# Higher Education and the S&T Job Market

**Katy Börner**

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School of Informatics, Computing, and Engineering
Indiana University, USA

*NAS Sackler Colloquium on Modeling and Visualizing Science and Technology Developments*
*Arnold and Mabel Beckman Center, Irvine, California*

*December 4, 2017*

*Olivier H. Beauchesne, 2011. Map of Scientific Collaborations from 2005-2009.*

Computed Using Data from Elsevier's Scopus

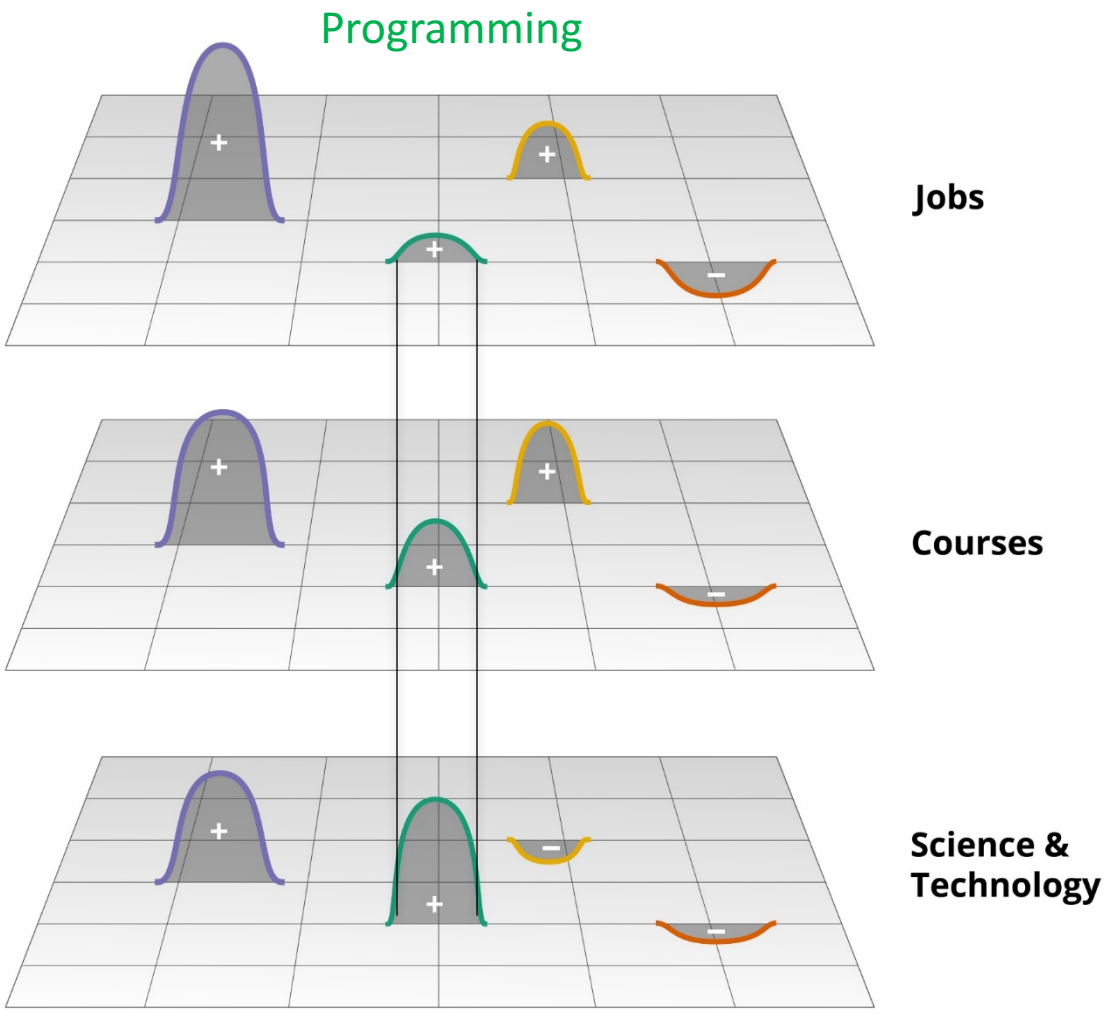
# Science & Technology vs. Education/Training vs. Jobs

Katy Börner, Olga B. Scrivner, Xiaozhong Liu, Indiana University

Need to study the **(mis)match** and **temporal dynamics** of S&T progress, education and workforce development options, and job requirements.

**Challenges:**

- Rapid change of STEM knowledge
- Increase in tools, AI
- Social skills (project management, team leadership)
- Increasing team size



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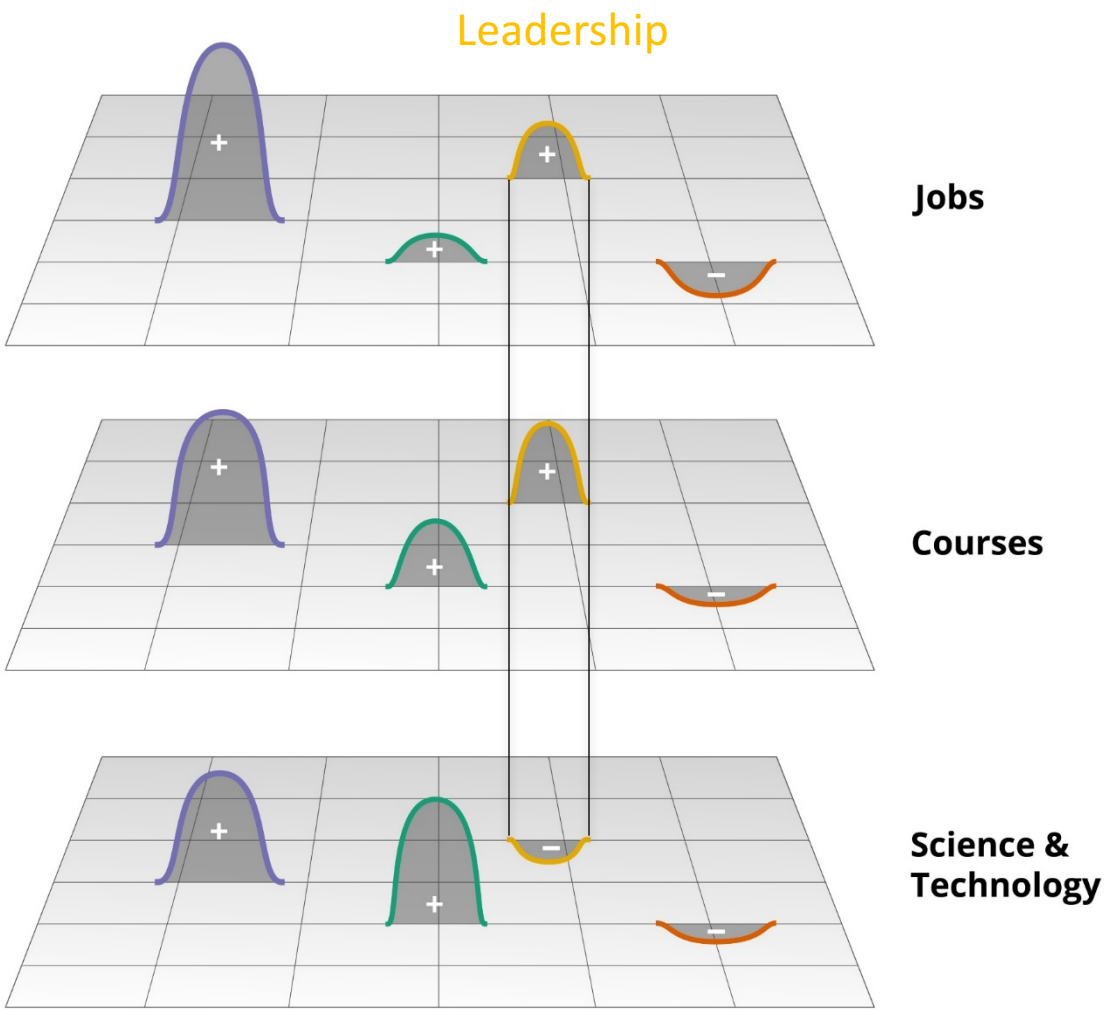

