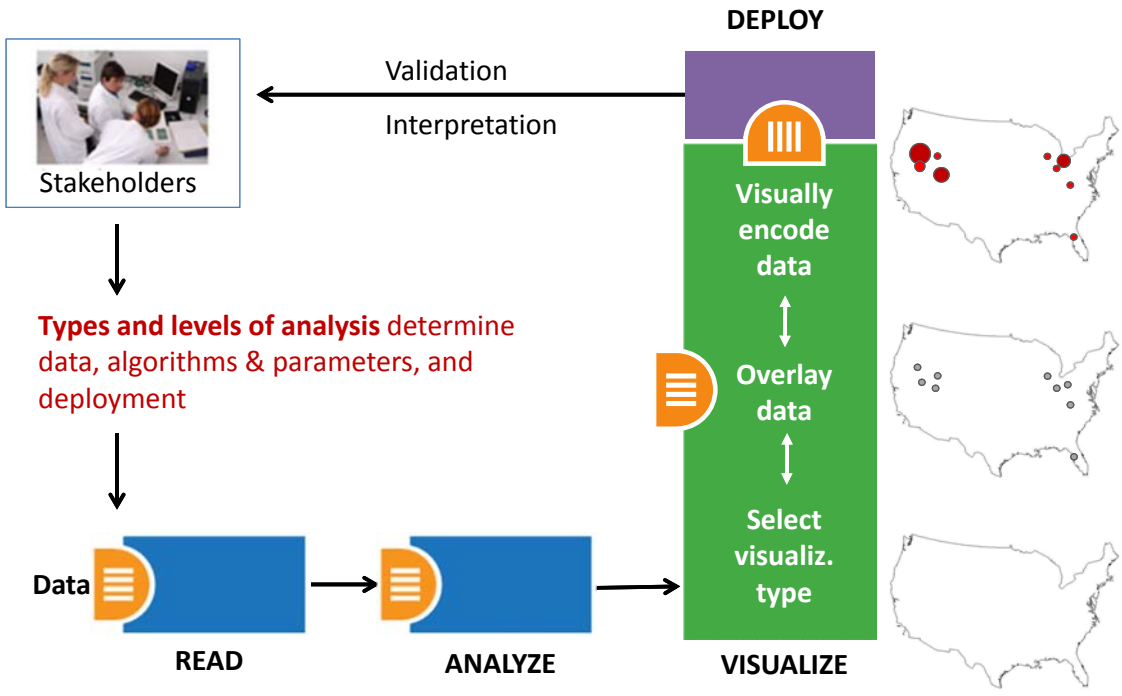

Visualization Types vs. Data Overlays

Visualization Type	Chart	Table	Graph	Geospatial Map	Network Graph
Modify / **visually encode** base map.					
Place and **visually encode** records/nodes.					
Place and **visually encode** links.					

Plus, add a title, labels, legend, explanatory text, and author info.

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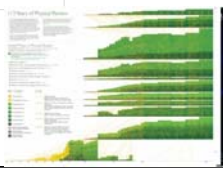
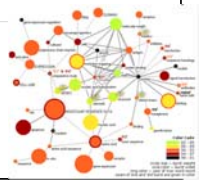
Place and **visually encode** links.					

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Course Schedule

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Mid-Term

Students work in teams with clients.

- **Session 5** – "With Whom:" Trees
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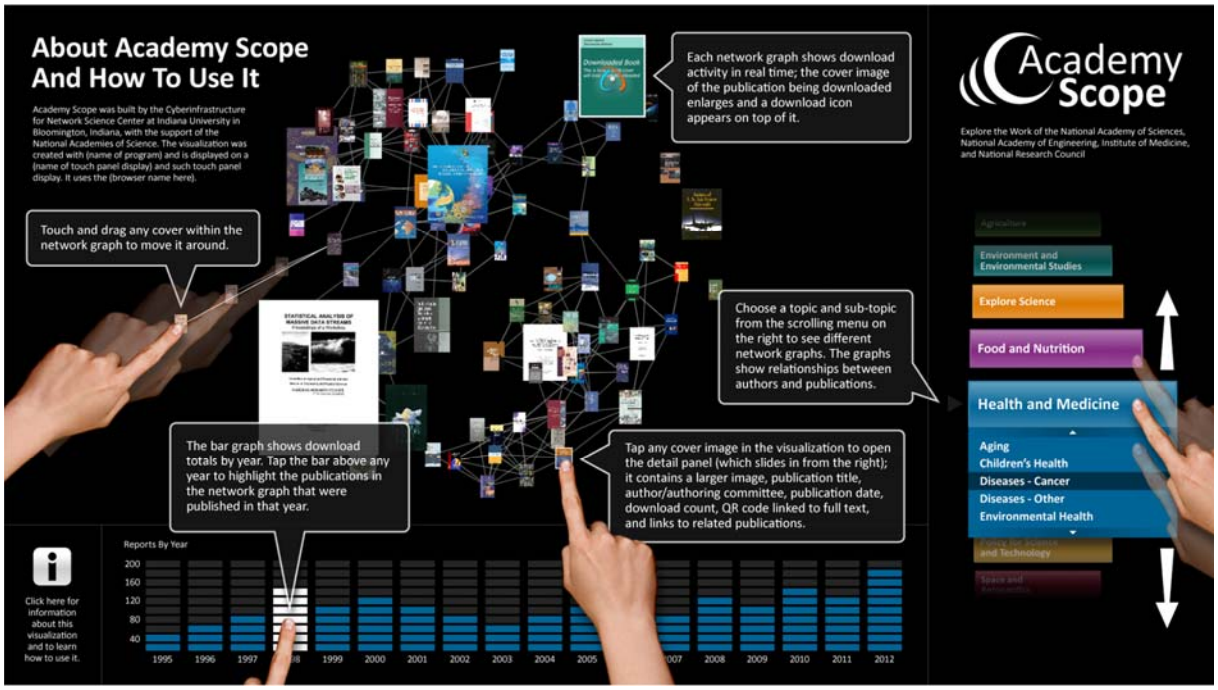
- **Session 7** – Dynamic Visualizations and Deployment

