Research Impact Indicators and Visualizations

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Research Impact Indicators and Visualizations

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I ILLINOIS
University Library

Use of Research Impact Measures

- Universities are routinely utilizing research impact metrics

- They are used to understand, monitor, and assess research performance for:
  - Unit and department funding decisions
  - Recruiting & hiring decisions
  - Promotion and tenure
  - Comparative rankings
  - Demonstrating to government or tax payers the value of university research
  - Grant funding applications

Research Impact Metrics

- They are used to measure the productivity, influence, and performance of individual faculty, research groups, departments, college, and universities and to compare individuals and units with other individuals and units

- For these reasons they are surrounded by controversy and widely criticized by individuals and units as invalid evaluation and assessment tools

- At Illinois, we want to provide a flexible framework for research impact measures that allows us to control the process

Research Impact Metrics

- There is a rich literature on research evaluation and measurement

- Much of the focus has been on citation data and, secondarily, on publications

- A number of quantitative research metrics have been proposed and applied in visualizations

- At Illinois, we are looking at a mix of research indicators

Faculty Productivity Metrics

- H-Index – maximum number of papers h where each of them has at least h citations

- G-Index – highest number of papers g that receive at least g squared citations

- H sub s index – h-index normalized by the average h-index of all researchers in the same discipline

- Others that assign relative credit to each co-author of a paper

Research Impact Metrics

- "Almost everyone agrees that even the most sophisticated metrics are not able to capture the diversity and richness of research impact" Wang et al, ACM Trans on Interactive Intelligent Syst 8(1), March 2018

- Moed & Halevi, "Multidimensional Assessment of Scholarly Research Impact", Jnl Assoc for Info Sci & Tech, 2015

- How do we define research impact and what indicators or metrics do we use in evaluations?

Possible Indicators

- **Articles Published by researcher**
  - Impact factor of the journals (CiteScore, ISI JCR, SNIP, Eigenvalue)
  - Usage (downloads) of the journal
  - Altmetric or Attention Scores of articles
  - Position within author list (last author)
  - Acceptance rate of journal or conference
- **Number of times cited**
  - Impact of citing journal and times citing is cited
  - Citations by year
- **Number of Grants Received**
 - NSF, NIH, DOE (custom databases)

More Indicators

- **Number of patents**
  - Best way to measure innovation
  - USPTA database
- **Prestigious awards and honors**
- **Number of start-up companies and intellectual property revenues**
- **Number of coauthors**
  - Prestige of coauthors
  - Coauthors within the cohort or group (NIH grants)
- Start-up companies, prestigious awards (e.g. Nobel Prizes), national academy memberships

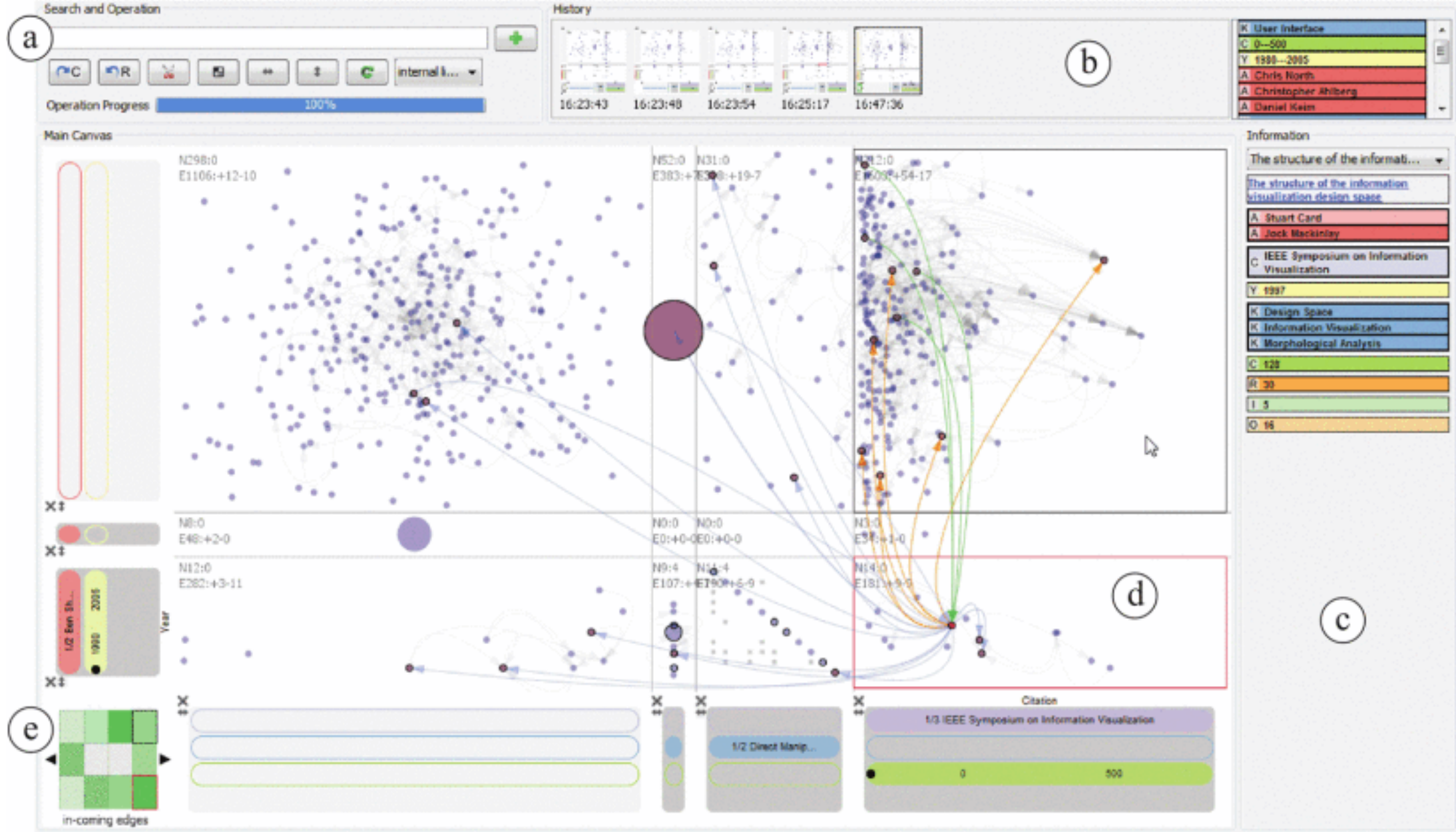- **Weighting of indicators

Research Impact Visualizations

- Impact metrics are often displayed in visualizations and graphical displays

- Number of attempts to visualize research impact and research productivity and output