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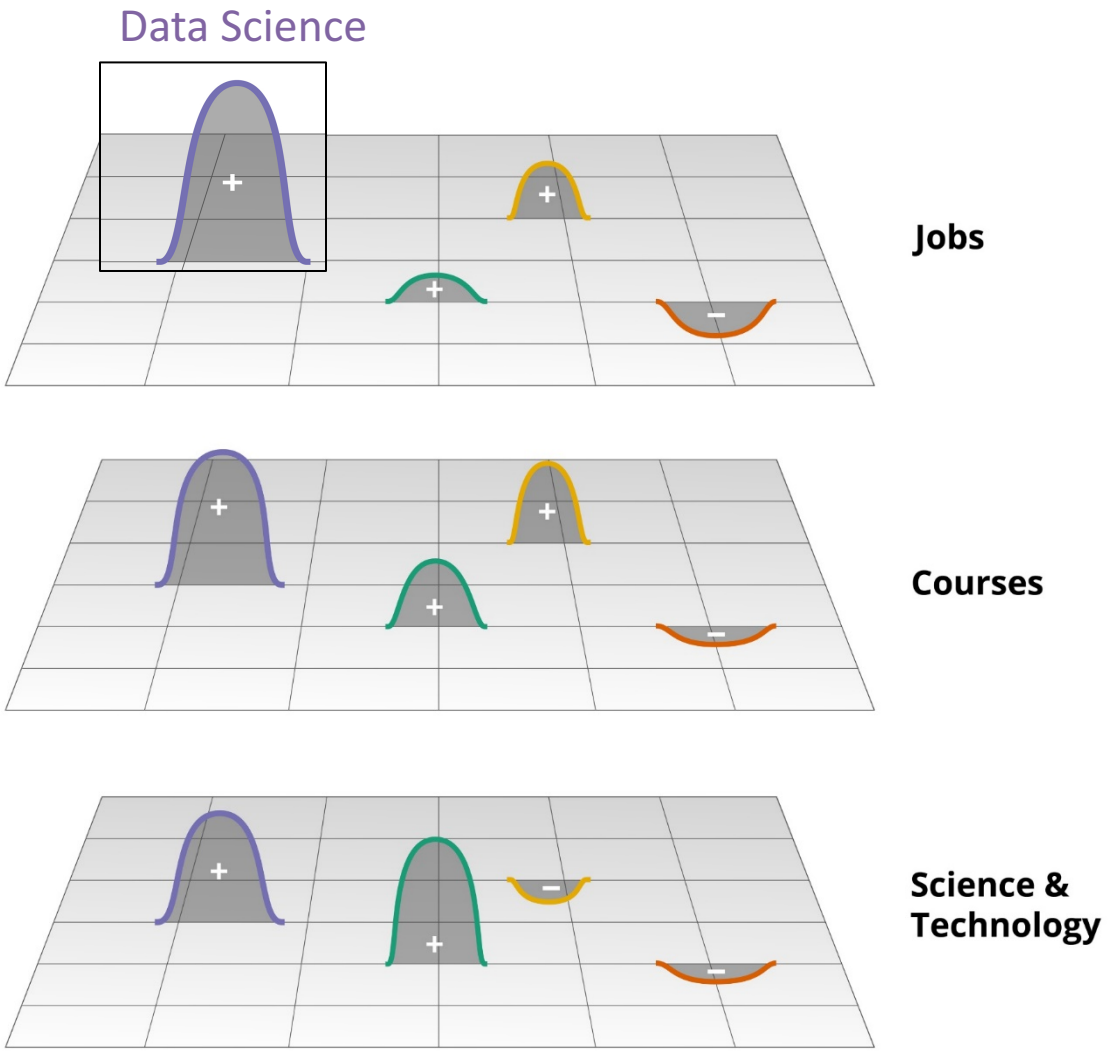