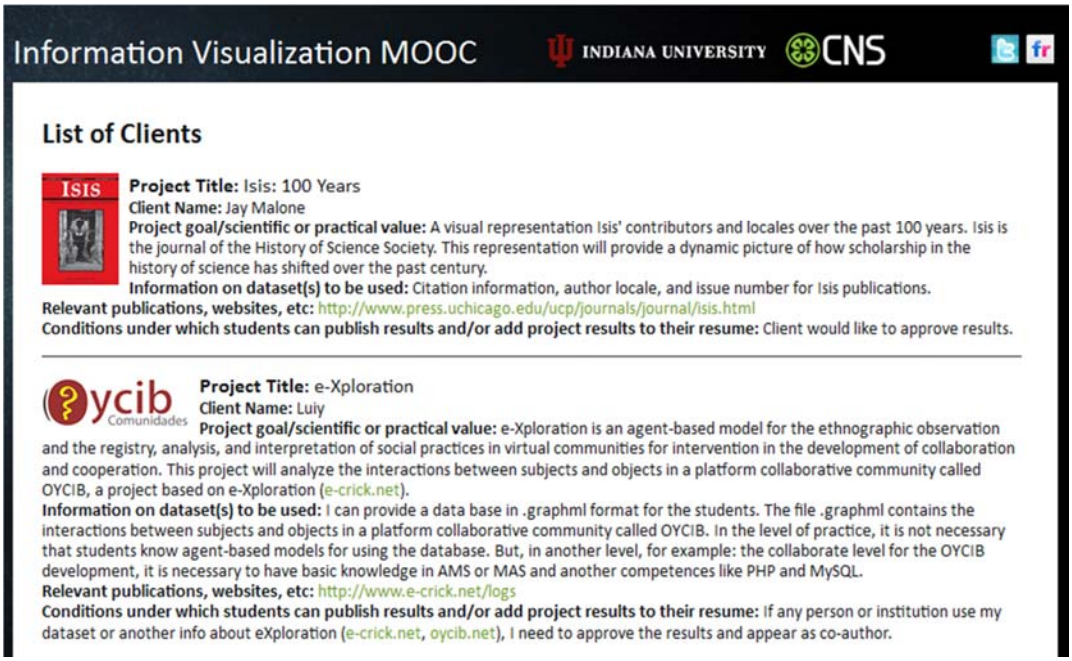
Final Exam

Dynamic Visualizations and Deployment



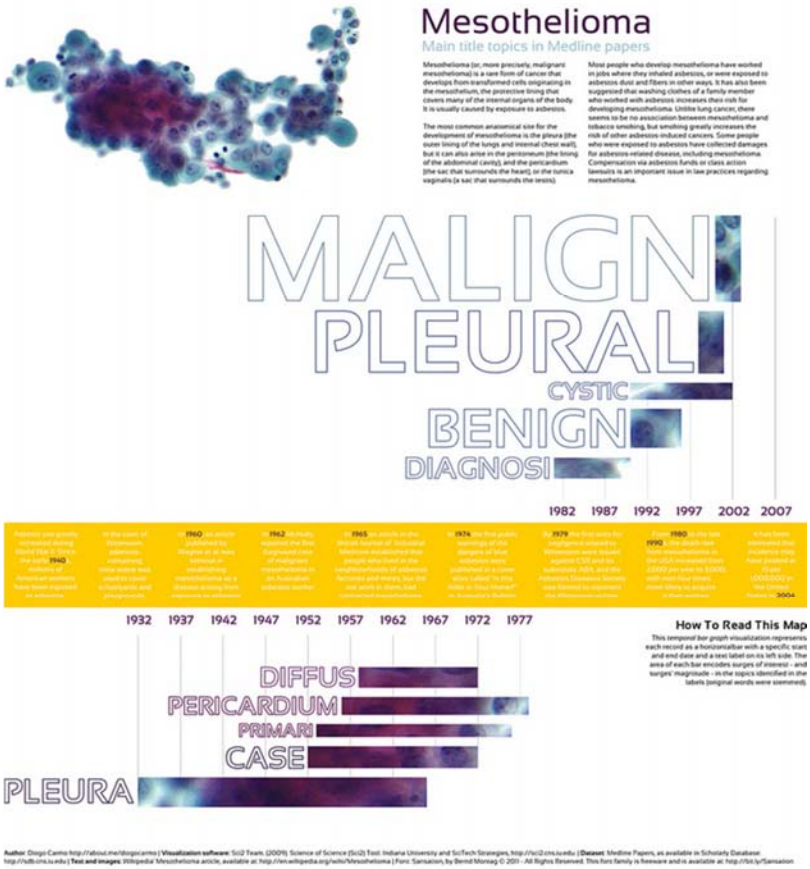
http://www.youtube.com/watch?feature=player_embedded&v=m_TwZXnZrkg