- Focus on citation analysis

- Commercial systems: Elsevier SciVal Analytics, ISI InCite

- Open and research systems
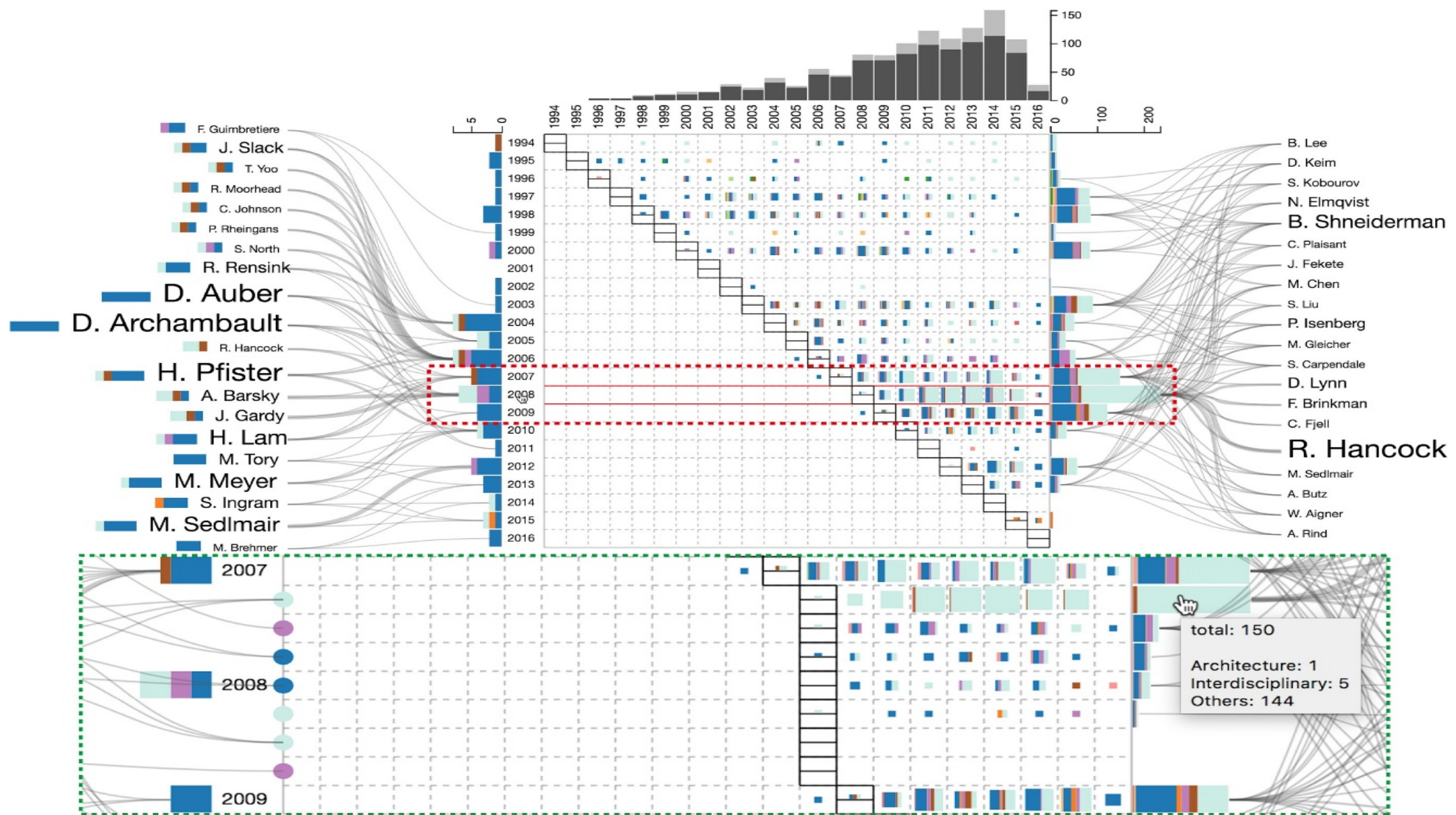
ImpactVis, Wang et al

PivotSlice, Zhao et al
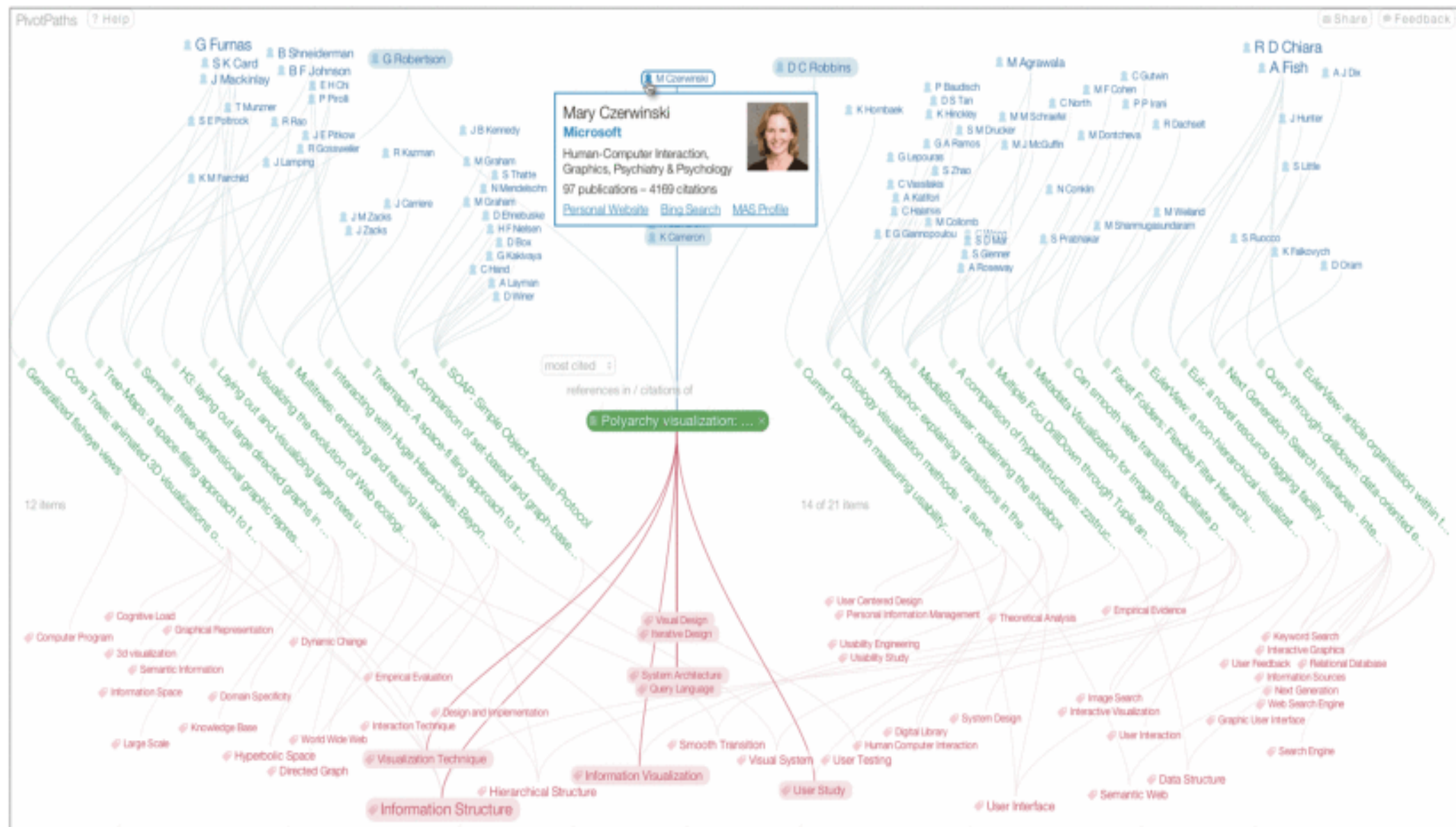
PivotPaths, Dork et al

