

Research Impact Indicators and Visualizations

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<https://hdl.handle.net/2324/2547229>

出版情報 : 2019-12-09. Kyushu University Library
バージョン :
権利関係 :



Research Impact Indicators and Visualizations

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Presentation at Kyushu University Library
December 9, 2019

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

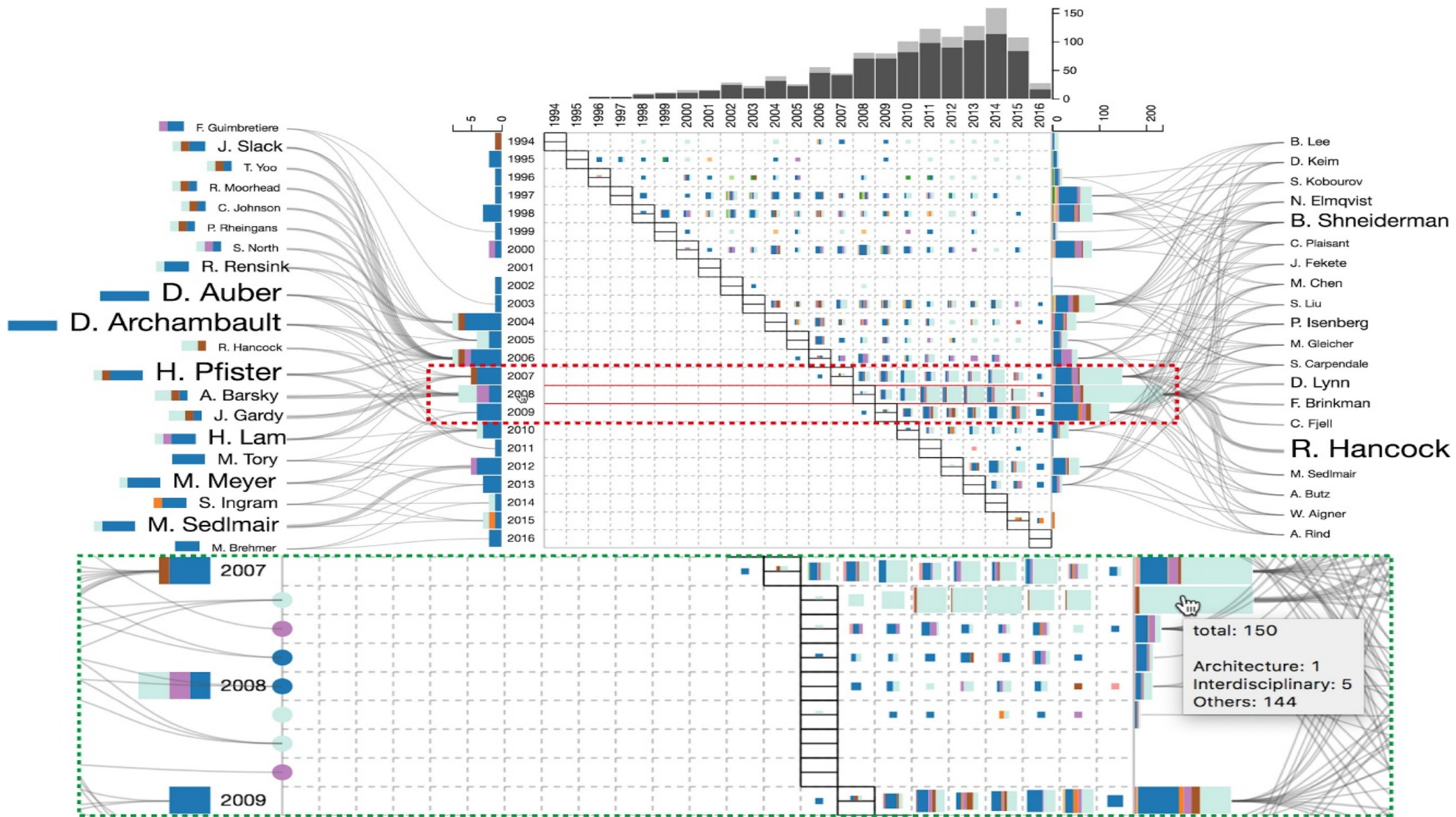
- Number of patents
 - Best way to measure innovation
 - USPTA database
- Prestigious awards and honors
- Number of start-up companies and intellectual property revenues
- Number of coauthors
 - Prestige of coauthors
 - Coauthors within the cohort or group (NIH grants)
- Start-up companies, prestigious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