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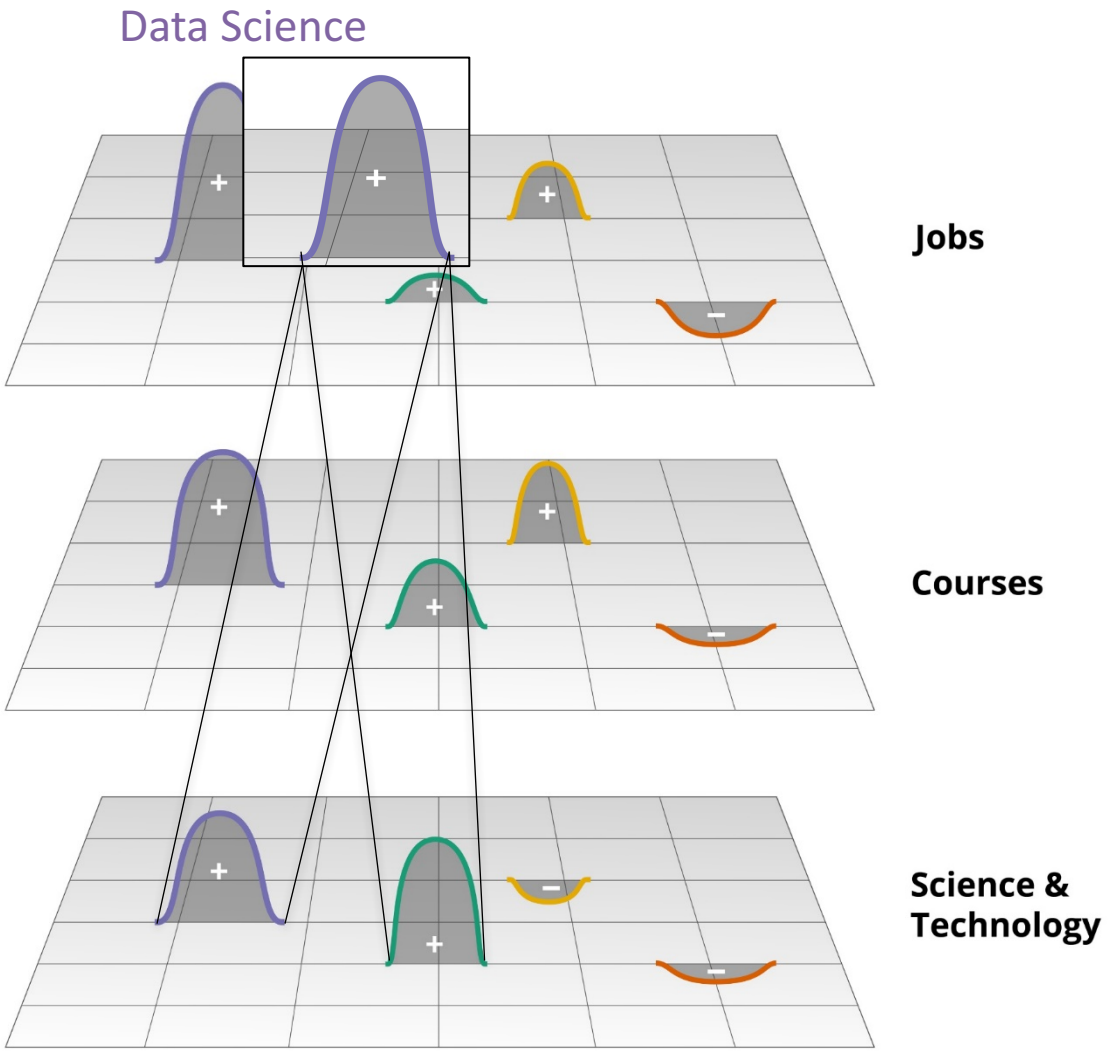
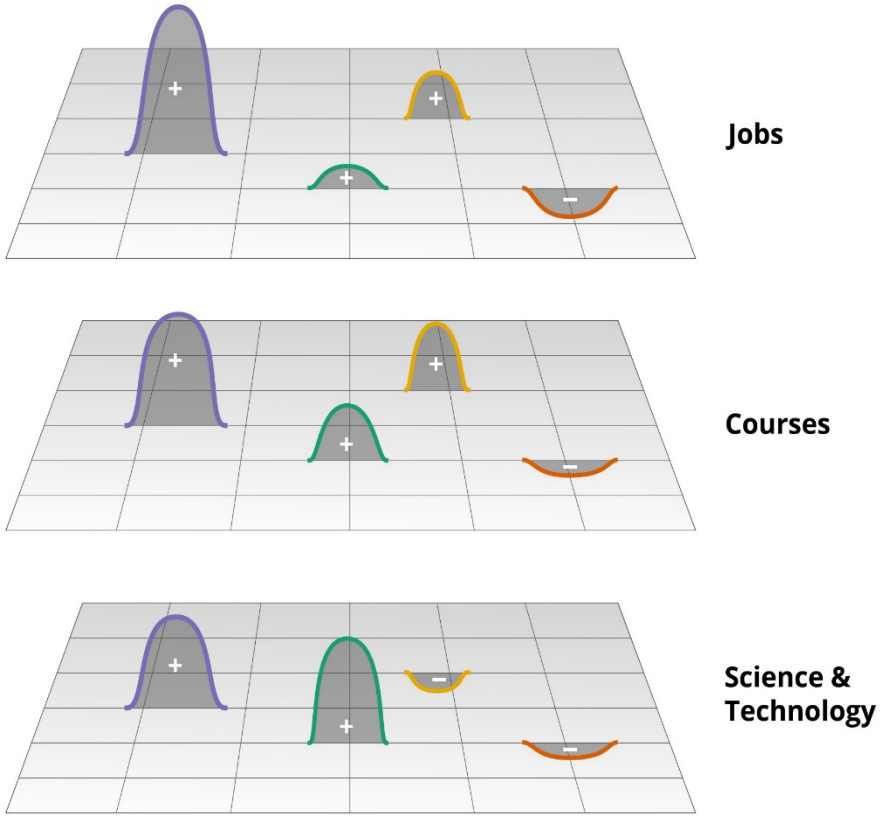


# Science & Technology vs. Education/Training vs. Jobs

Katy Börner, Olga B. Scrivner, Xiaozhong Liu, Indiana University

Study results are needed by:

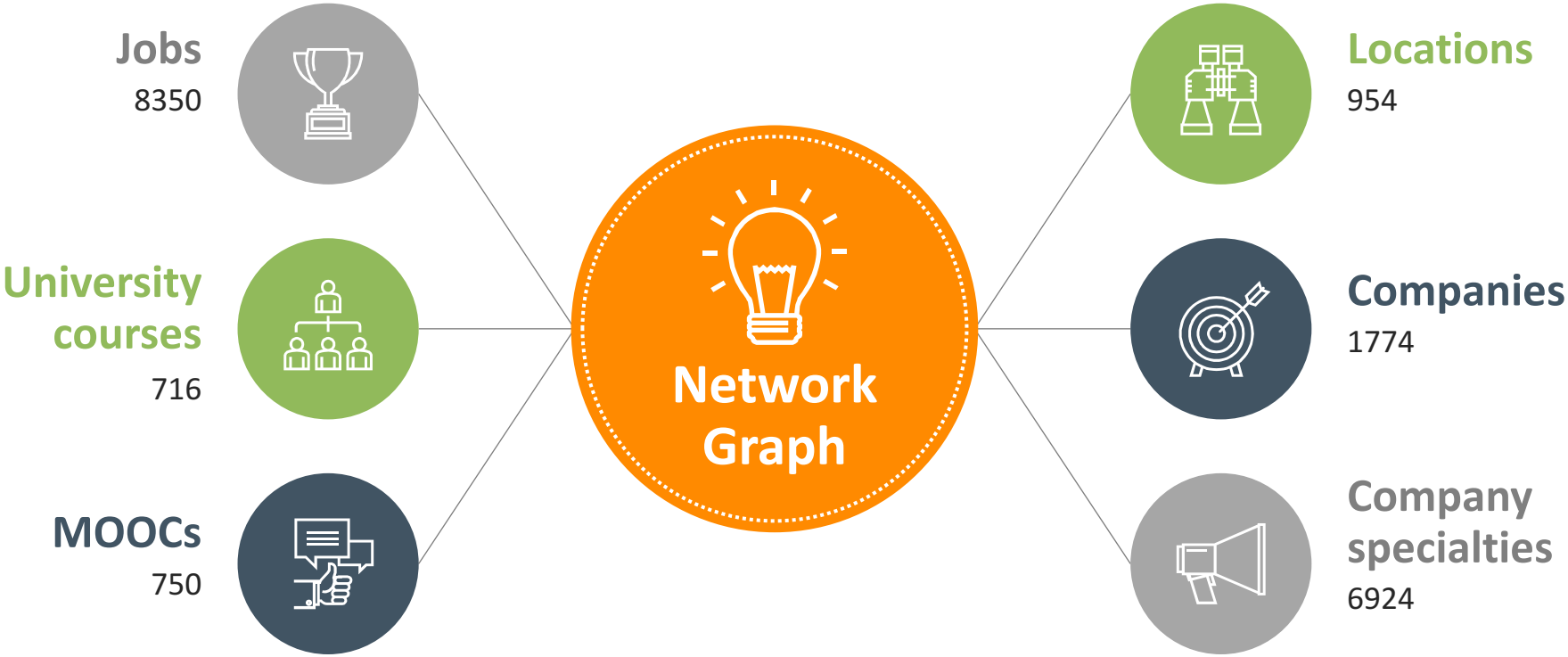
- **Students:** What jobs will exist in 1-4 years? What program/learning trajectory is best to get/keep my dream job?
- **Teachers:** What course updates are needed? What curriculum design is best? What is my competition doing? How much timely knowledge (to get a job) vs. forever knowledge (to be prepared for 80 productive years) should I teach? How to innovate in teaching and get tenure?
- **Employers:** What skills are needed next year, in 5 years? Who trains the best? What skills does my competition list in job advertisements? How to hire/train productive teams?




**What is ROI of my time, money, compassion?**

# Enter a Job, Get Course Recommendations

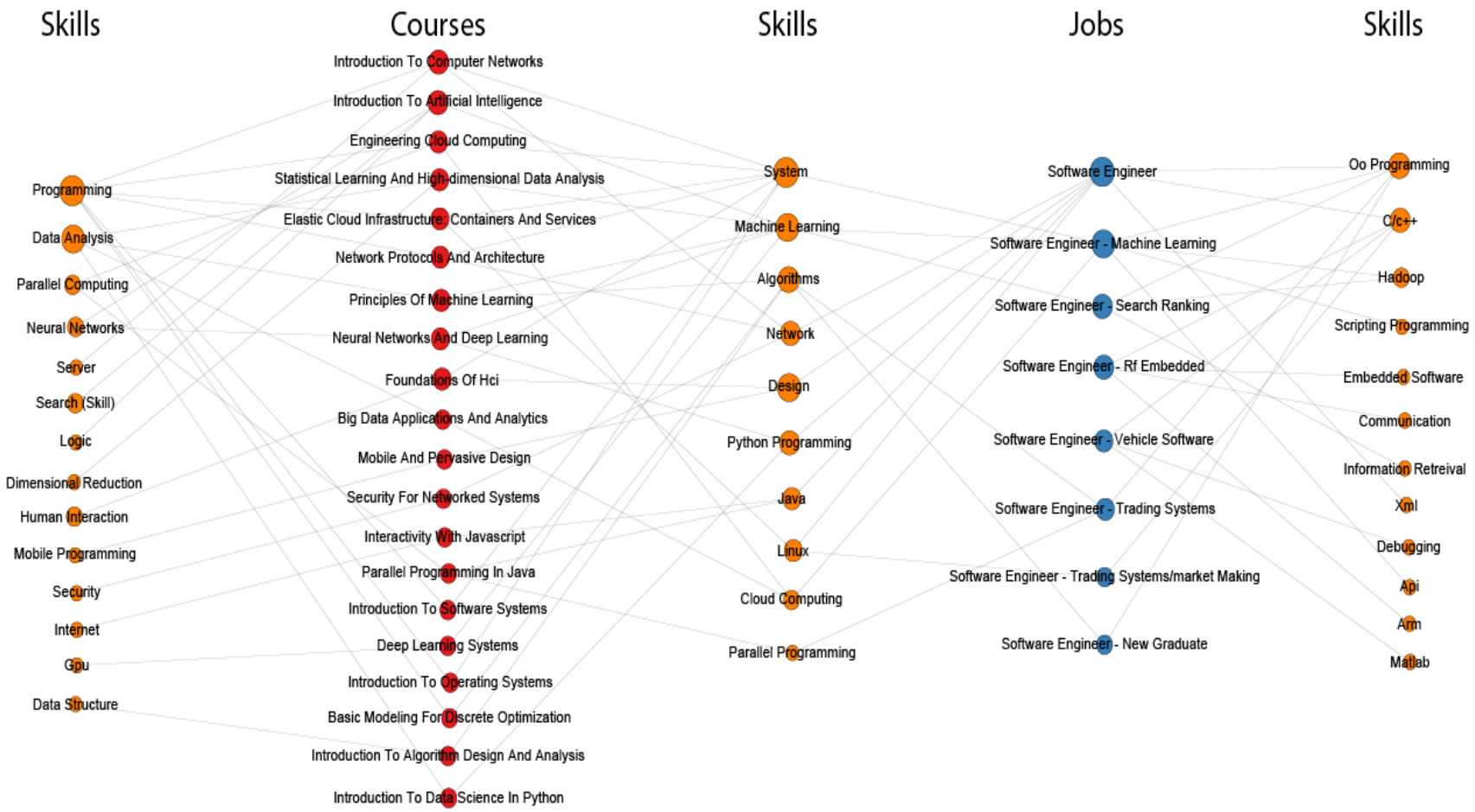
The system represents information on jobs, courses, companies, etc. via a heterogeneous knowledge graph with 395,030 nodes and 993,526 edges. Students pick a dream job; then text and graph-based algorithms recommend optimized education opportunities, i.e., courses that maximize time, money, and/or learning.