CiteRivers, Heimerl et al
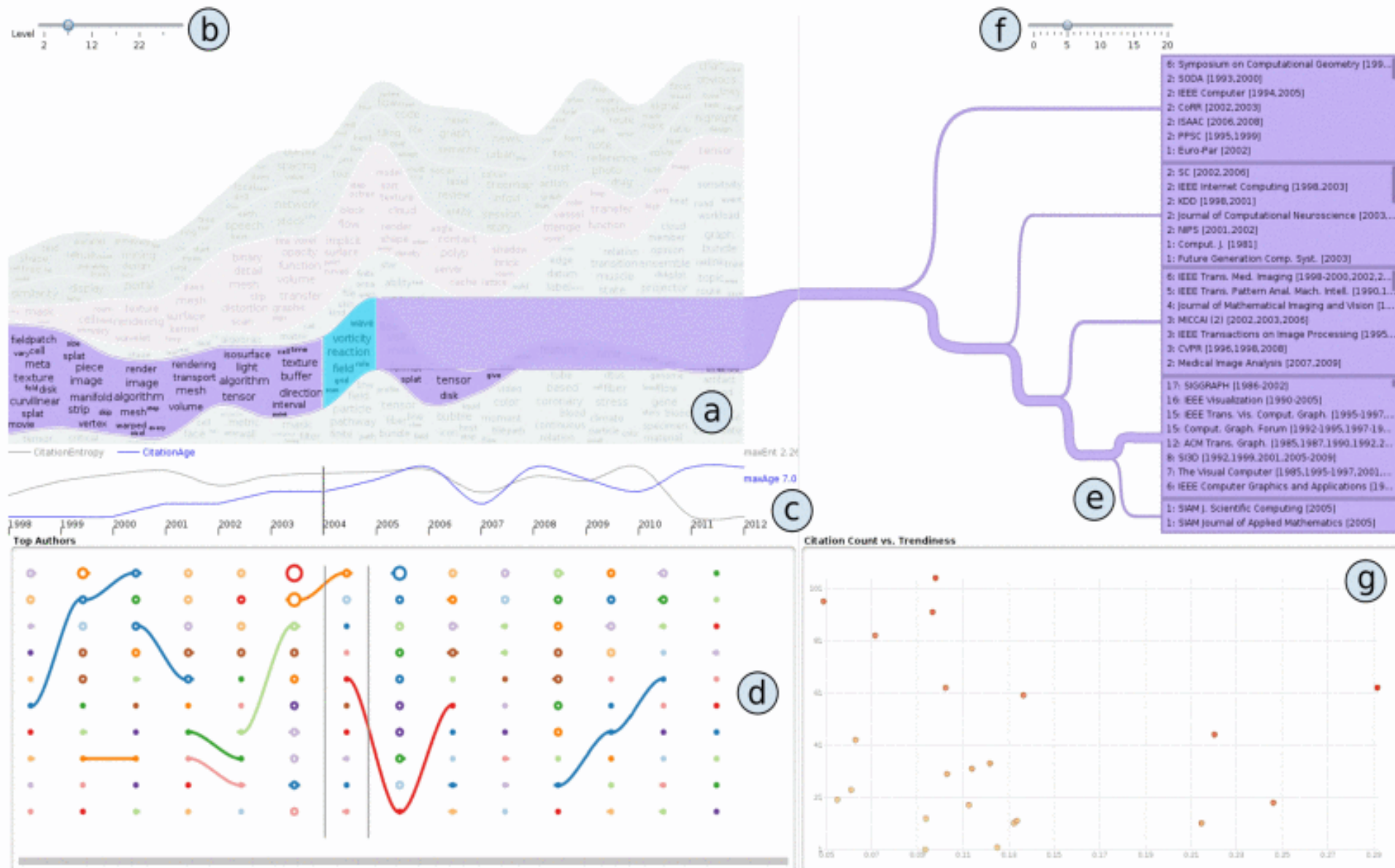
Our Approach

- Create easy-to-understand visualizations

- Connect the visualization/dashboard elements to the bibliographic literature and distributed information resources and databases

- Have the visualizations be interactive and dynamic

- Allow customization of displays and weighting of impact indicators

Library Involvement in Data Visualization

- Trend for libraries to utilize visualization metrics to assess services and describe collections

- Libraries partnering with other university units in the gathering of research impact measures

- Libraries can utilize Abstracting and Indexing Service and vendor APIs (Application Programming Interfaces) and other scholarly communication and database skills

- Leiden Manifesto describes best practices for quantitative and bibliometric metrics

Libraries

- Library focus has been on bibliographic and service visualizations, often static

- Software: Tableau, VOSViewer, Gephi, Science of Science (Sci2), R, Python

- Scopus, WOS, and other APIs

- Server side scripting, Scalar Vector Graphics (SVG), HTML5, D3, Javascript Libraries