- **Weighting of indicators

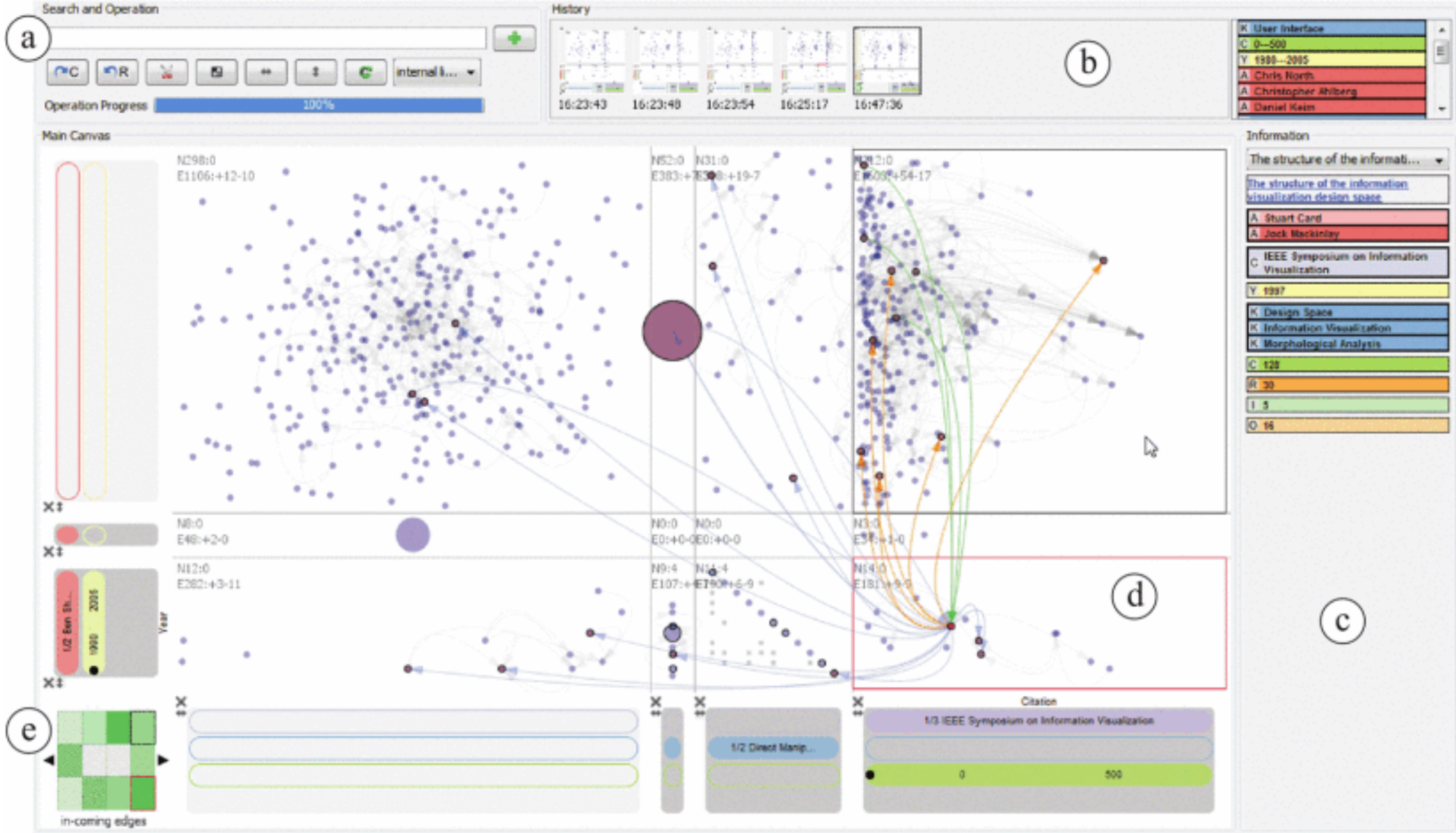
Research Impact Visualizations

- 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

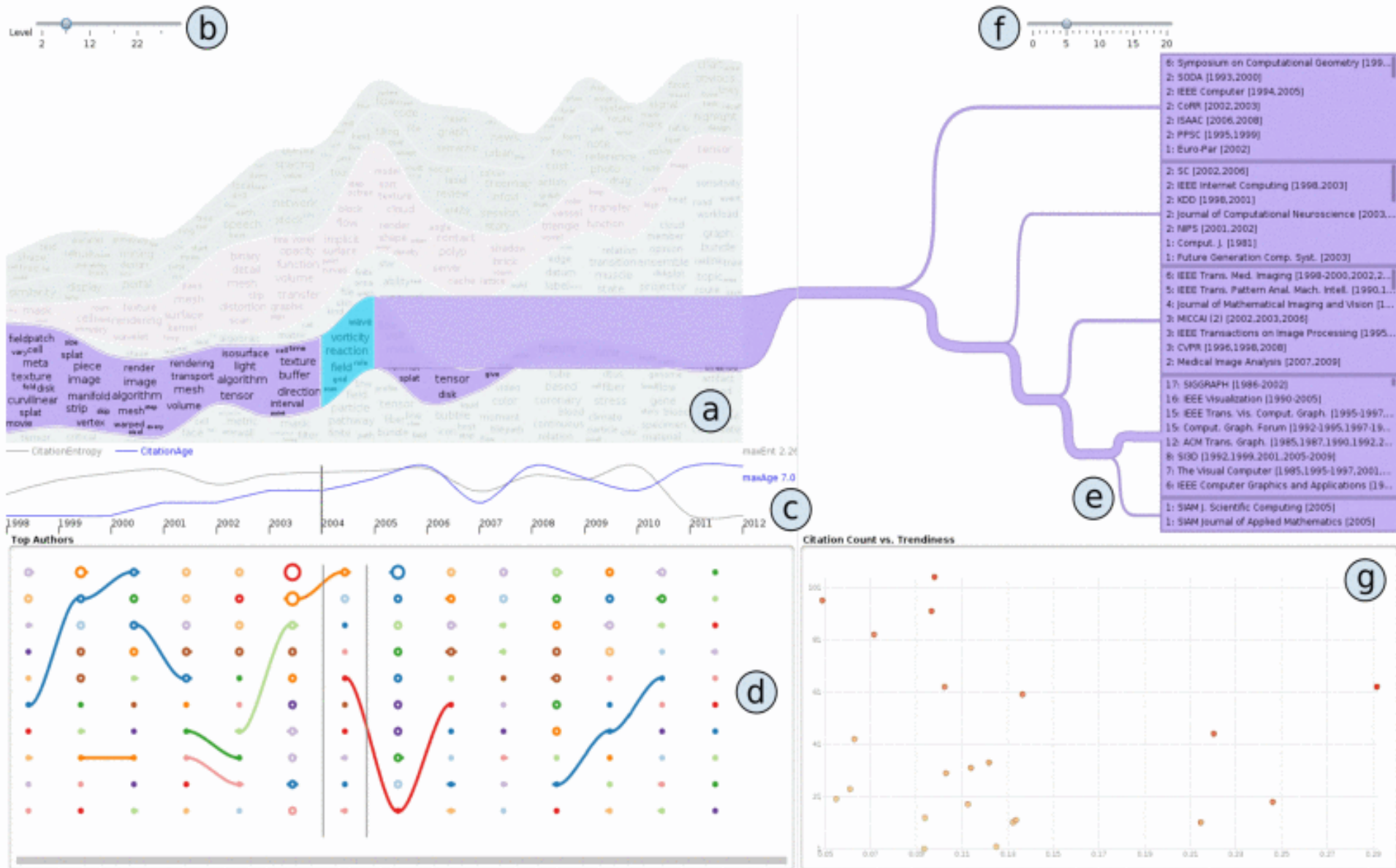
■ Architecture
 ■ Network
 ■ Security
 ■ Software
 ■ DB, mining
 ■ Theory
 ■ Graphics, visualization, multimedia
 ■ AI, ML, CV
 ■ HCI
 ■ Interdisciplinary
 ■ Others