Li, Nan, Naren Suri, Zhen Gao, Tian Xia, Katy Börner, and Xiaozhong Liu. 2017. "Enter a Job, Get Course Recommendations". *iConference 2017, Wuhan, China*.

# IU Data Science Program: Courses, Skills & Jobs

Katy Börner, Michael Ginda & Xiaozhong Liu, Indiana University

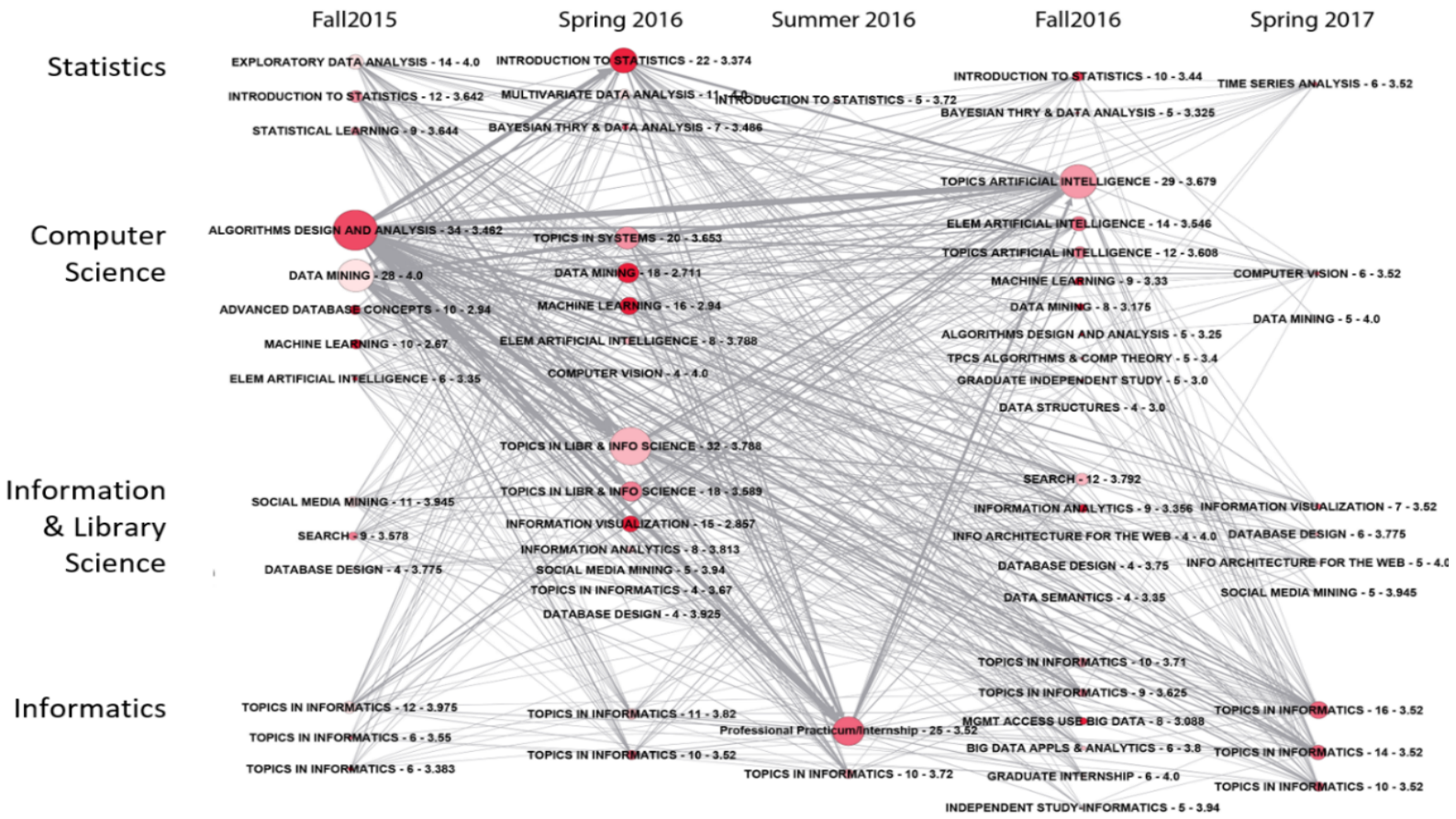



Exemplary set of IU Data Science courses, ‘Software Engineering’ jobs, and associated skills.

Job data was retrieved from LinkedIn and CareerBuilder and course data come from the IU course list. As can be seen, there are many skills (in orange) that are exclusively associated with courses or jobs; however, the skills in the middle interlink courses (in red) to jobs (in blue).