UIUC University Library
Dewey Print Collection: Analysis by Subject Headings

[Constraints: Items whose call numbers are assigned according to the Dewey Decimal Classification but start with prefixes were NOT included in the analysis]
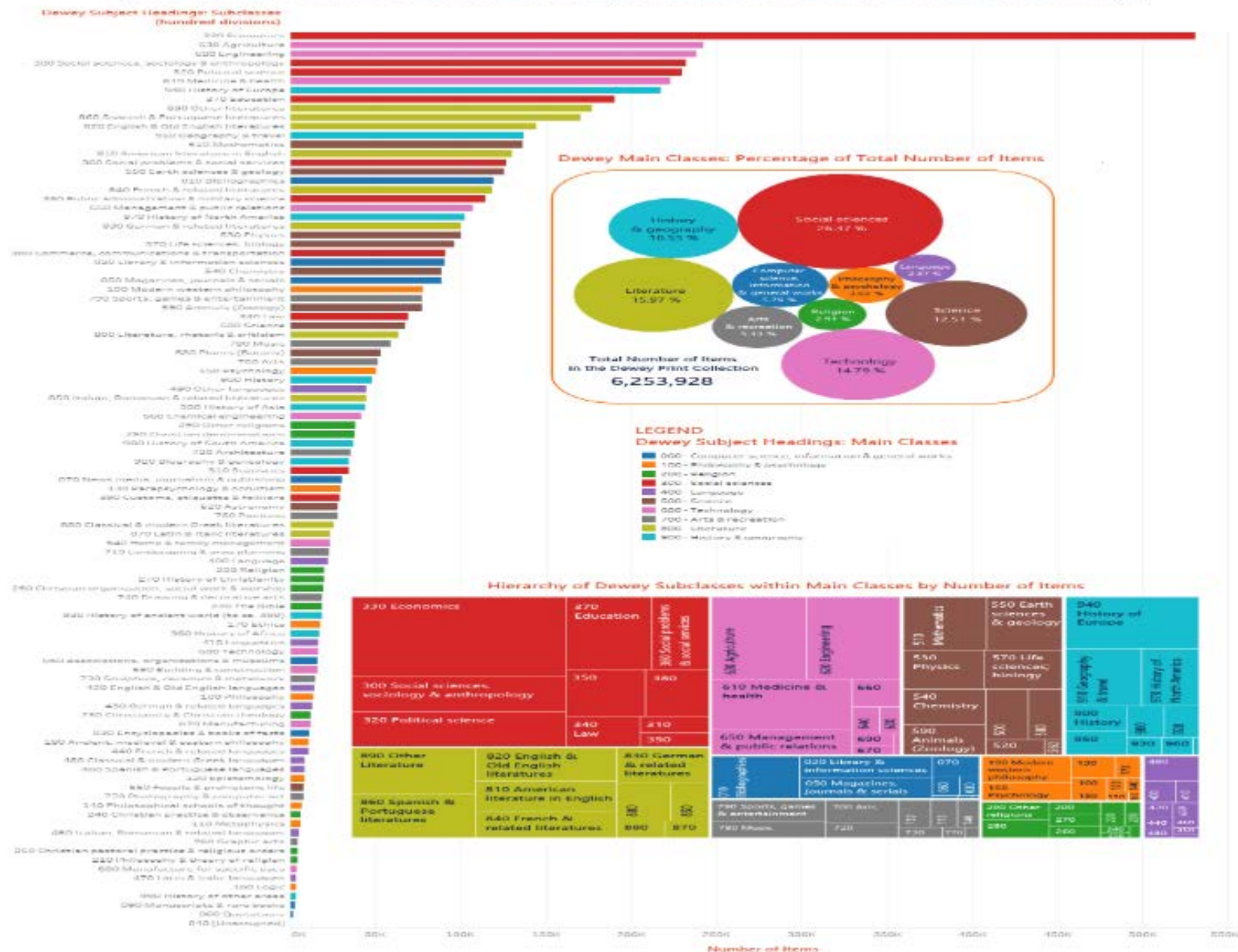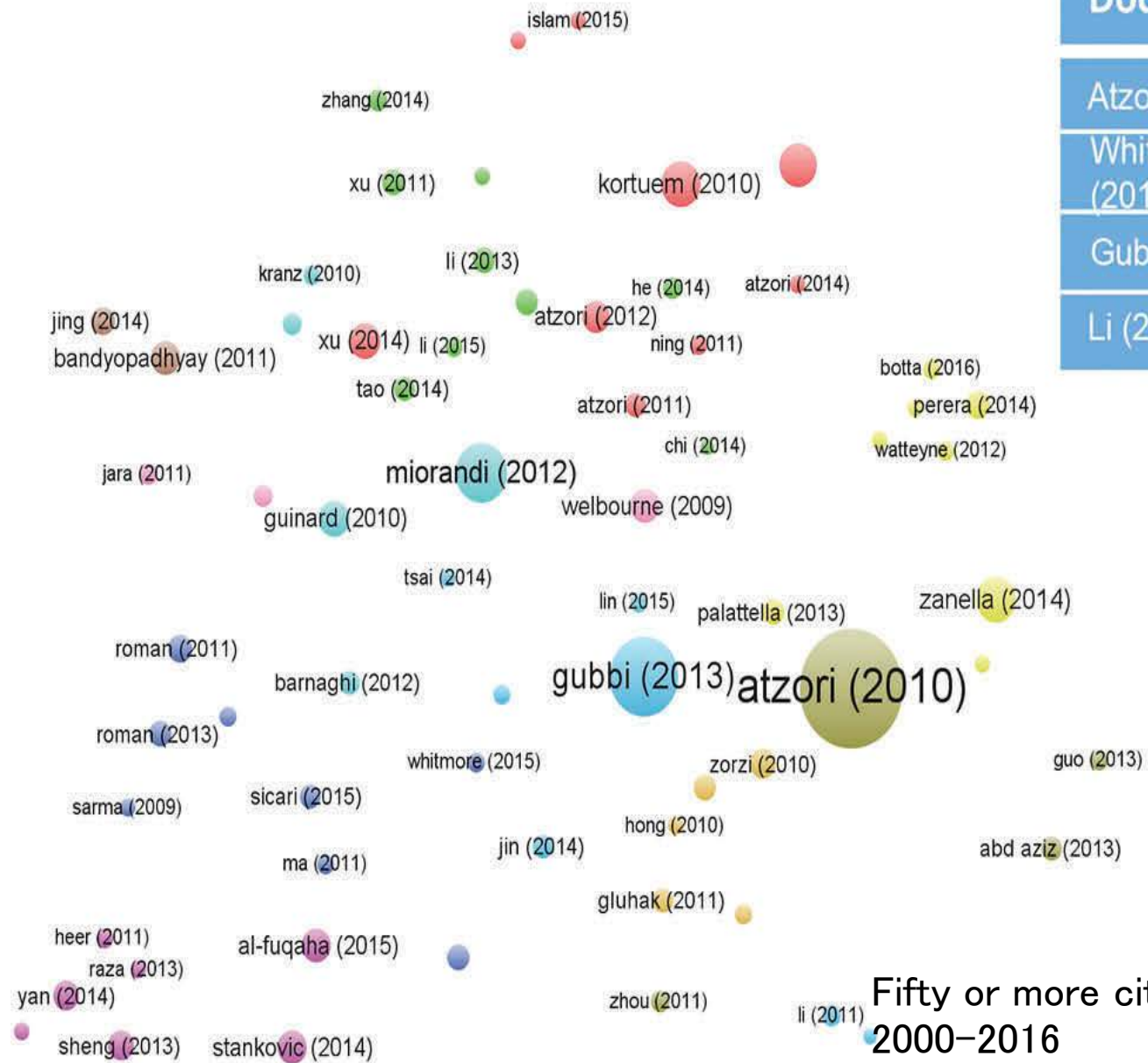
Document	Citations	Total Link Strength
Atzori (2010)	2308	30
Whitmore (2015)	73	21
Gubbi (2013)	1061	16
Li (2015)	94	14