ImpactVis, Wang et al



PivotSlice, Zhao et al



CITENETS, FIEBEL 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

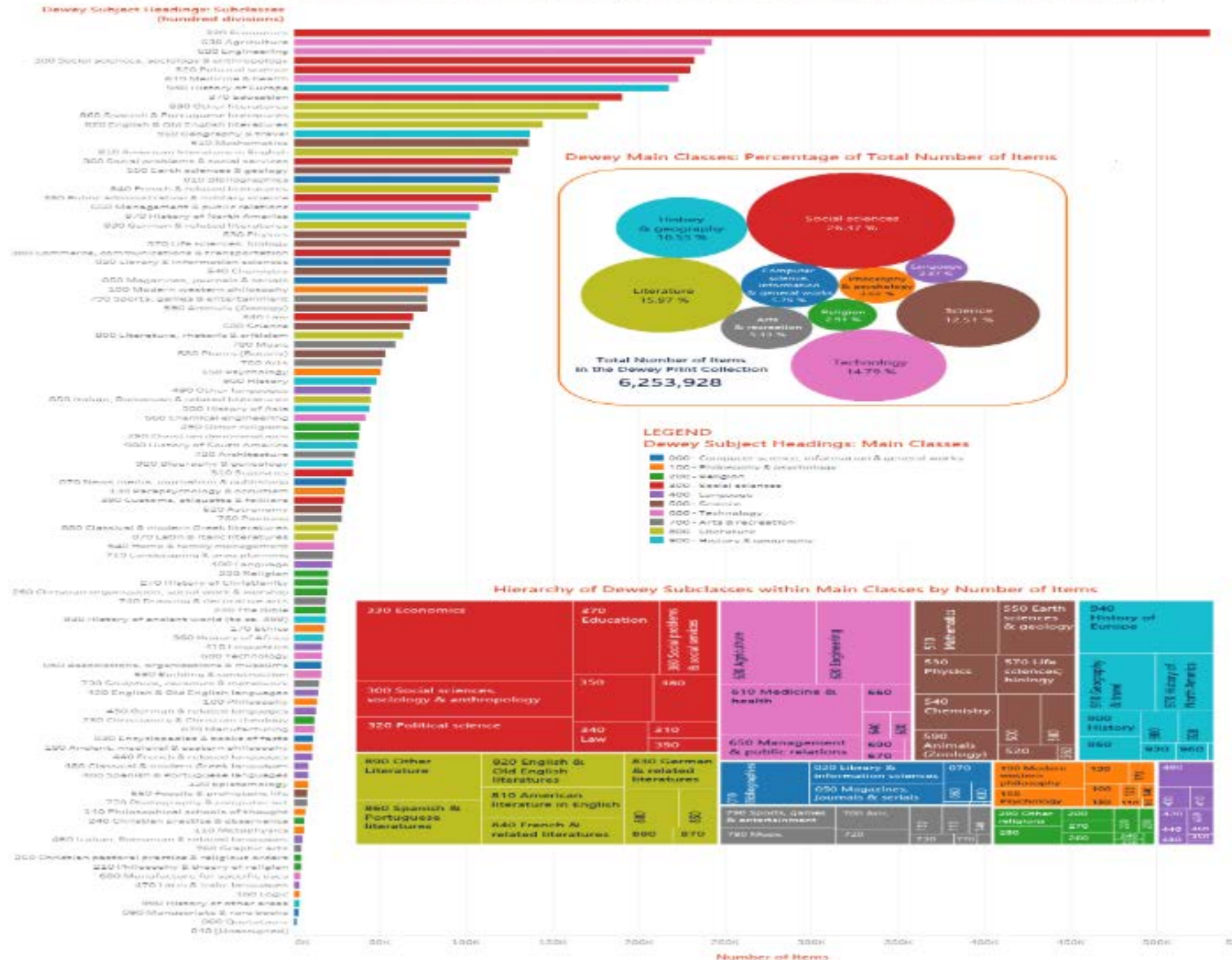
- Trend for libraries to utilize visualization metrics to assess services and describe collections
- Libraries partnering with other university units in the gathering of research impact measures
- Libraries can utilize Abstracting and Indexing Service and vendor APIs (Application Programming Interfaces) and other scholarly communication and database skills
- Leiden Manifesto describes best practices for quantitative and bibliometric metrics