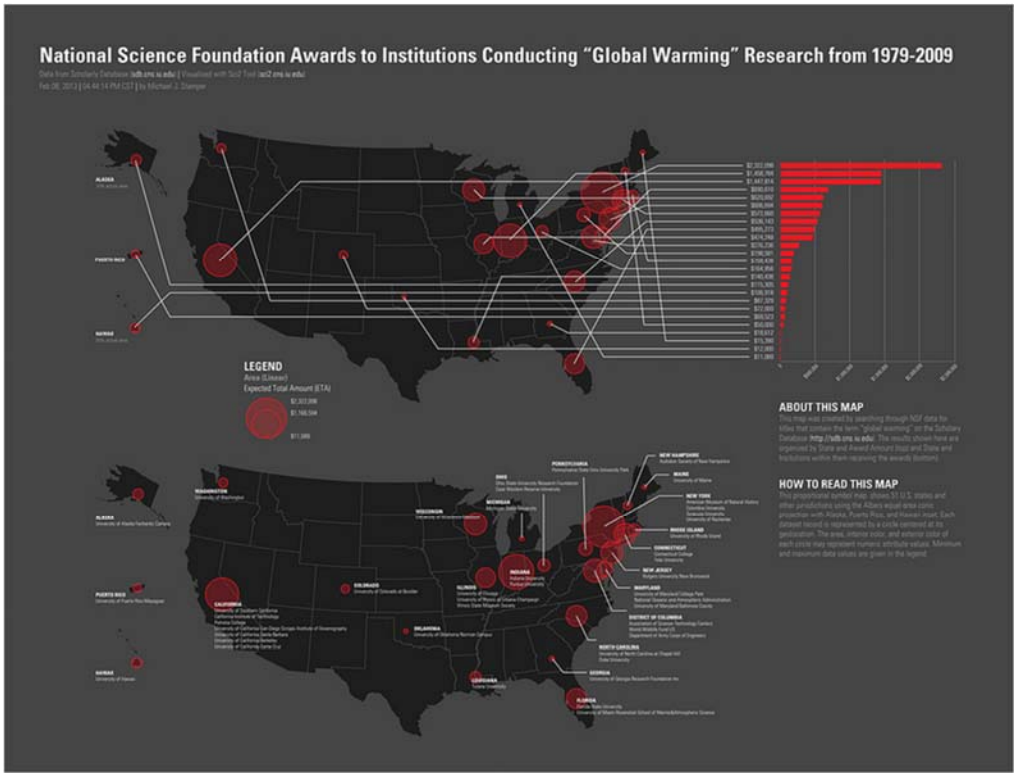
Clients



http://ivmooc.cns.iu.edu/ivmooc_clientprojects.html

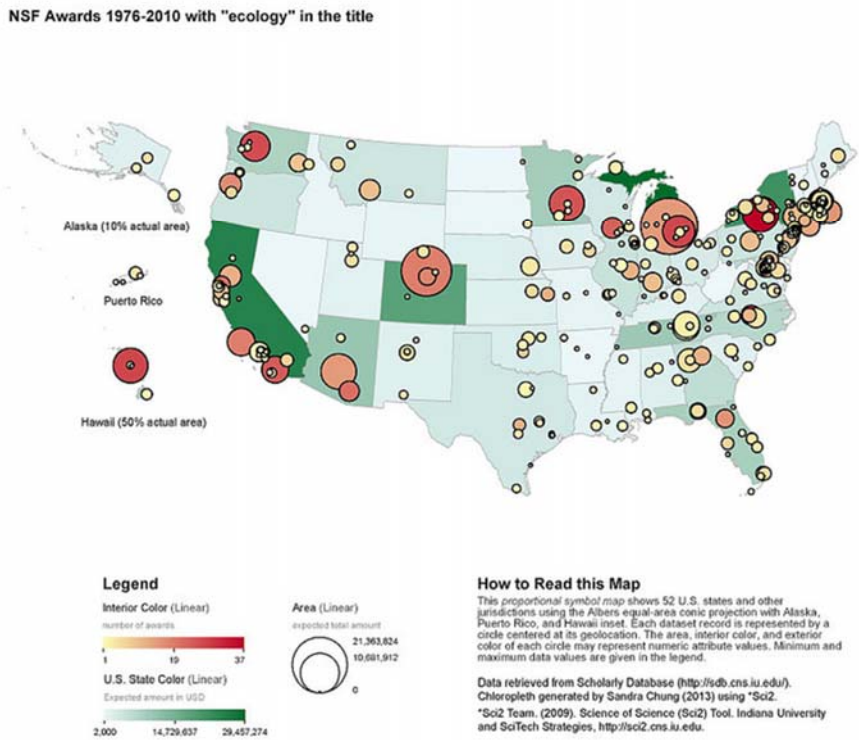
Diogo Carmo

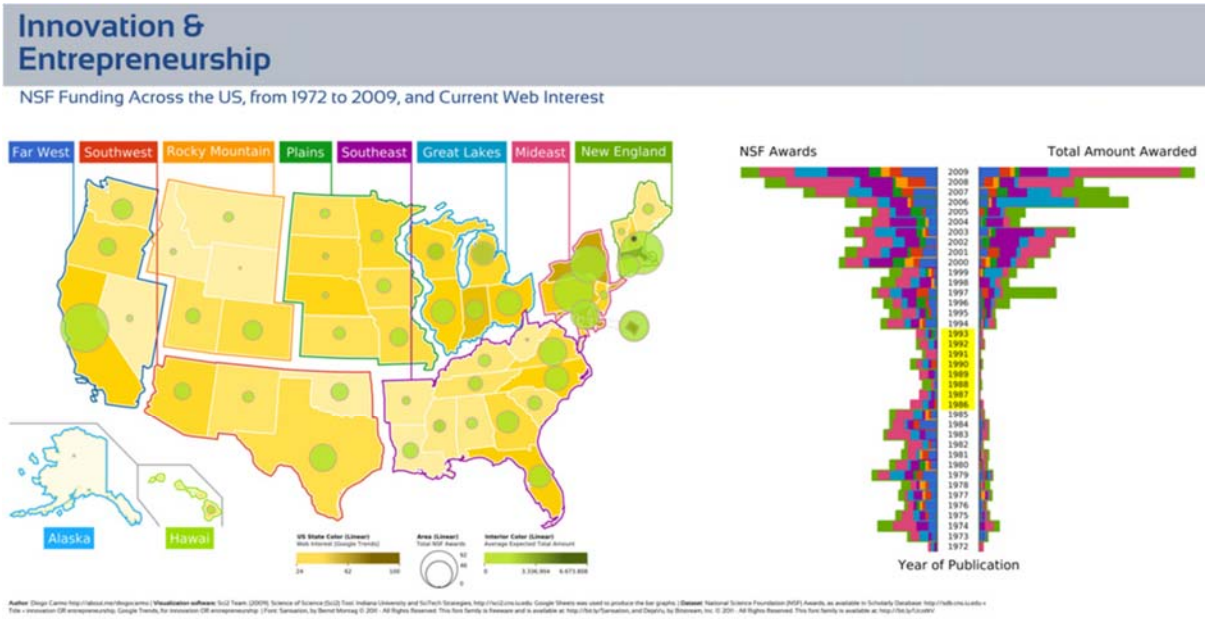




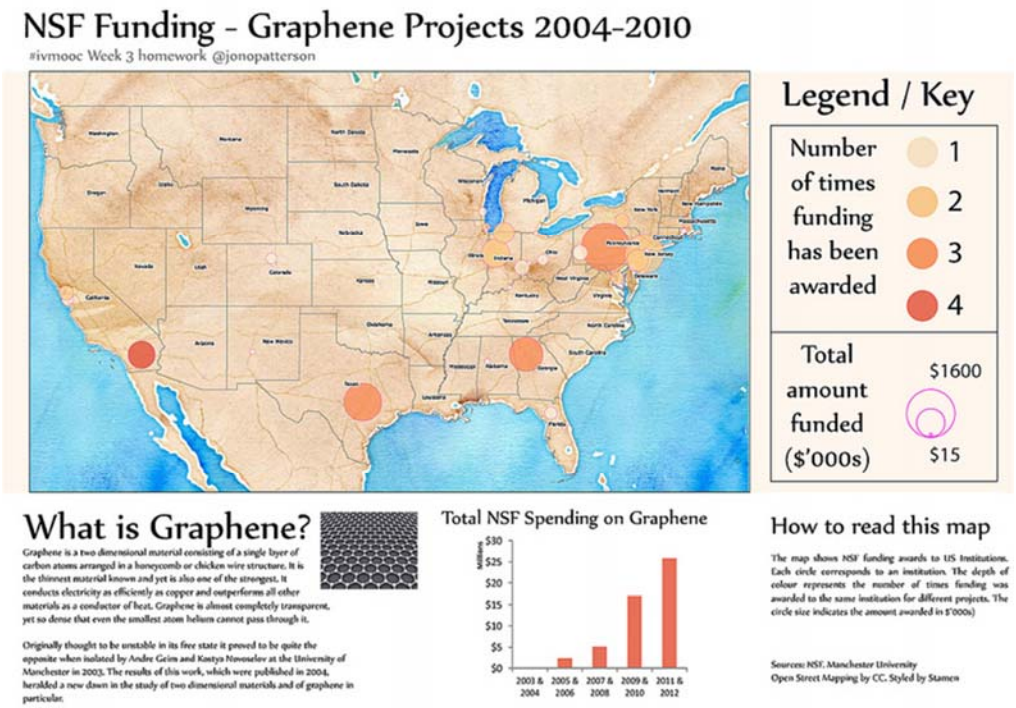
mjstamper_ivmooc

Sandra M. Chung

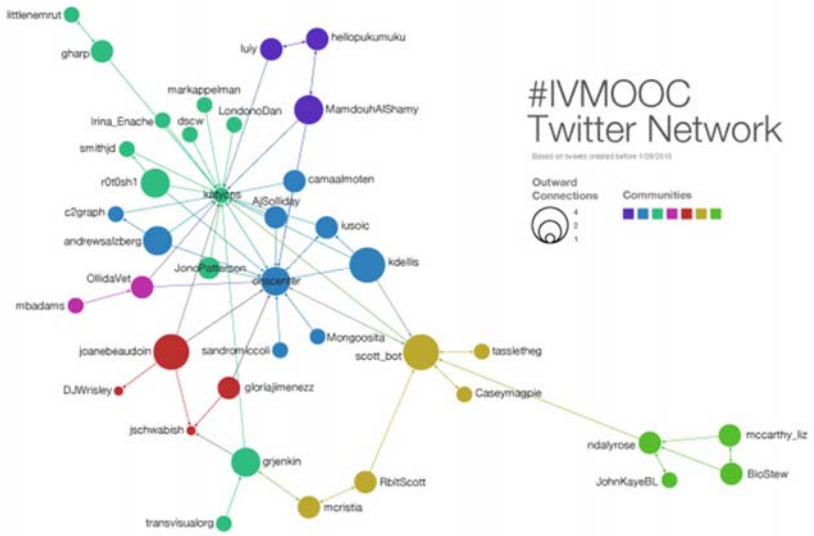




Diogo Carmo



JonoPatterson


#IVMOOC
Twitter Network
Outward Connections
Communities
littlenemrut
gharp
luiy
hellopukumuku
markappelman
LondonoDan
MamdouhAlShamy
Irina_Enache
dscw
smithjd
r0t0sh1
camaalmoten
AjSolitidy
c2graph
lusoic
andrewsalzberg
kdellis
JonoPatterson
OllidaVet
mbadams
Mongoosita
joanebeaudoin
sandromiccoli
scott_bot
tassietheg
DJWrisley
gloriajimenezz
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mccarthy_liz
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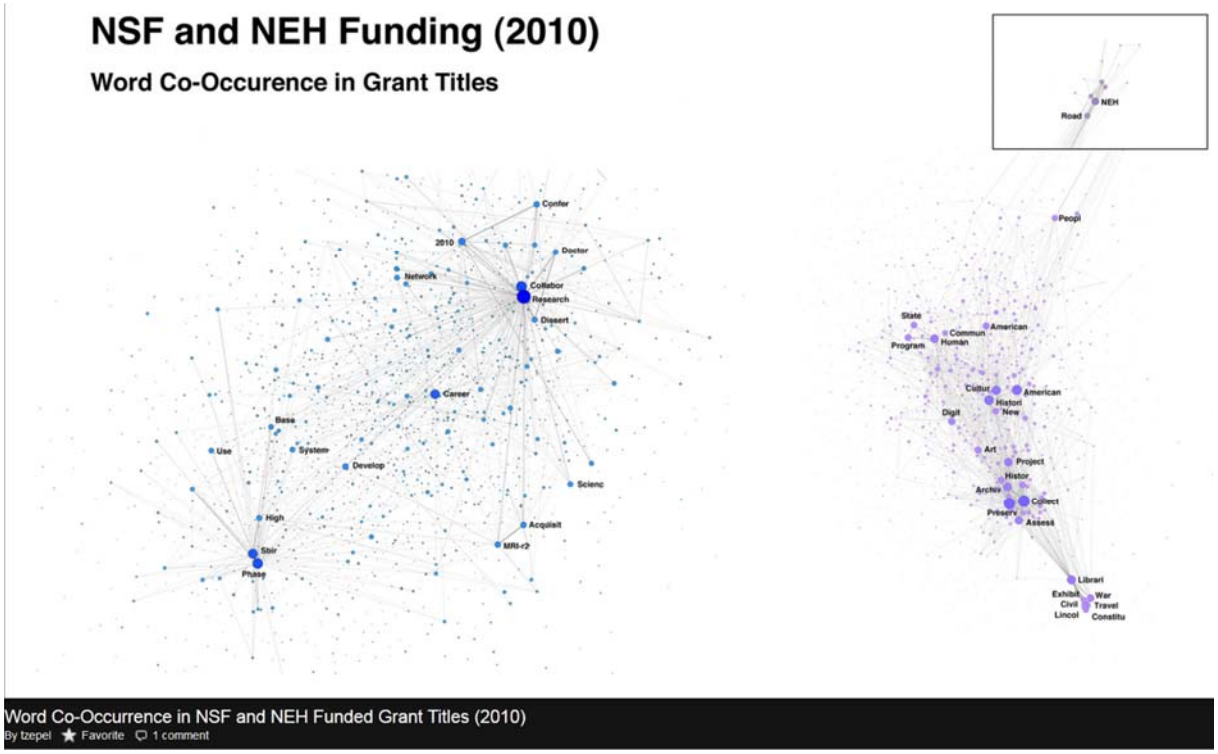
BlcStew
RbitScott
mcristia
transvisualorg

camaal


NSF and NEH Funding (2010)
Word Co-Occurence in Grant Titles
NEH
Road
Confer
2010
Doctor
Network
Collabor
Research
Dissert
Career
Base
Use
System
Develop
Scienc
High
Acquisit
MRI-r2
Stsir
Phase
People
State
American
Commun
Human
Program
Cultur
American
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Histor
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Collect
Preserv
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Librari
Exhibit
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Word Co-Occurrence in NSF and NEH Funded Grant Titles (2010)
By tzepel ★ Favorite 1 comment

Recently, a number of high school students took the IVMOOC.

We are interested to discuss in how far IVMOOC learning modules could be integrated into the high school curriculum.