Fifty or more citations of highly cited articles, 2000–2016

Figure 10: Simplified impact wheels for all 60 topics

HEFCE Higher Education Funding Council of England. The nature, scale and beneficiaries of research impact: An initial analysis of Research Excellence Framework (REF) 2014 impact case studies

Illinois Research Impact Visualizations

- University of Illinois Library generating research impact dashboards over units/departments

- Using the Elsevier Scopus API to create bibliographic metadata database. The process begins with one table of researcher names and Scopus ID numbers

- Elsevier webinar available on their system

- Additional scripts to create co-author, grants received, and cited-by tables

Illinois System

- Creates a database-driven, dynamic, and interactive web-based visualization of research group members

- Scaled and clickable display bubbles for articles, cited-by articles, grants, patents, and co-authors within the cohort group with clickable publication number labels

- The bibliographic metadata is downloaded via several Scopus APIs and additional data (CiteScore values and Altmetric scores) are added to records. Other tables are generated (Coauthor information) and custom grant and patent databases built
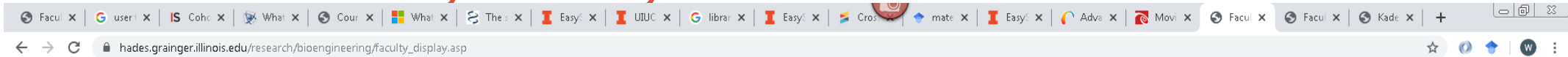
Illinois Visualization/Dashboard

- Initially designed to support Cancer Center of Illinois NIH grant request

- In addition to the visualization, custom spreadsheets (e.g. the affiliations of all the non-Illinois coauthors) can be generated

- Display does shows comparison of unit/group researchers and can include non-Illinois researchers

- Able to customize to include only latest year or cross-institution researchers in visualization
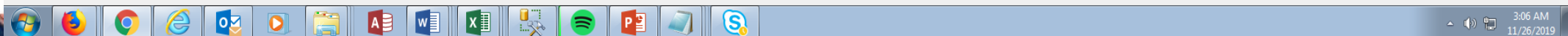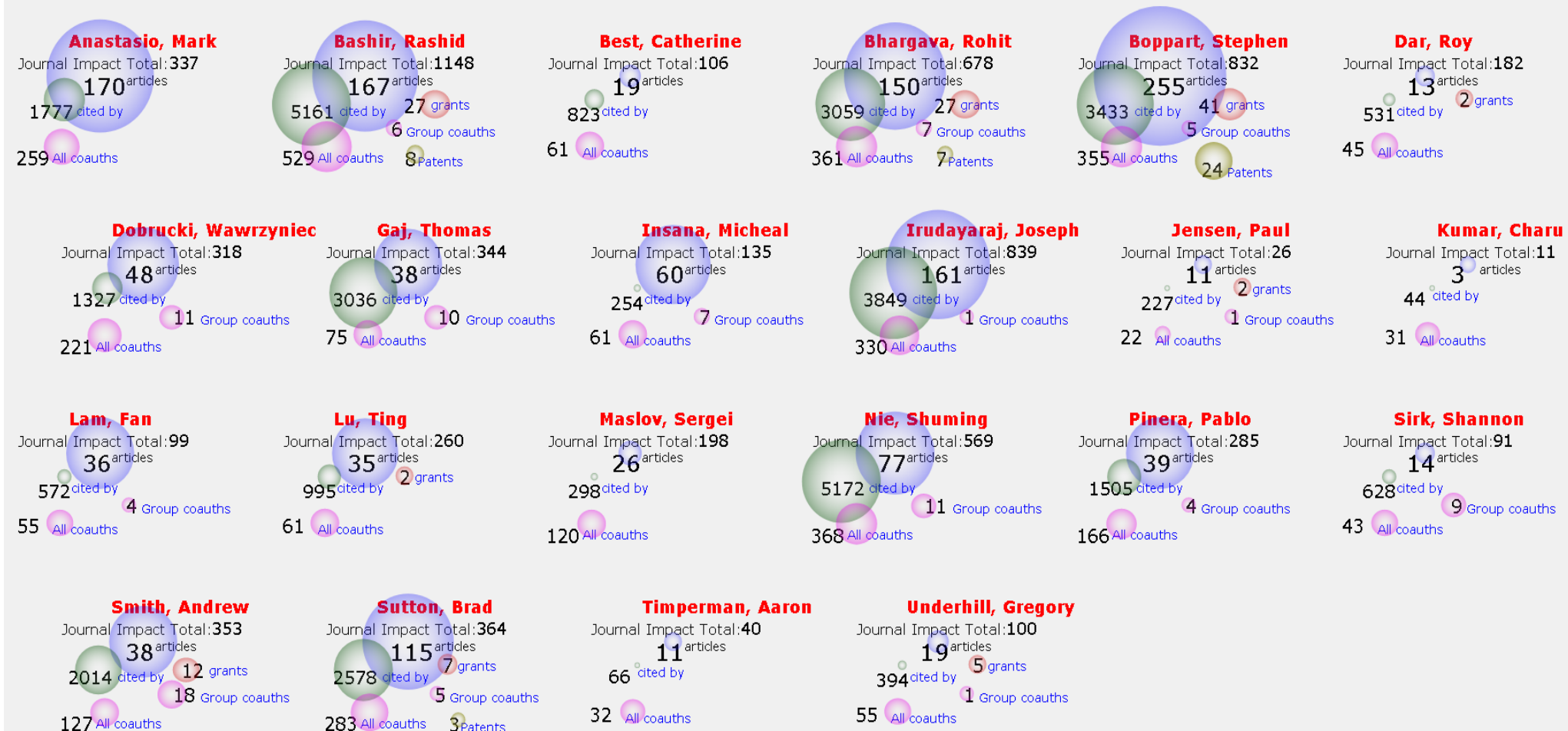
Illinois Dashboard