# IU Data Science Program: Student Course Transition Network

Michael Ginda, Kayla Scroggins & Katy Börner, Indiana University

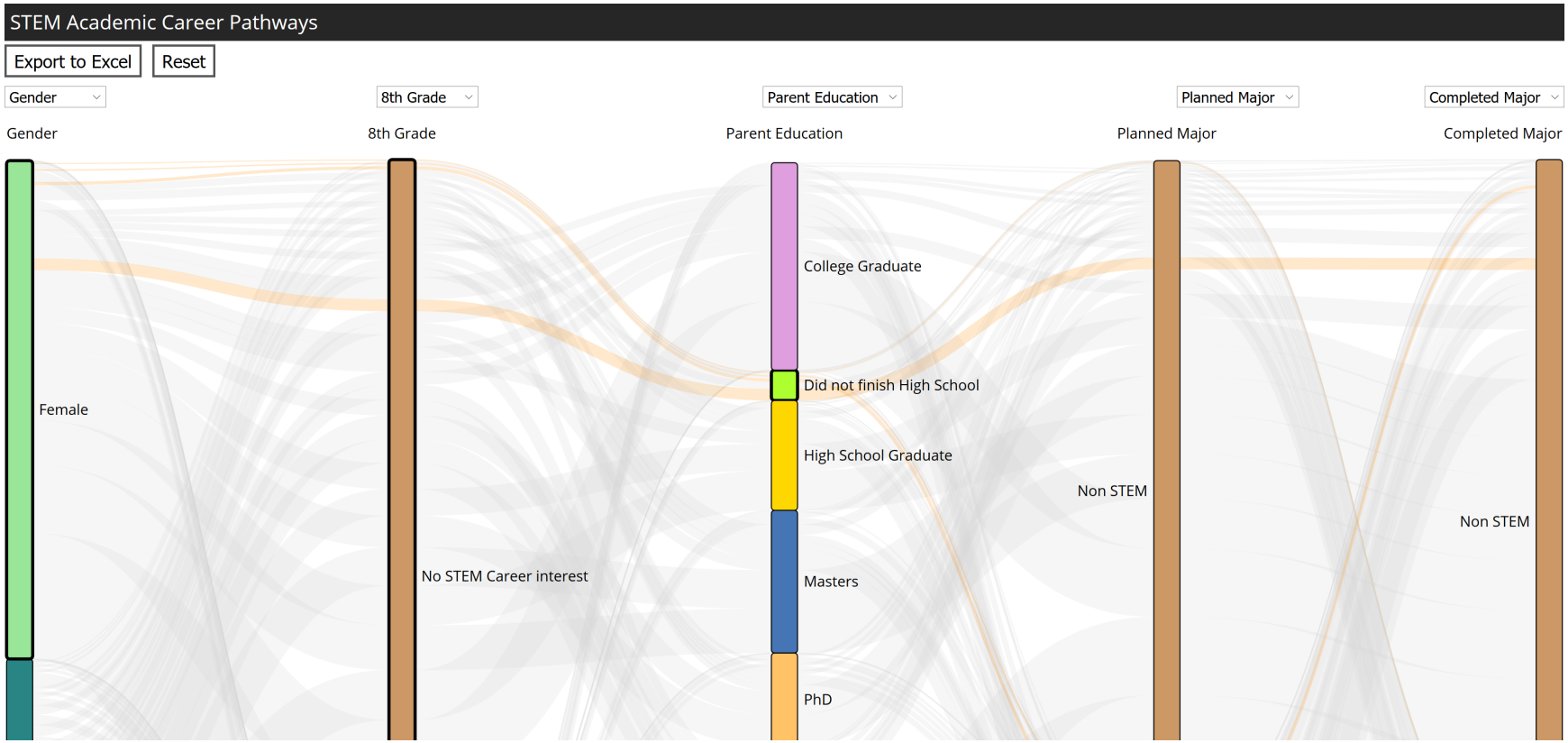



Empower students, teachers, and curriculum committee members to understand and discuss current and desirable student cohorts, key course trajectories, or the (gatekeeper) role that specific courses play.

Vertically, courses are arranged into four groups based on the department offering the course. Within each vertical grouping, the nodes are sorted by the total enrollment for the course with highest values on top. Node size encodes number of students enrolled; node color denotes overall GPA for the course.

# US STEM: Academic Career Pathways

Michael Ginda, Adam Maltese & Katy Börner, Indiana University



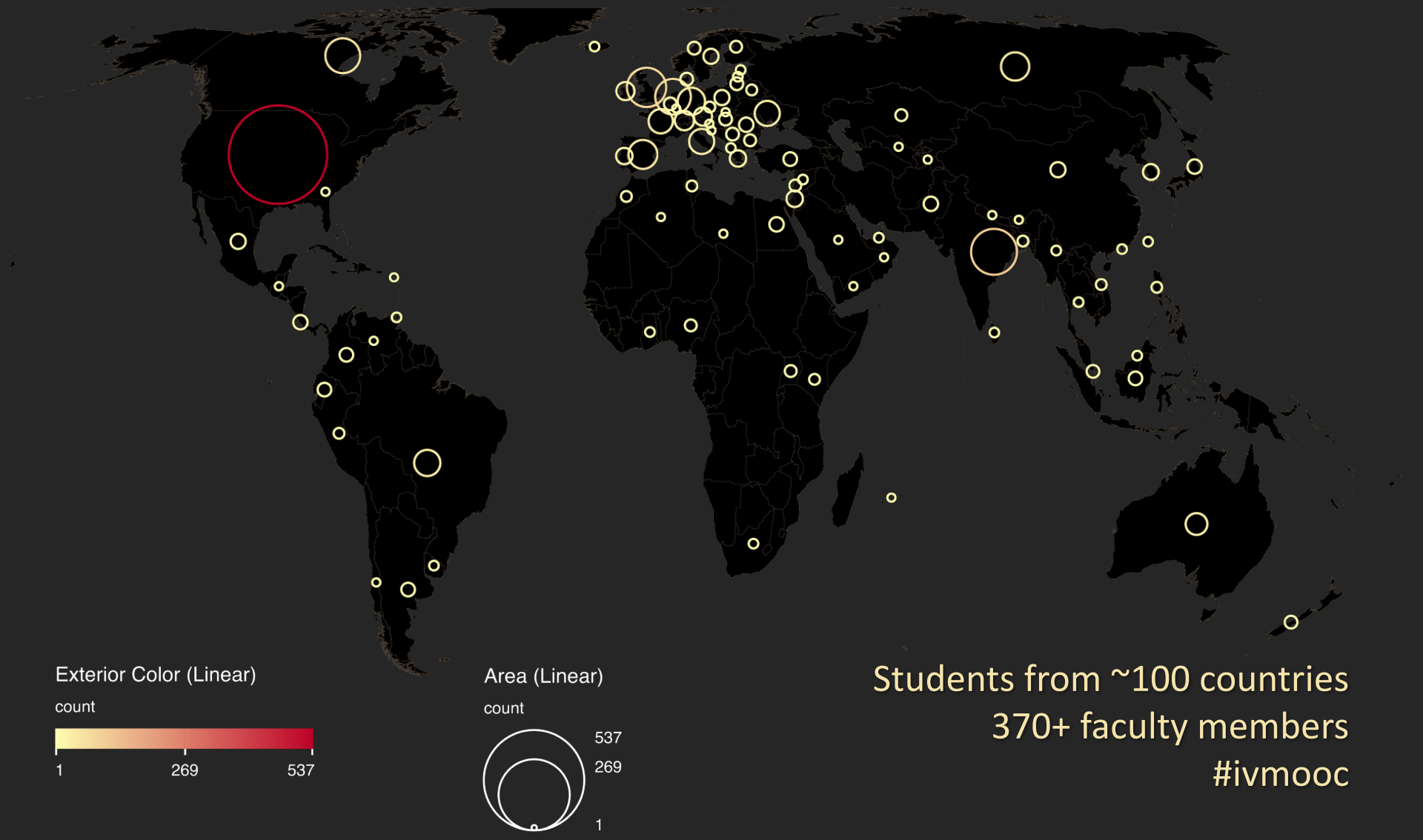

Measure and visualize how students enter, exit and persist in pathways toward STEM degrees and careers. Uses data on students and the workforce by the National Center for Education Statistics and the National Center for Science and Engineering Statistics.

Funded by NSF NCSE-1538763. Interactive web site: http://demo.cns.iu.edu/webvis/stem


Register for free: http://ivmooc.cns.iu.edu. Class restarts Jan 8, 2018.