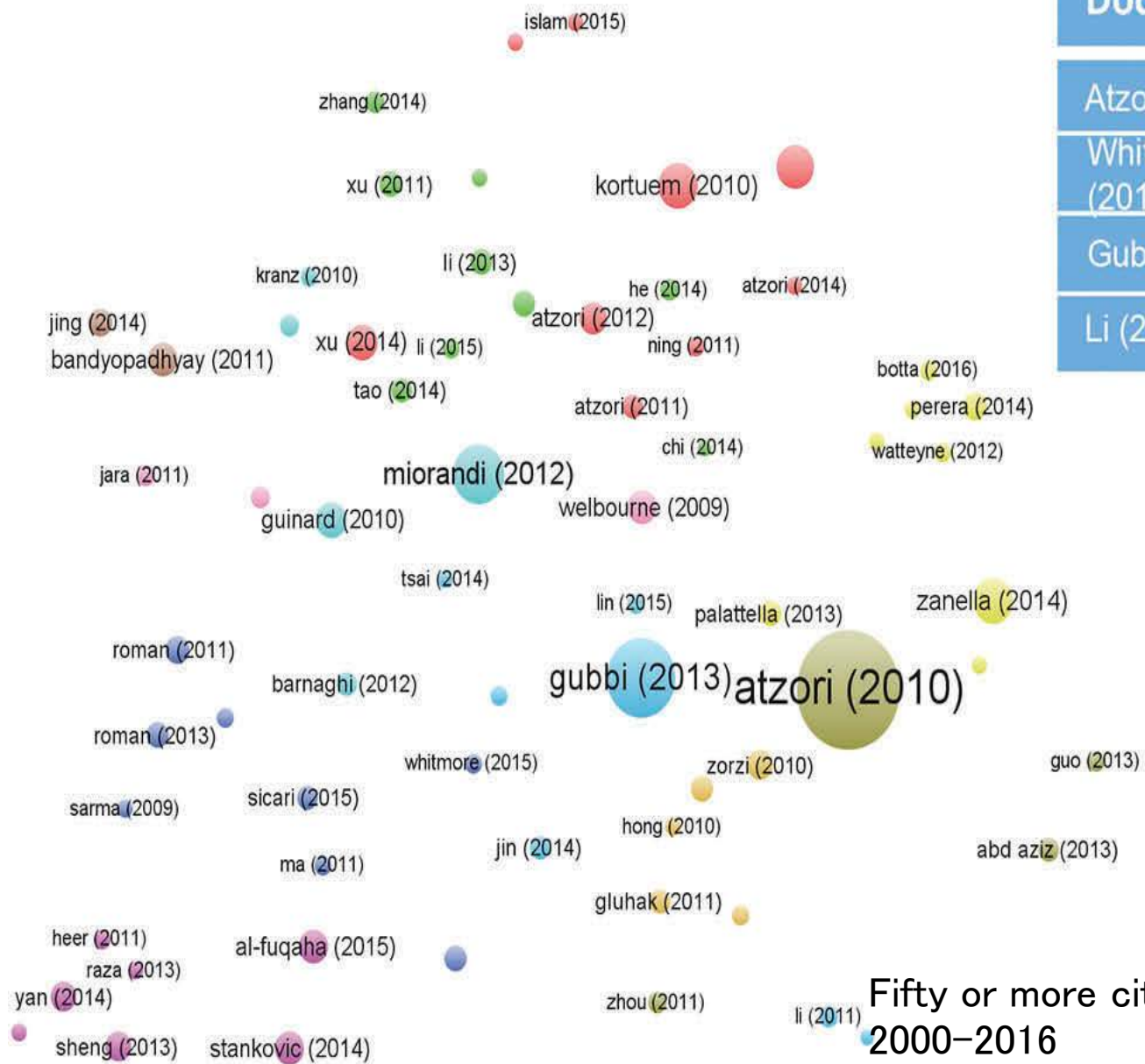
Libraries

- 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

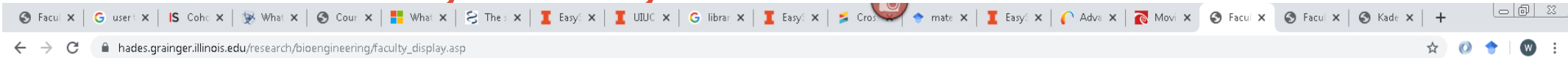
Illinois Visualization/Dashboard

- 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

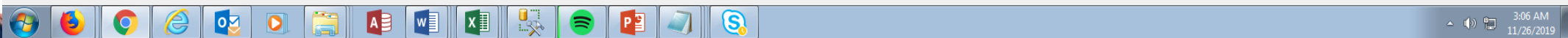
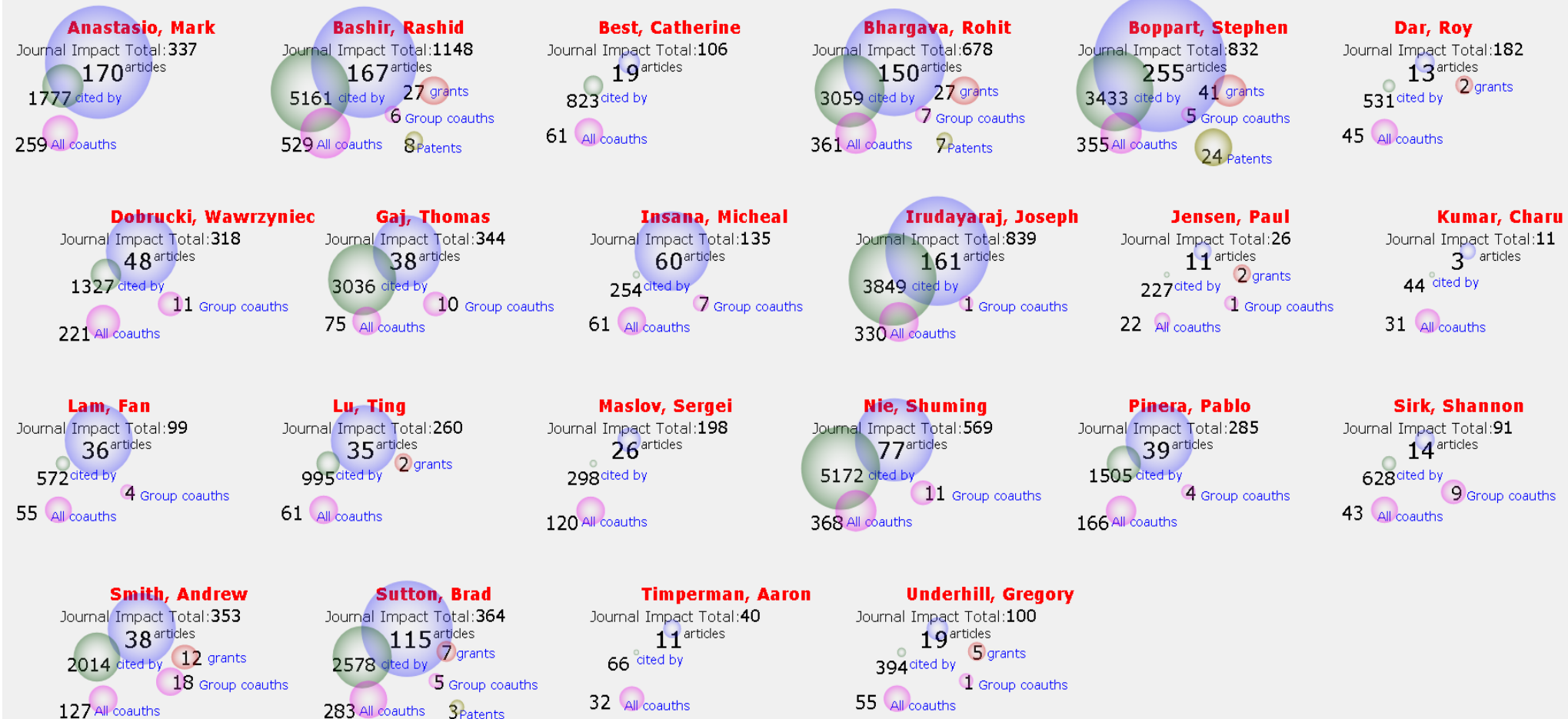
- The process uses 8 executed scripts to build the entire database
- The display script is the same for all groups and the display is database-driven
- Shows articles published in designated time period, number of times the articles are cited, number of NSF or NIH grants, number of patents received, number of and list of coauthors, and a custom coauthors within the cohort visualization