- The process uses 8 executed scripts to build the entire database

- The display script is the same for all groups and the display is database-driven

- Shows articles published in designated time period, number of times the articles are cited, number of NSF or NIH grants, number of patents received, number of and list of coauthors, and a custom coauthors within the cohort visualization
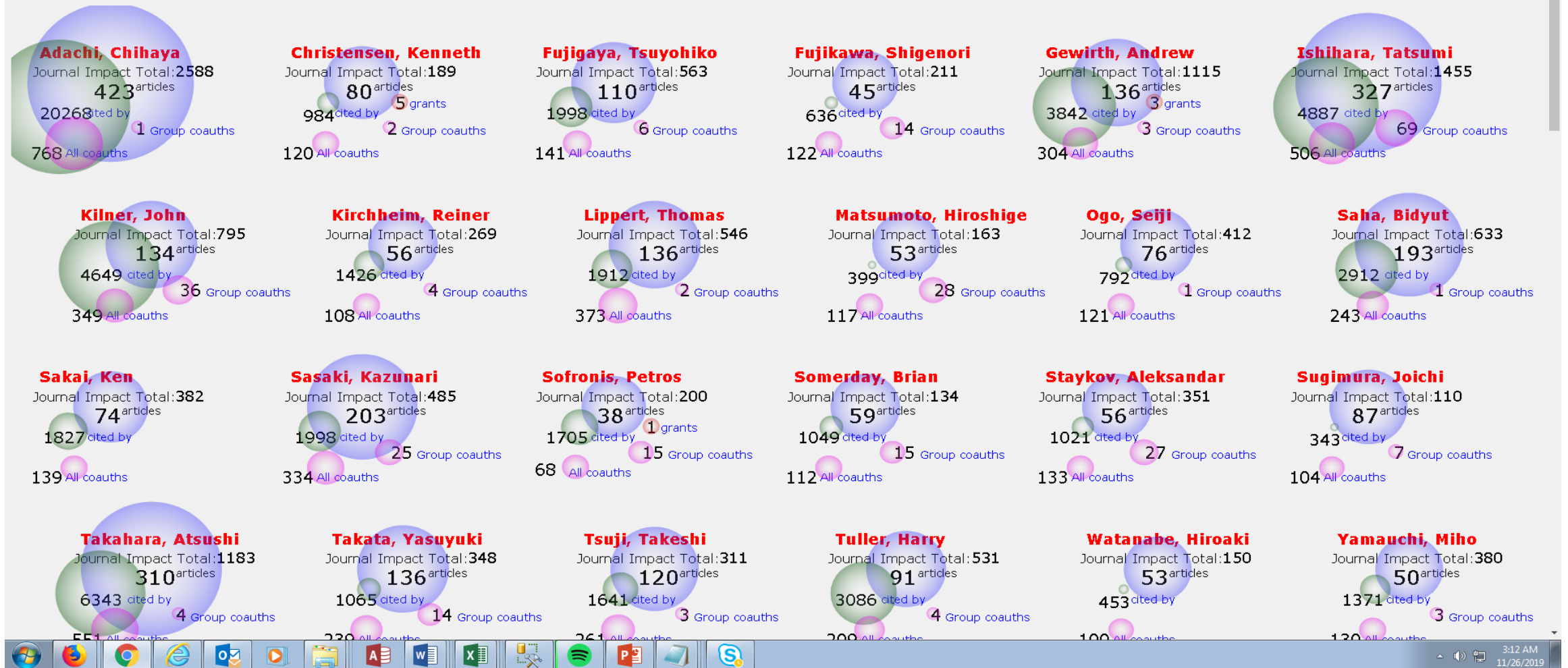
Bioengineering Research Metrics Visualization

Bioengineering Faculty at the University of Illinois at Urbana-Champaign-- Six Clickable Bubbles: Articles from 2010 to Present: Number of Times Cited; NSF & NIH Grants since 2010; Patents Granted; and Co-Authors Visualization

Search for Bioengineering Faculty articles by Author Name, Title, Journal...

Anastasio, Mark
Journal Impact Total: 337
170 articles
1777 cited by
259 All coauths

Bashir, Rashid
Journal Impact Total: 1148
167 articles
5161 cited by
27 grants
6 Group coauths
529 All coauths
8 Patents

Best, Catherine
Journal Impact Total: 106
19 articles
823 cited by
61 All coauths

Bhargava, Rohit
Journal Impact Total: 678
150 articles
3059 cited by
27 grants
7 Group coauths
361 All coauths
7 Patents

Boppart, Stephen
Journal Impact Total: 832
255 articles
3433 cited by
41 grants
5 Group coauths
355 All coauths
24 Patents

Dar, Roy
Journal Impact Total: 182
13 articles
531 cited by
2 grants
45 All coauths

Dobrucki, Wawrzyniec
Journal Impact Total: 318
48 articles
1327 cited by
11 Group coauths
221 All coauths

Gaj, Thomas
Journal Impact Total: 344
38 articles
3036 cited by
10 Group coauths
75 All coauths

Insana, Micheal
Journal Impact Total: 135
60 articles
254 cited by
7 Group coauths
61 All coauths

Irudayaraj, Joseph
Journal Impact Total: 839
161 articles
3849 cited by
1 Group coauths
330 All coauths

Jensen, Paul
Journal Impact Total: 26
11 articles
227 cited by
2 grants
1 Group coauths
22 All coauths

Kumar, Charu
Journal Impact Total: 11
3 articles
44 cited by
31 All coauths

Lam, Fan
Journal Impact Total: 99
36 articles
572 cited by
4 Group coauths
55 All coauths

Lu, Ting
Journal Impact Total: 260
35 articles
995 cited by
2 grants
61 All coauths