# The Information Visualization MOOC
ivmooc.cns.iu.edu

IVMOOC




Students from ~100 countries
370+ faculty members
#ivmooc

# IVMOOC Data

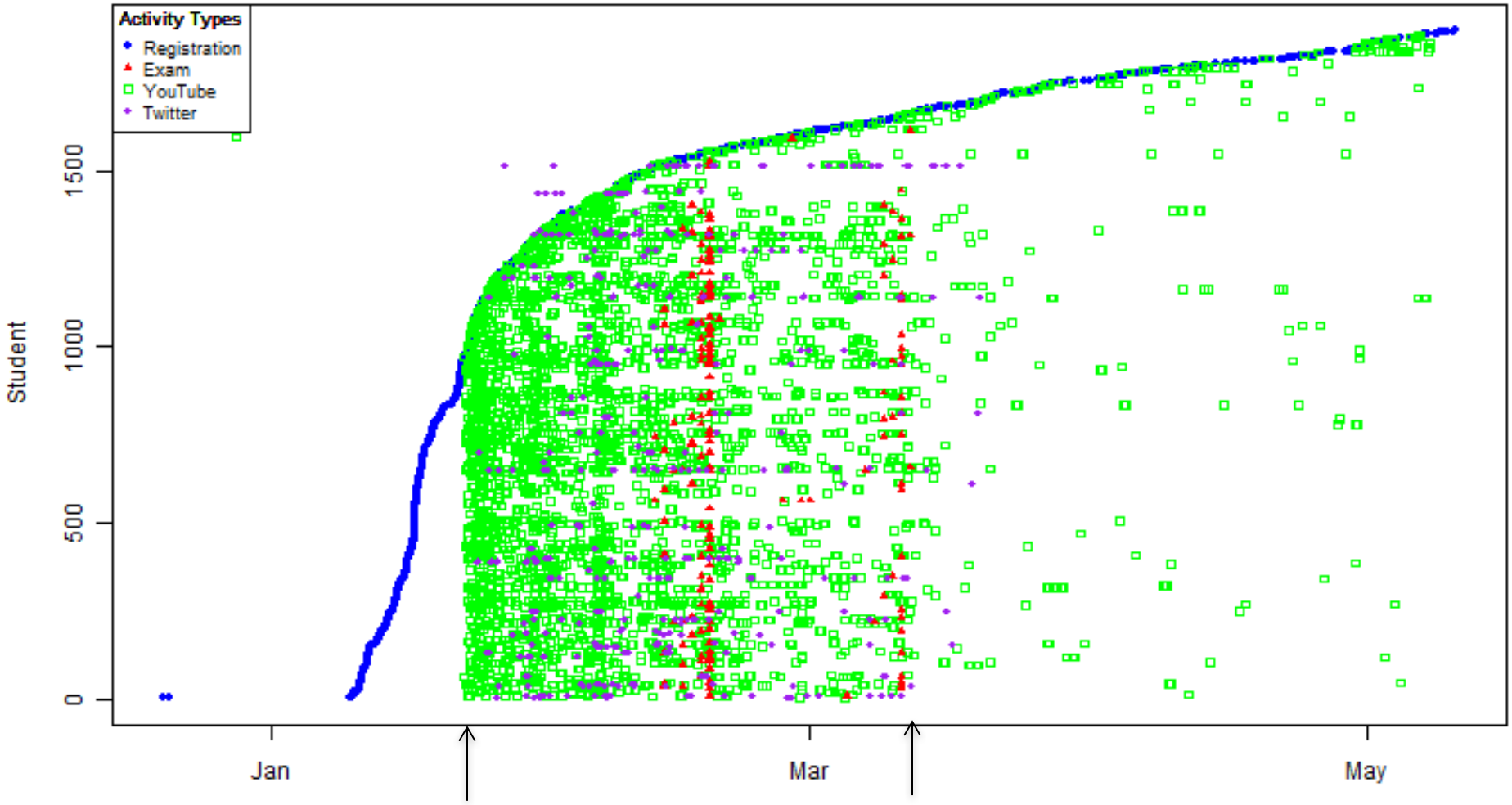
Michael Ginda & Katy Börner, Indiana University

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 Google Course Builder (GCB)
- 674 remarks on 215 different forum threads in Drupal
- 64 students submitted projects via Drupal

# IVMOOC Student Registration and Activity

Michael Ginda & Katy Börner, Indiana University




Jan. 22: Course Starts

March 11: Final Exam Deadline

# IVMOOC Student Client Projects: All Interactions

Michael Ginda & Katy Börner, Indiana University


## Nodes

Previous experience with information visualization

- No response
- Very Low
- Low
- Medium
- High
- Instructors

## Edges

- Direct communication via Twitter
- Group membership

# IVMOOC Student Engagement and Performance

Michael Ginda & Katy Börner, Indiana University

Learning Analytics

IVMOOC 2015 Student Group Engagement and Scores

| | Pre-Course | Week 1 | Week 2 | Week 3 | Week 4 | Midterm | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Final | Curr. Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IVMOOC | 26.05% | 38.32% | 31.32% | 29.96% | 27.1% | 28.34% | 31.07% | 24.28% | 16.86% | 18.23% | 13.08% | 13.41% | 20.87% |
| Z637-29374 | 33.01% | 52.91% | 49.89% | 59.22% | 50.89% | 82.56% | 65.04% | 49.99% | 39.59% | 61.63% | 54.91% | 82.25% | 82.4% |
| Z637-32593 | 25.08% | 54.54% | 43.58% | 50.67% | 53.63% | 77.67% | 65.7% | 59.48% | 52.19% | 65.71% | 47.27% | 72.59% | 75.13% |
| Z637-33781 | 29.33% | 55.38% | 49.26% | 62.18% | 77.47% | 85% | 87.4% | 69.8% | 55.56% | 57.6% | 45.69% | 70.89% | 77.94% |

IVMOOC 2015 Student Group Engagement for Midterm

| | Midterm | Final | Curr. Score | Overall Engagemer |
|---|---|---|---|---|
| Student 198 | 100% | 85.33% | 92.67% | 30.34% |
| Student 210 | 100% | 84% | 92% | 33.91% |
| Student 242 | 97.14% | 98.67% | 97.9% | 55.89% |
| Student 265 | 95.71% | 92% | 93.86% | 82.64% |
| Student 216 | 95.71% | 24% | 59.86% | 34.92% |
| Student 257 | 94.29% | 98.67% | 96.48% | 68.25% |
| Student 264 | 94.29% | 89.33% | 91.81% | 80.47% |
| Student 262 | 94.29% | 85.33% | 89.81% | 79.65% |