Visualizing IVMOOC Data

- Empowering **teachers**: How to make sense of the activities of thousands of students? How to guide them?
- Empowering **administrators**: What courses have the highest success rates are most profitable, etc.?
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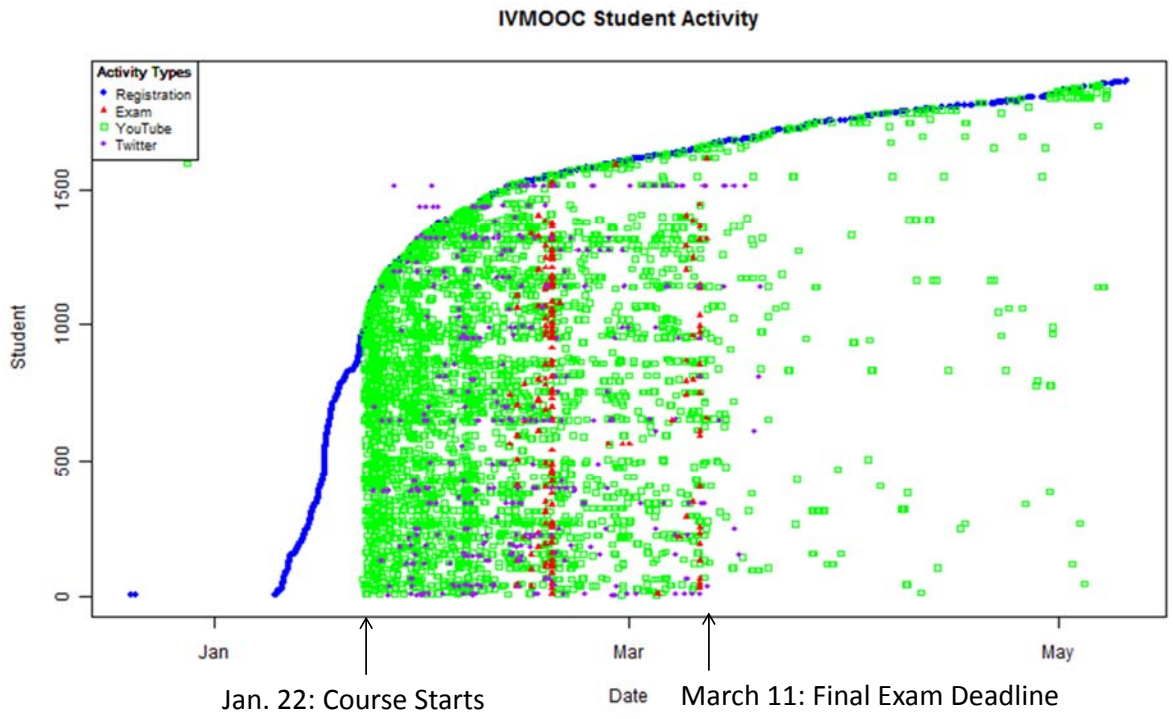
- Informing **platform designers**: What technology helps and what hurts?
- Conducting research: What teaching and learning works online?

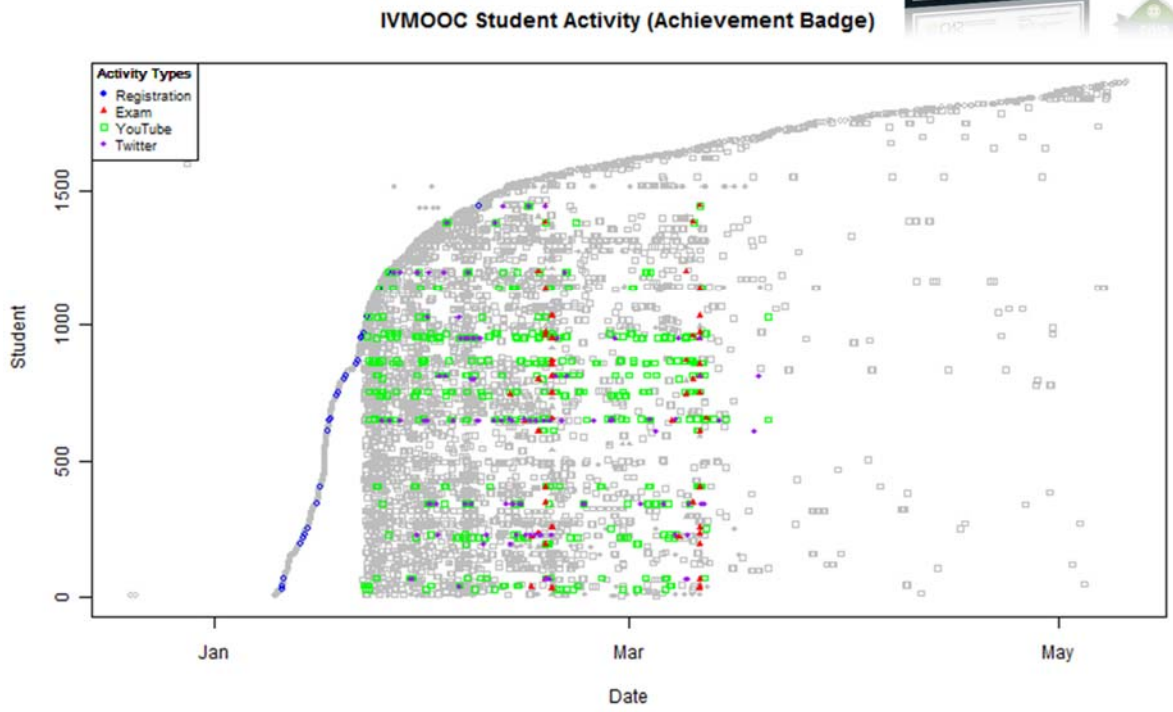
Visualizing IVMOOC Data

Data was collected from different sources:

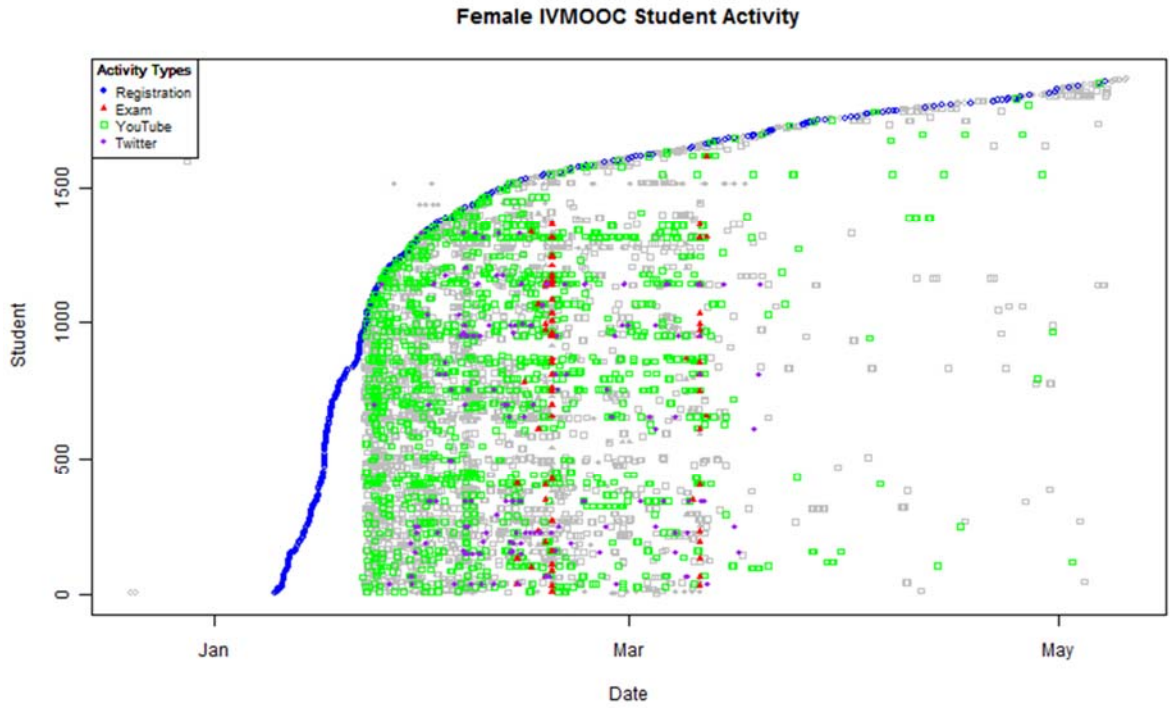
- 1,901 students registered via GCB (1215 male/557 female)
- 52,557 slide downloads from our server
- 18,893 video views via YouTube
- 193 accounts made 730 tweets
- 134 students took 183 exams in GCB
- 674 remarks on 215 different forum threads in Drupal
- 64 students submitted projects via Drupal