Maslov, Sergei
Journal Impact Total: 198
26 articles
298 cited by
120 All coauths

Nie, Shuming
Journal Impact Total: 569
77 articles
5172 cited by
11 Group coauths
368 All coauths

Pinera, Pablo
Journal Impact Total: 285
39 articles
1505 cited by
4 Group coauths
166 All coauths

Sirk, Shannon
Journal Impact Total: 91
14 articles
628 cited by
9 Group coauths
43 All coauths

Smith, Andrew
Journal Impact Total: 353
38 articles
2014 cited by
12 grants
18 Group coauths
127 All coauths

Sutton, Brad
Journal Impact Total: 364
115 articles
2578 cited by
7 grants
5 Group coauths
283 All coauths
3 Patents

Timperman, Aaron
Journal Impact Total: 40
11 articles
66 cited by
32 All coauths

Underhill, Gregory
Journal Impact Total: 100
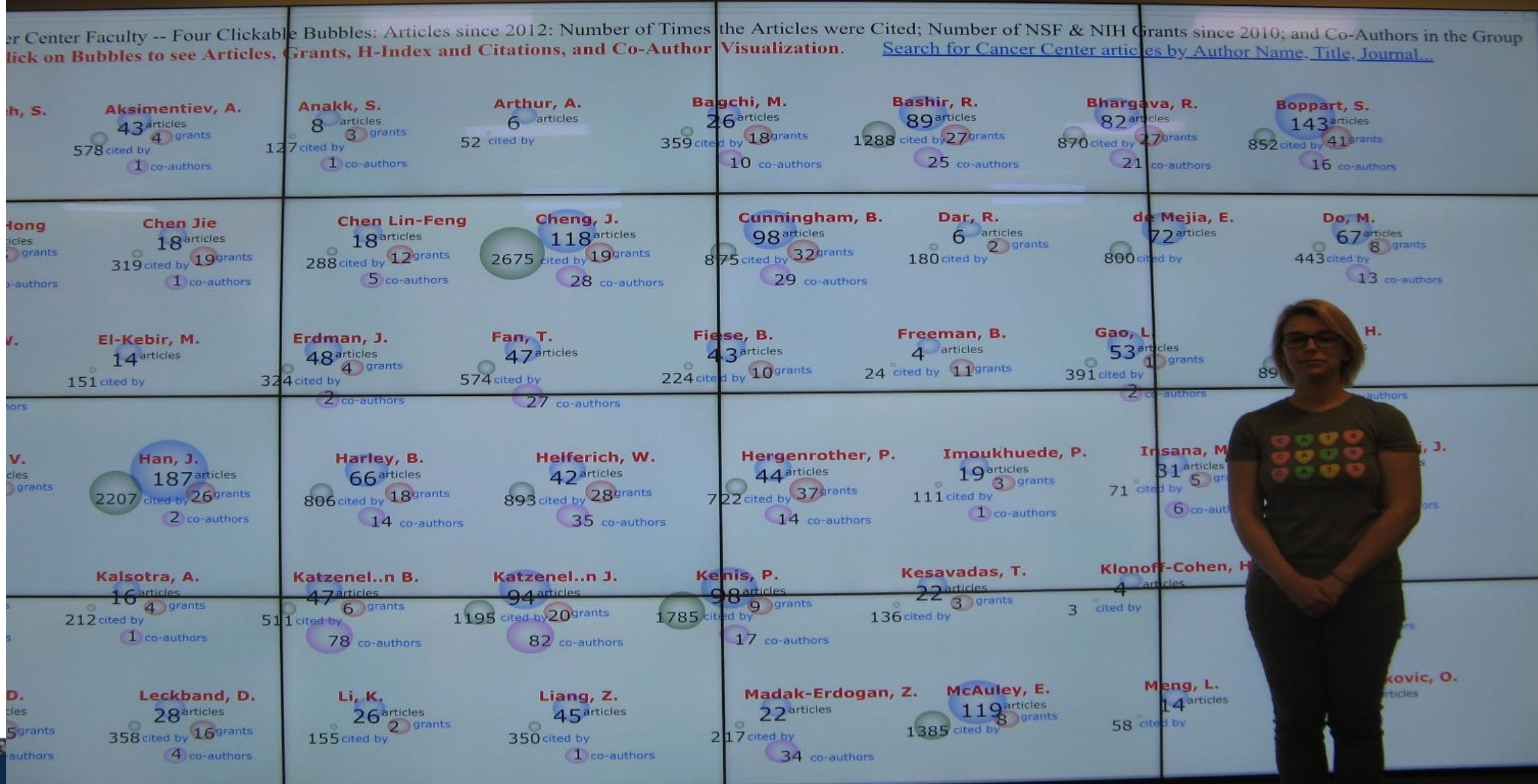19 articles
394 cited by
5 grants
1 Group coauths
55 All coauths

I2CNER Research Metrics Visualization

I2CNER Principal Investigators at the University of Illinois at Urbana-Champaign-- Six Clickable Bubbles: Articles from 2010 to Present: Number of Times Cited; NSF & NIH Grants since 2010; Patents Granted; and Co-Authors Visualization

Search for I2CNER Principal Investigators articles by Author Name, Title, Journal...

Adachi, Chihaya
Journal Impact Total:2588
423 articles
20268 cited by
1 Group coauths
768 All coauths

Christensen, Kenneth
Journal Impact Total:189
80 articles
5 grants
984 cited by
2 Group coauths
120 All coauths

Fujigaya, Tsuyohiko
Journal Impact Total:563
110 articles
1998 cited by
6 Group coauths
141 All coauths

Fujikawa, Shigenori
Journal Impact Total:211
45 articles
636 cited by
14 Group coauths
122 All coauths

Gewirth, Andrew
Journal Impact Total:1115
136 articles
3 grants
3842 cited by
3 Group coauths
304 All coauths

Ishihara, Tatsumi
Journal Impact Total:1455
327 articles
4887 cited by
69 Group coauths
506 All coauths

Kilner, John
Journal Impact Total:795
134 articles
4649 cited by
36 Group coauths
349 All coauths

Kirchheim, Reiner
Journal Impact Total:269
56 articles
1426 cited by
4 Group coauths
108 All coauths

Lippert, Thomas
Journal Impact Total:546
136 articles
1912 cited by
2 Group coauths
373 All coauths

Matsumoto, Hiroshige
Journal Impact Total:163
53 articles
399 cited by
28 Group coauths
117 All coauths

Ogo, Seiji
Journal Impact Total:412
76 articles
792 cited by
1 Group coauths
121 All coauths