**Legends**

Engagement

Inactive Active Very Active

0% 25% 50% 75% 100%

Score

F D C B A

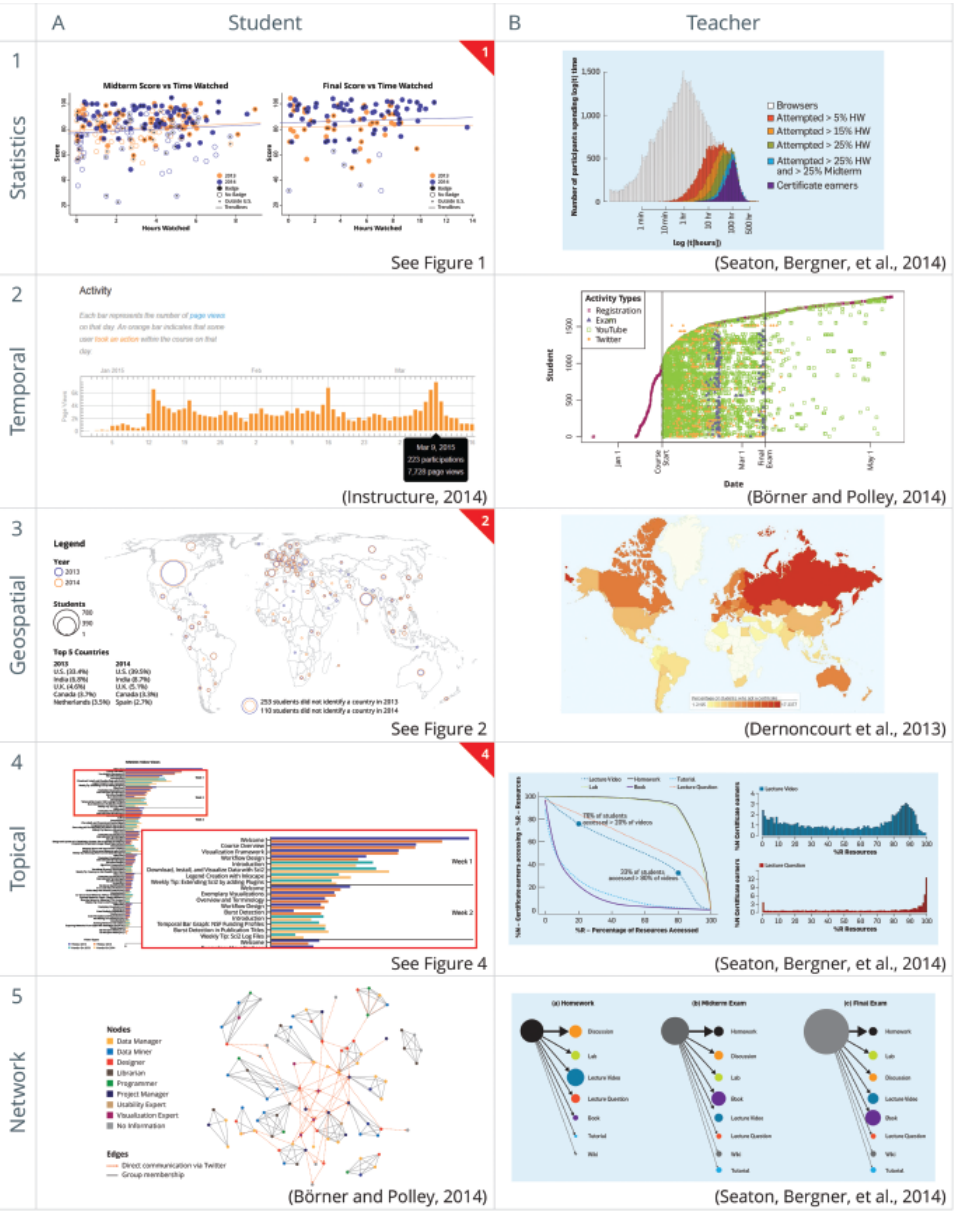
0% 60% 70% 80% 100%

Description

The heat map visualization is a representation of student engagement (magenta to blue color scale) and performance (red to green color scale) throughout a course. The visualization has two levels. The top level provides an overview of engagement and performance for groups of students, while the bottom level provides a detailed break out of student engagement statistics for individuals with an identified group.

Custom interactive visualizations of 2015 IVMOOC student engagement and performance data, explore functionality online at [http://demo.cns.iu.edu/webvis/learning-analytics/heatmap.html](http://demo.cns.iu.edu/webvis/learning-analytics/heatmap.html)

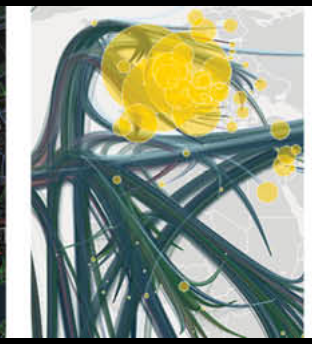
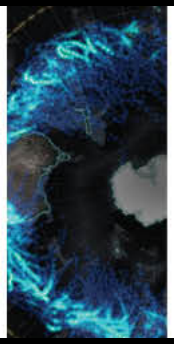
# Analysis and Visualization Types vs. User Need Types




Emmons, Light, and Börner. 2017. "MOOC Visual Analytics: Empowering Teachers, Students, Researchers, and Developers of Massively Open Online Courses". *JASIST. DOI:10.1002/asi.23852*

#SacklerModVisST

Arthur M. Sackler COLLOQUIA
OF THE NATIONAL ACADEMY OF SCIENCES


# Modeling and Visualizing Science and Technology Developments

National Academy of Sciences Sackler Colloquium, December 4-5, 2017, Irvine, CA

## Rankings and the Efficiency of Institutions

H. Eugene Stanley | Albert-László Barabási | Lada Adamic | Marta González | Kaye Husbands Fealing | Brian Uzzi | John V. Lombardi

## Higher Education and the Science & Technology Job Market

Katy Börner | Wendy L. Martinez | Michael Richey | William Rouse | Stasa Milojevic | Rob Rubin | David Krakauer

## Innovation Diffusion and Technology Adoption

William Rouse | Donna Cox | Jeff Alstott | Ben Shneiderman | Rahul C. Basole | Scott Stern | Cesar Hidalgo

## Modeling Needs, Infrastructures, Standards

Paul Trunfio | Sallie Keller | Andrew L. Russell | Guru Madhavan | Azer Bestavros | Jason Owen-Smith

nasonline.org/Sackler-Visualizing-Science

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