Bioengineering Research Metrics Visualization



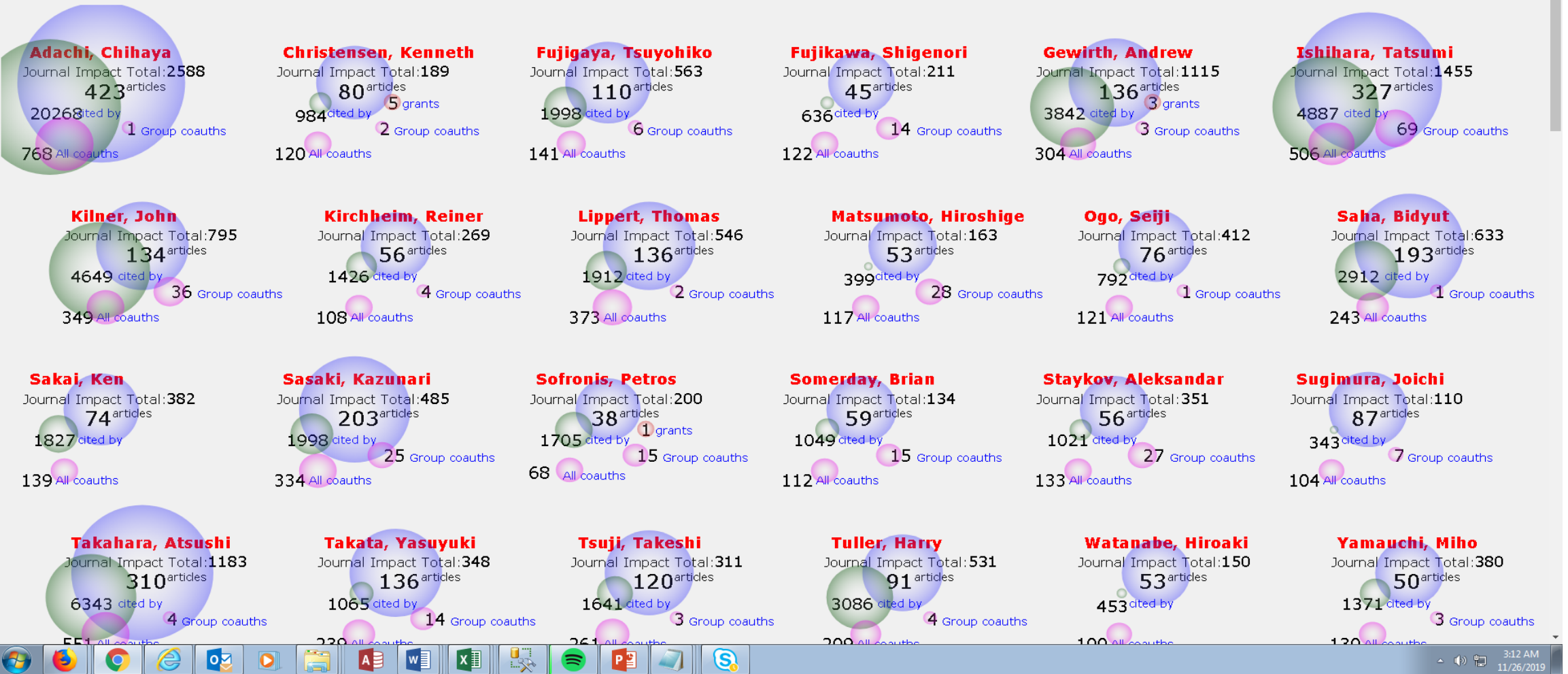
Bioengineering Faculty at the University of Illinois at Urbana-Champaign-- **Six Clickable Bubbles:** Articles from 2010 to Present: Number of Times Cited; NSF & NIH Grants since 2010; Patents Granted; and Co-Authors Visualization

[Search for Bioengineering Faculty articles by Author Name, Title, Journal...](#)