Visualizing IVMOOC Data





1215 male students
557 female students



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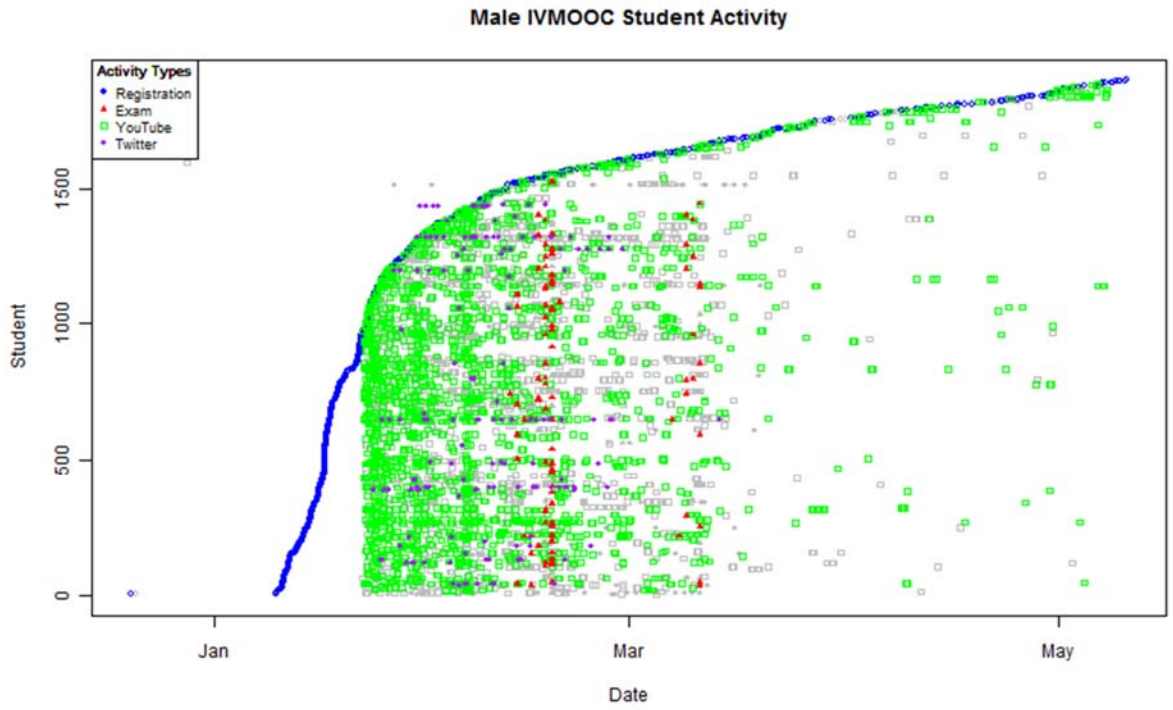