Saha, Bidyut
Journal Impact Total:633
193 articles
2912 cited by
1 Group coauths
243 All coauths

Sakai, Ken
Journal Impact Total:382
74 articles
1827 cited by
139 All coauths

Sasaki, Kazunari
Journal Impact Total:485
203 articles
1998 cited by
25 Group coauths
334 All coauths

Sofronis, Petros
Journal Impact Total:200
38 articles
1 grants
1705 cited by
15 Group coauths
68 All coauths

Somerday, Brian
Journal Impact Total:134
59 articles
1049 cited by
15 Group coauths
112 All coauths

Staykov, Aleksandar
Journal Impact Total:351
56 articles
1021 cited by
27 Group coauths
133 All coauths

Sugimura, Joichi
Journal Impact Total:110
87 articles
343 cited by
7 Group coauths
104 All coauths

Takahara, Atsushi
Journal Impact Total:1183
310 articles
6343 cited by
4 Group coauths
551 All coauths

Takata, Yasuyuki
Journal Impact Total:348
136 articles
1065 cited by
14 Group coauths
239 All coauths

Tsuji, Takeshi
Journal Impact Total:311
120 articles
1641 cited by
3 Group coauths
261 All coauths

Tuller, Harry
Journal Impact Total:531
91 articles
3086 cited by
4 Group coauths
209 All coauths

Watanabe, Hiroaki
Journal Impact Total:150
53 articles
453 cited by
100 All coauths

Yamauchi, Miho
Journal Impact Total:380
50 articles
1371 cited by
3 Group coauths
130 All coauths

Research Metrics Visualization

Article Display

Grants Display

Co-Author Display with Links to Articles
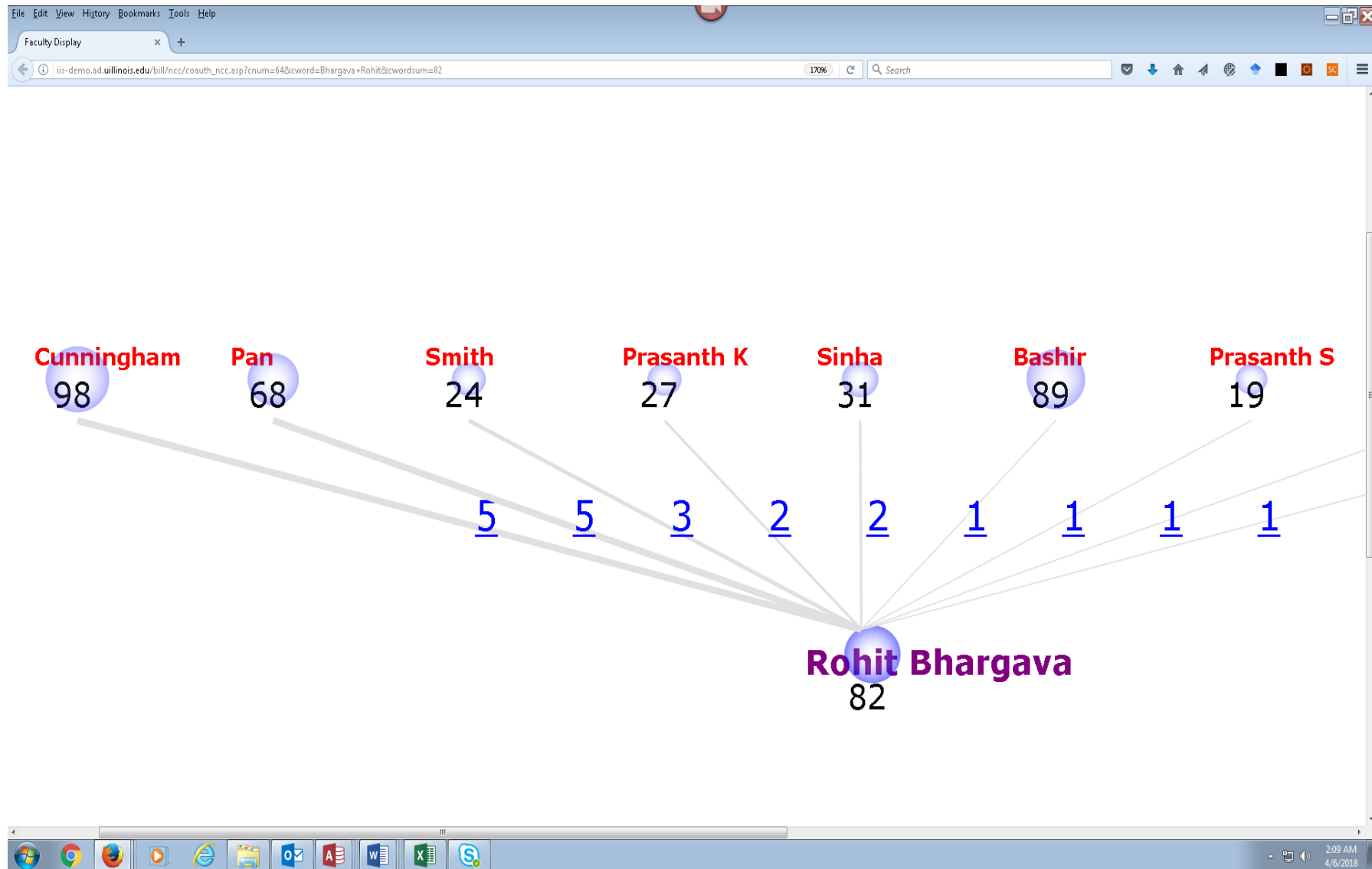
Separate Search System

Research Impact Visualizations

- These activities enhance the role of the library in supporting scholarly communication and in fostering campus partnerships

- We use the same scripts and display software for all departments and research groups

- Correlations on research impact indicators

- Developing system for weighting indicators & generating composite research impact values

Relationships between Research Indicators

- Do researchers with the most articles have the highest number of items cited? CiteScore journal impact total? H-Index? Number of grants? Number of patents?

- Correlation analysis over the research impact indicator values from individual researchers at the University of Illinois

- Used 294 UIUC faculty from departments of Bioengineering, the Cancer Center, Chemistry, Computer Science, & Physics

Results of Correlation Analysis

- Results illustrate the known issues with H-Index

- They also show some variance in written article totals and the CiteScore Journal Total values

- Results show that grant and patents awarded can provide useful alternative metrics in evaluating research impact and productivity

- Opportunity to add altmetrics, acceptance rates, last authorship, awards, etc.