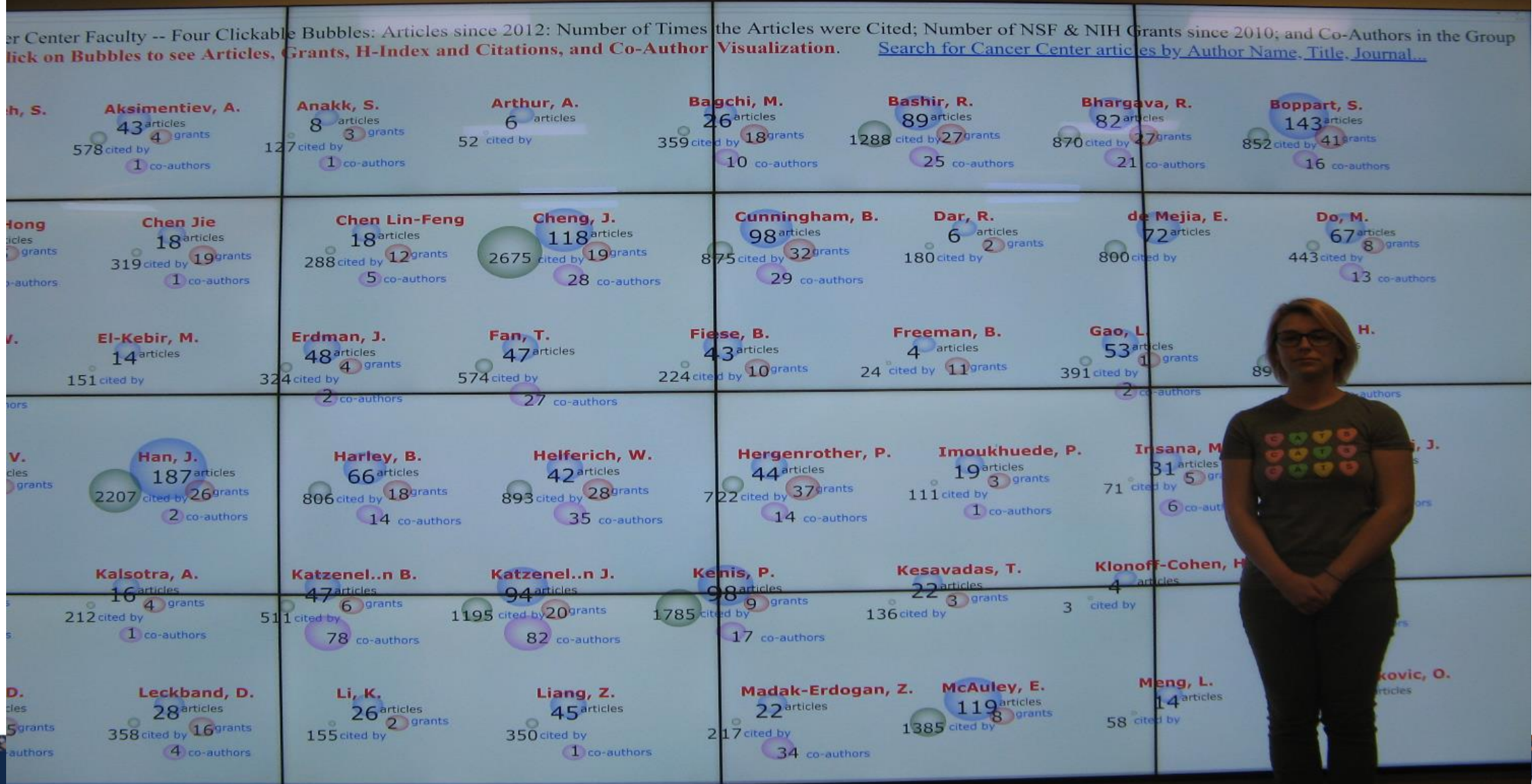


I2CNER Research Metrics Visualization

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...](#)



Research Metrics Visualization



Article Display

The screenshot shows a web browser window with the following elements:

- Browser Tab:** Ncc Faculty Search Results
- Address Bar:** hades.granger.illinois.edu/bill/ncc_group_post.asp?authormame=Boppart Stephen&fromc=cited
- Page Header:** UNIVERSITY LIBRARY UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
- Section Header:** Search Results
- Search Information:** You searched for: [Boppart Stephen](#) and retrieved 143 results. [Sort Results by Times Cited](#)
- Result 1:**
 - Title:** Real-time in vivo computed optical interferometric tomography
 - Authors:** Ahmad, Adeel; Shemonski, Nathan D.; Adie, Steven G.; Kim, Hee Seok; Hwu, Wen Mei W; Carney, P. Scott; Boppart, Stephen A.
 - Source Title:** [Nature Photonics](#), v. 7(6) p. 444-448 June 2013
 - Abstract:** High-resolution real-time tomography of scattering tissues is important for many areas of medicine and biology. However, the compromise between transverse resolution and depth-of-field, in addition to low sensitivity deep in tissue, continues to impede progress towards cellular-level volumetric tomography. Computed imaging has the potential to solve these long-standing limitations. Interferometric synthetic aperture microscopy is a computed imaging technique enabling high-resolution volumetric tomography with spatially invariant resolution. However, its potential for clinical diagnostics remains largely untapped because full volume reconstructions required lengthy post-processing, and the phase-stability requirements have been difficult to satisfy in vivo. Here, we demonstrate how three-dimensional Fourier-domain resampling, in combination with high-speed optical coherence tomography, can achieve high-resolution in vivo tomography. Enhanced depth sensitivity was achieved over a depth of field extended in real time by more than an order of magnitude. This work lays the foundation for high-speed volumetric cellular-level tomography. © 2013 Macmillan Publishers Limited. All rights reserved.
 - Links:** [Full-Text of Article](#) [49 Citing Articles](#) [Scopus link with References](#)
- Result 2:**
 - Title:** Coherent fiber supercontinuum for biophotonics
 - Authors:** Tu, Haohua; Boppart, Stephen A.
 - Source Title:** [Laser and Photonics Reviews](#), v. 7(5) p. 628-645 September 2013

The Windows taskbar at the bottom shows the time as 1:46 AM on 5/3/2018 and includes icons for various applications like Chrome, Firefox, and Office software.

Grants Display

The screenshot shows a web browser window with the address bar containing the URL: `hades.granger@illinois.edu/bill/ncc/grants_post.asp?authorname=Bhargava+Rohit`. The browser's title bar reads "Grant Results". The page header features the University of Illinois at Urbana-Champaign logo and the text "UNIVERSITY LIBRARY UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN".

Grants (NSF and NIH) Search Results

You searched for: [Bhargava Rohit](#) and retrieved 4 NSF Grants and 23 NIH Grants

NSF Grant #1

PIs: Jeffrey Moore, Rohit Bhargava, Ralph Nuzzo, Nancy Sottos, John Rogers

Title: [MRI: Acquisition of a Confocal Raman Microscope for Non-destructive Imaging of Complex Heterogeneous Materials](#)