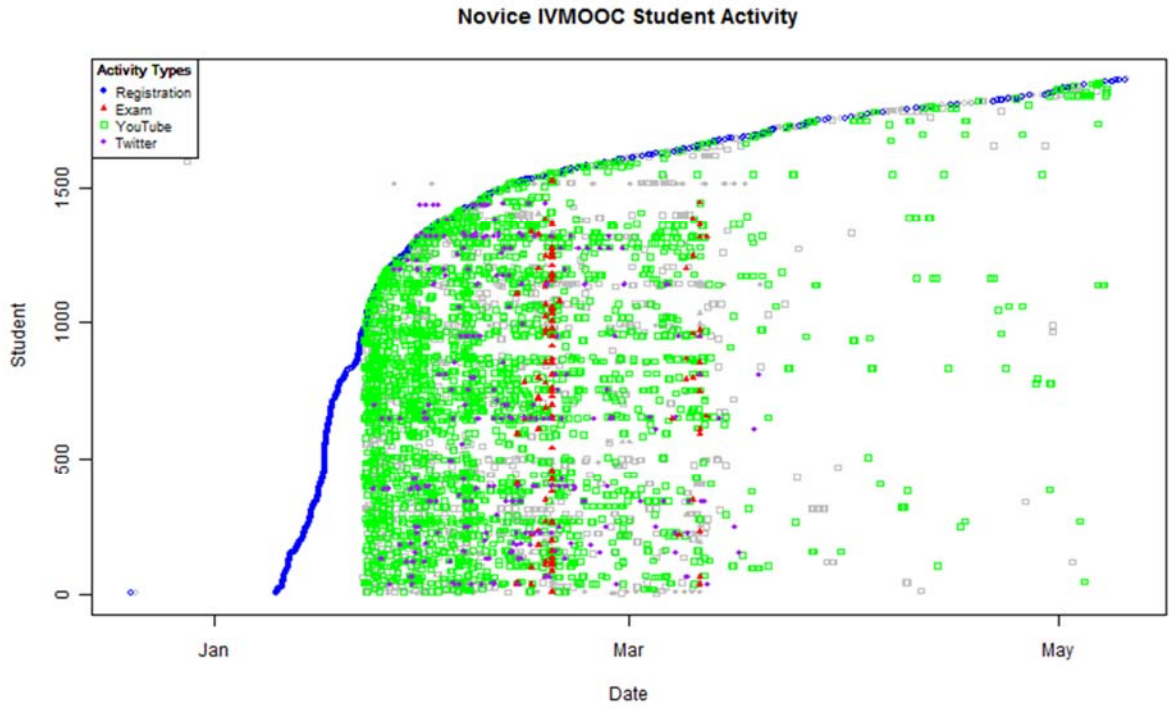
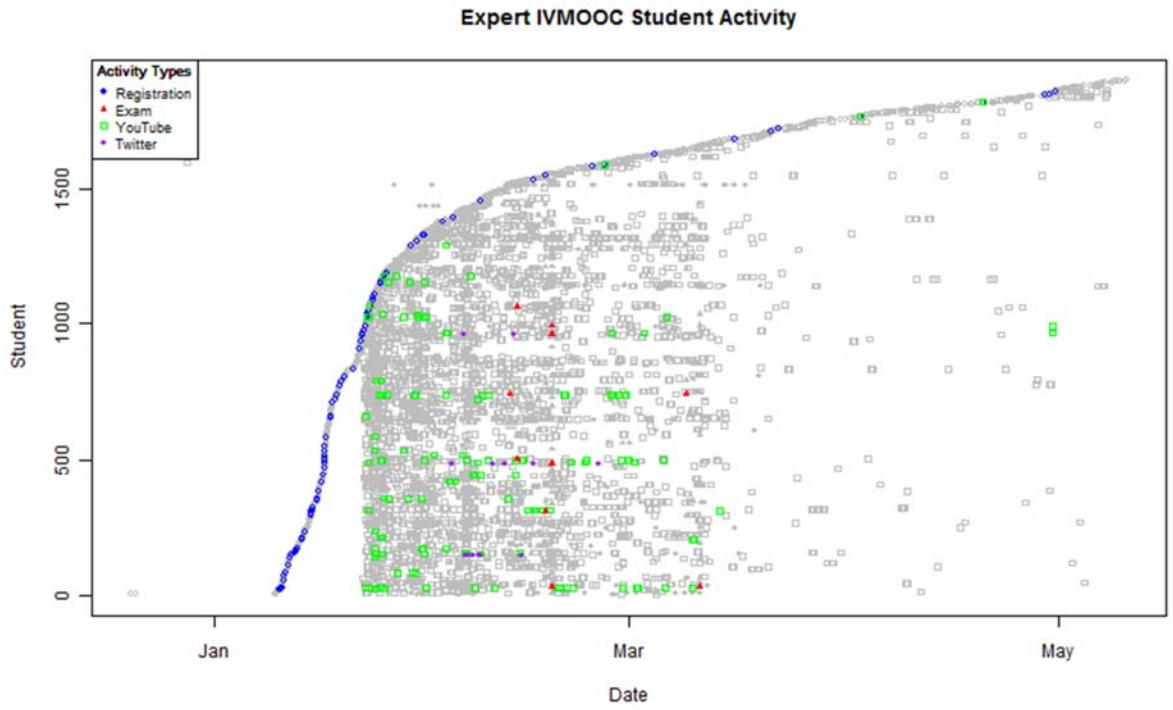
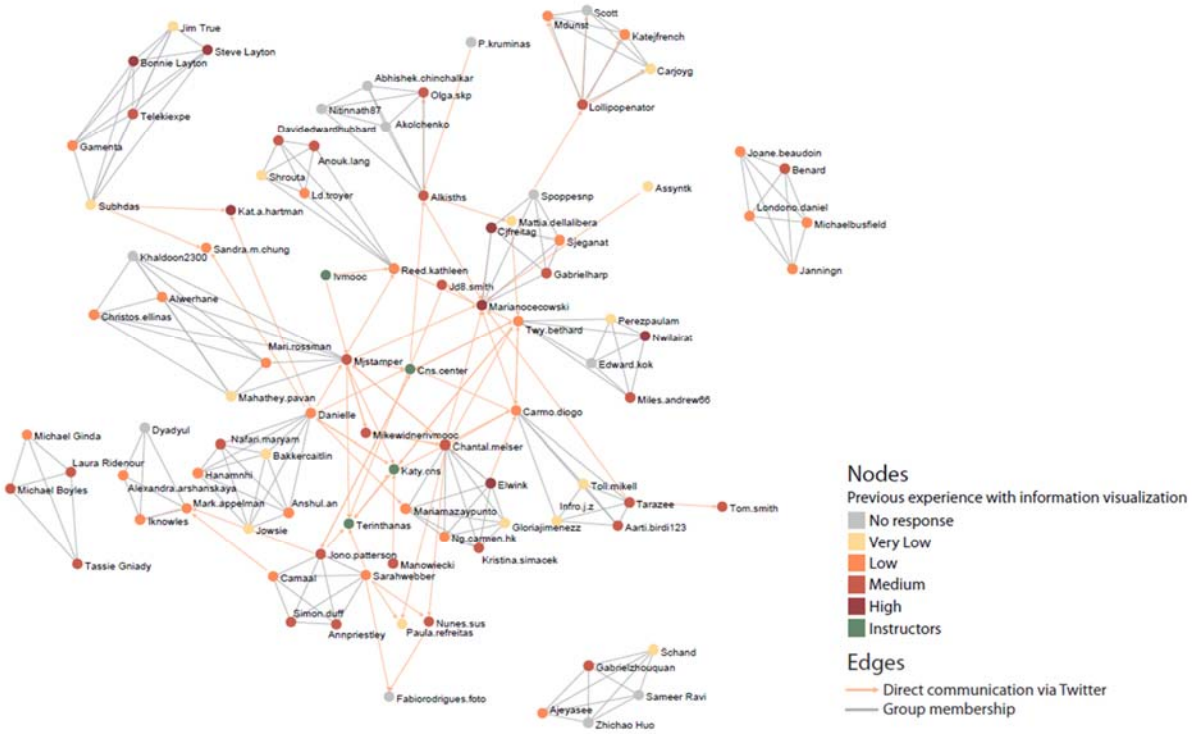