Dates, Amount: 10/01/2010 - 09/30/2013 \$459,111.00 MPS

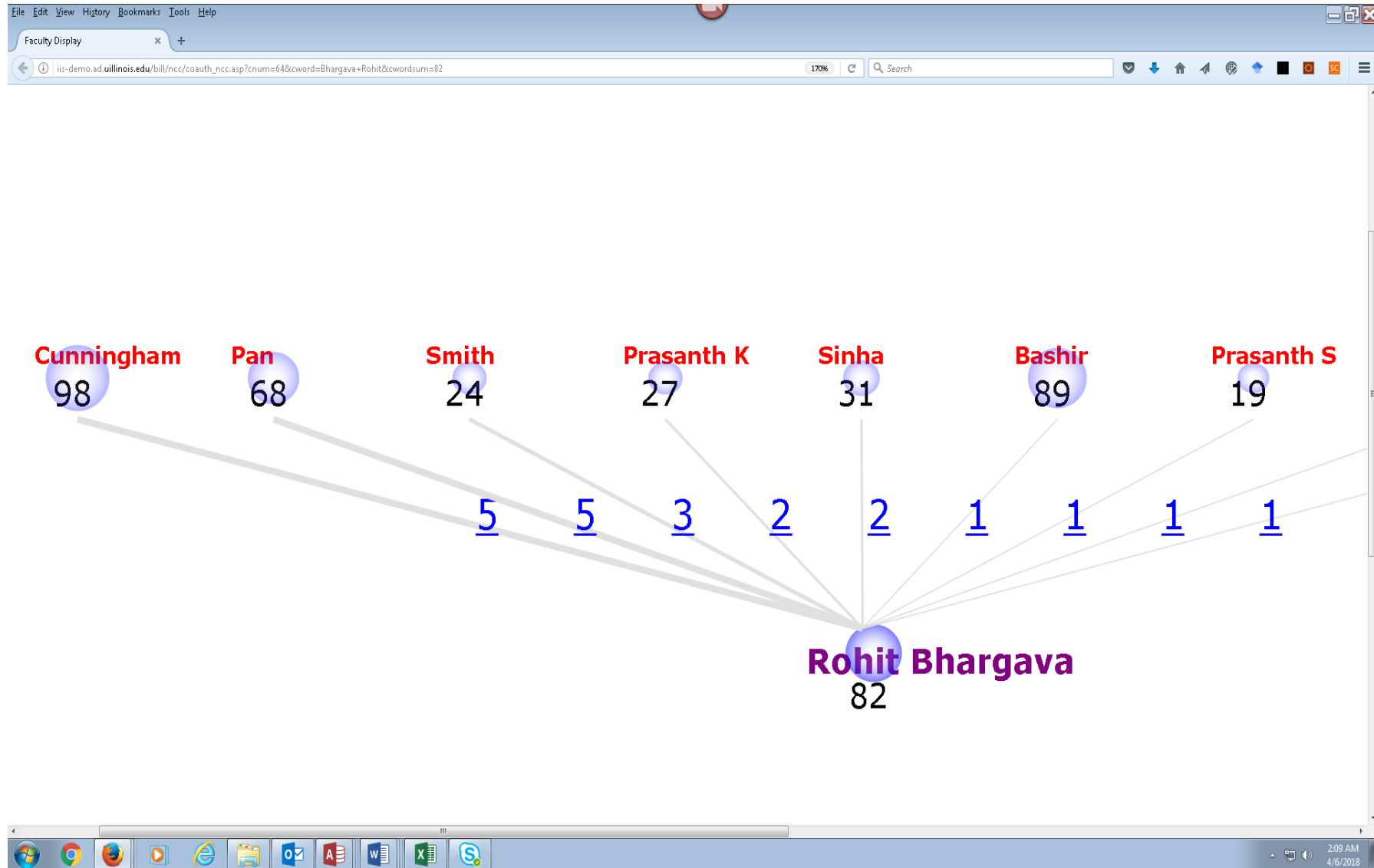
Abstract:

Technical Summary: Non-destructive and non-invasive imaging in three dimensions allows for the analysis of intact samples of a diverse nature. Several techniques are available for 3D imaging from the atomic to macroscopic scales, such as x-ray diffraction, micro and nano x-ray computed tomography, positron emission tomography, and fluorescence confocal microscopy. In some specimens, the limitations of these techniques require more advanced instrumentation to produce high-contrast, high-resolution images. Some samples do not diffract x-rays consistently, are sensitive to visible light, display dynamic behavior within the sampling time, diffract light, are non-fluorescent, or do not include heavy atom labels. Confocal Raman microscopy provides a non-invasive and non-destructive method for 3D imaging of these and other challenging samples. The new instrument will allow for collection of Raman spectra at multiple positions within a sample can be used to generate images containing an abundance of chemical information that includes time-resolved investigations of fast dynamic processes. Confocal Raman spectroscopy will be used to analyze polymers, semiconductors, solid-state materials, live cells, and nanomaterials. This instrument will be the only multi-user-accessible multi-wavelength (532, 633, and 785 nm laser sources) confocal Raman microscope on campus. The instrument has relevance in a diverse array of research at Illinois and will be housed at the Microscopy Suite of the Imaging Technology Group at the Beckman Institute for broad access across campus. The Imaging Technology group and collaborating faculty will continue to enhance science education and training through a variety of outreach projects for a diverse group of students and staff.

Layman Summary:

Non-destructive and non-invasive imaging in three dimensions allows for the analysis of intact samples of a diverse nature. Several techniques are available for 3D imaging from the atomic to macroscopic scales but are limited in their ability to probe complex materials. Confocal Raman microscopy provides a non-invasive and non-destructive method

Co-Author Display with Links to Articles



Separate Search System



Search the Cancer Center at Illinois faculty publications

Author Name(s)

use parts of last/first
of names:

Title Word(s):

Journal Title Word(s):

Abstract Word(s):

Affiliation:

Year:

Author Names

Browse:

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.