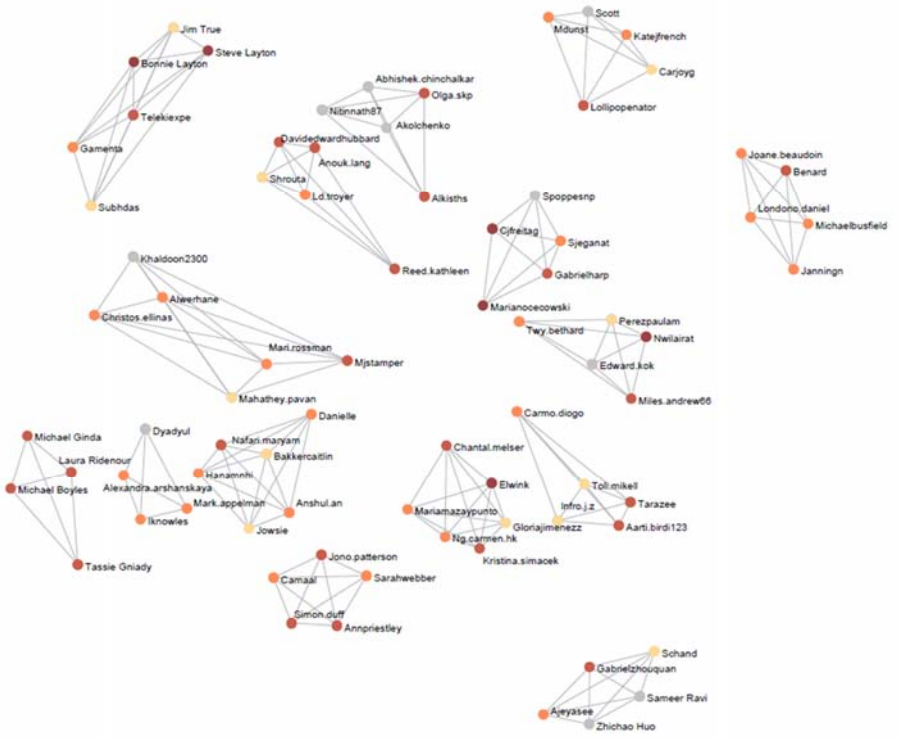




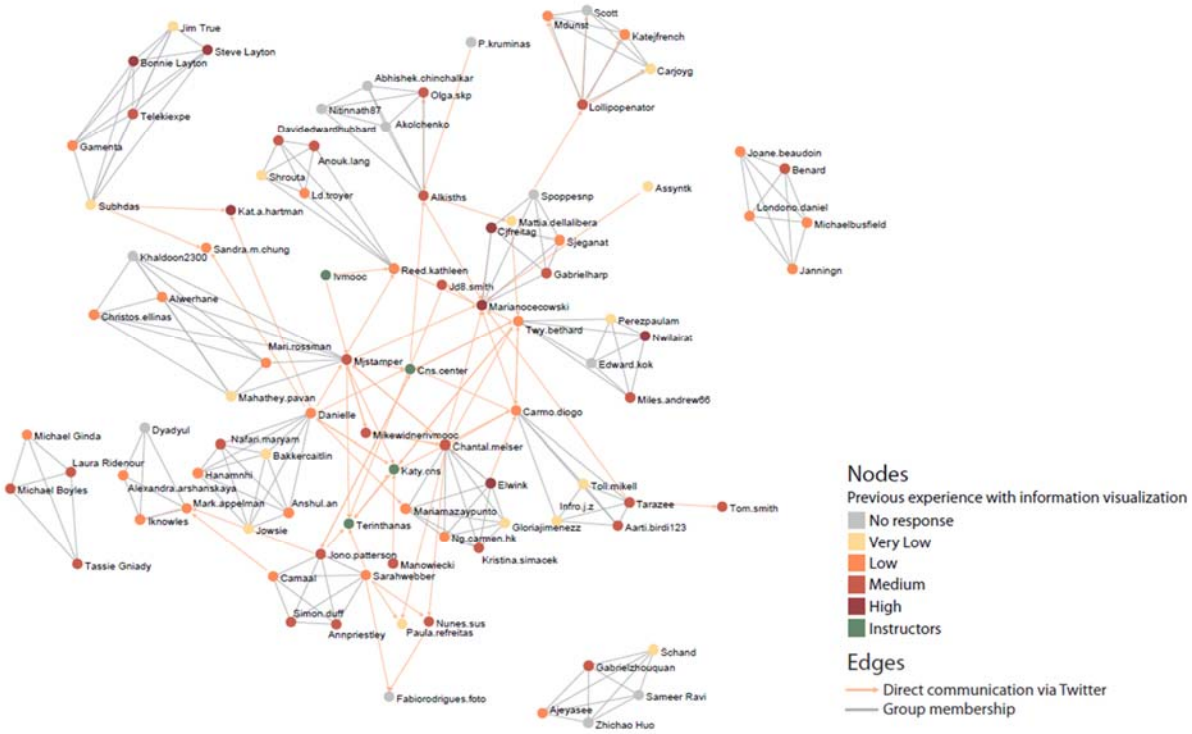
Student Client Projects: All Interactions



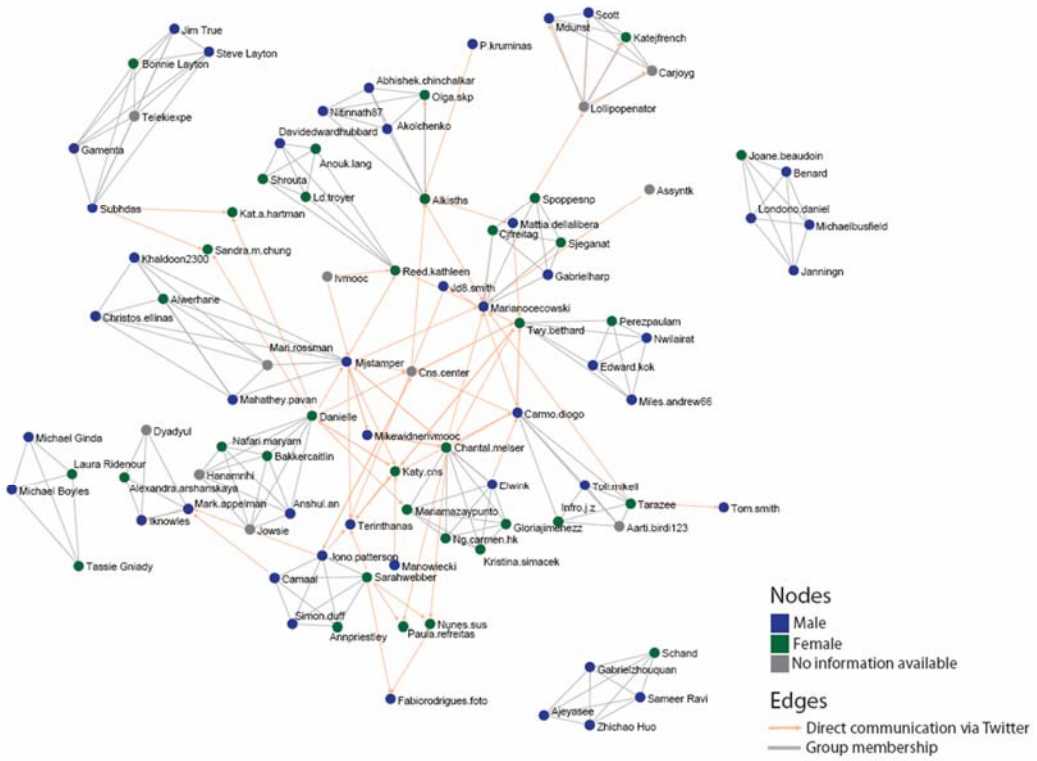
Student Client Projects: Group Memberships



Student Client Projects: All Interactions



Student Client Projects: Gender



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What questions would you have when learning/teaching online?

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All papers, maps, tools, talks, press are linked from http://cns.iu.edu
These slides are at http://cns.iu.edu/docs/presentations/2013-borner-visualinsights-cs10k.pdf

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