Visualizing the Scholarly Impact of Medical Education Researchers

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Abstract: The Carle Illinois College of Medicine is a new professional school with an engineering-focused approach to the medical education of Physician Innovators. Over 200 faculty representing diverse disciplines from across the Illinois campus were identified to provide instruction, curricular support, and mentorship for student-driven research. Representing academic departments in STEM, medicine, health and life sciences, this trans-disciplinary approach to medical education creates unique opportunities for innovation. While processes to review the academic performance of students are continually being iterated upon, another aspect of assessing the research efficacy of a college is to track the scholarly impact of affiliated faculty. Librarian information professionals embedded in academic libraries have developed expertise in the understanding, use and application of research metrics. This information has typically been provided in narrative form, non-interactive graphs, or has required a significant understanding of specialized visualization tools (such as Tableau), which may also incur licensing fees.

The Grainger Engineering Library Information Center at the University of Illinois at Urbana-Champaign has developed a new visualization web tool to display and disseminate data on scholarly impact of faculty in the new medical school. This tool requires no additional software for use or access, displays information in interactive form, and provides meaningful connections between data points. By harvesting bibliographic metadata through the Scopus API, the NIH and NSF websites, and the USPTO office, college administrators are able to visualize the publications, collaborations, citation metrics, and funded projects of their faculty. Harvested metadata is stored in a Microsoft Access relational database in separate tables. Bibliographic data and metrics including author name, list of publications within a specific date range, h-index, cited by count, number of co-authors and list of funded grants, and patents is then transcribed into a combined table. Utilizing HTML5 and Scalable Vector Graphics (SVG), a web-based program displays each data element of the combined table with a clickable link to expanded results for each author. With a focus on engineering, technology, and innovation in the new medical school, granted patents of affiliated faculty and students are tracked to assess the entrepreneurial impact of the curricula. By tracking scholarly impact, universities are provided with metrics to help set the direction.
of curricular development, recruit high performing faculty and students, and make strategic budgeting decisions.

**Keyboards:** Visualization Tool, Research Impact, Metrics, Bibliographic Analysis, Citations, Patents, Grants

1. **Literature Review:**

   Visualization as a tool for assessing scholarly impact is not a new concept. As Behrisch et al (2018) found “effective and efficient visualizations” can “show the most information in the simplest possible form.” To understand scholarly impact, visualizations can provide an interactive display that brings together many different data points to understand the multiple facets of scholarship. As Martin (1996) stated, “no single indicator of research output or performance will ever reveal more than a small part of the multidimensional picture.” Ravenscroft, Liakata, Clare, and Duma (2017) tell us “academic impact is traditionally measured through the use of author metrics, such as per-author and per-journal citation counts.” While bibliometric data on citations and number of publications is plentiful, there is limited connectivity between research articles, corresponding authors, and information available for other scholarly information, such as data on grants and patents. Svider et al (2012) and Li et al (2017) remind us that information on grants is often used to measure research productivity. However, there is a significant lack of connectivity between grants and corresponding published articles for the funded research (Boyack & Jordan, 2011). Bibliometric data on patents can also provide a method for evaluating the impact of a researcher on technology and innovation (Narin, 1994). Moed and Halevi (2015) go further and tell us that “patents are almost the only form of public communication that can be used as indicators of technological innovation and thus it is used as a part of the evaluation of institutions and individuals.” As these data end points are often siloed in different databases and websites, it can be difficult to develop a holistic approach to assessing the scholarly impact of individuals and institutions. Data on scholarship is also increasingly being included in the assessment of the level of efficacy of research efforts in a college (Hendrix, 2008; Li et al, 2017; Svider et al, 2012; Waltman, 2016). However, faculty and administrators seeking a broader perspective of the impact of scholarship in their college or department find they must navigate different systems to gather this data. For students seeking guidance on research projects, there are often no resources available that brings these many different data points together in a single display that is both interactive and informative. Multiple studies found in the literature have shown that mentorship can be an effective method for improving student performance and success, particularly at the graduate and doctoral level (Ahsan, Zheng, DeNoble, & Musteen, 2018; Roberts, Tinari, & Bandlow, 2019; Schexnayder et al., 2018).

2. **Overview:**

   As Physician Innovators, medical students in the Carle Illinois College of Medicine work with a group of 35 faculty mentors from across campus. As these students progress through the engineering-focused curriculum, they have
access to interdisciplinary researchers for mentorship on developing innovative interdisciplinary solutions to health’s greatest challenges. To provide faculty, administrators, and students with data on the scholarly impact of these research mentors, the Grainger Engineering Library developed a web-based visualization tool to display bibliographic data on research publications, grants, and patents. From 2009 to 2019, this group of research mentors published 3,690 unique scholarly articles with a combined 102,479 times cited. In addition, this group has a combined total of 456 National Science Foundation (NSF) and National Institutes of Health (NIH) funded grants and 1,656 patents granted by the United States Patent and Trademark Office (USPTO).

3. Methodology:
Utilizing server-side scripting, the Elsevier Scopus API (Application Programming Interface) is called to harvest research articles by bringing back publications of authors based on their unique Scopus ID. Metadata from these articles is stored in a table in a relational Microsoft Access database. With the table of publications de-duplicated, further scripts and SQL (Structured Query Language) queries are utilized to generate tables and counts of co-authors and number of times publications in the articles table have been cited.

By querying a separate Access database of NSF and NIH grants funded at the University of Illinois at Urbana-Champaign, scripts are run to search by author name. All corresponding metadata for grants is then harvested for this group of research mentors. By calling on the USPTO PatentsView API, an Access database table of all patents assigned to the Board of Trustees of the University as an organization is generated. From here a table is created including all of the metadata for patents where these 35 researchers are listed as inventors or co-inventors.
4. Visualization Tool:
With all of the necessary data harvested, a web-tool utilizing server-side scripting in Active Server Pages (ASP) was created to bring these many different data points into one single display for all 35 research mentors.

Six clickable bubbles are generated using Scalable Vector Graphics (SVG) and HTML5. Each bubble represents one of 6 data points for each research mentor: articles published in the date range specified, a Scopus index of citations for each author’s publications, a list of all co-authors and their affiliations, funded NSF and NIH grants, list of articles co-authored within the group of authors, and patents granted by the USPTO. By bringing this data together in a single display, users are provided with an easy, quick, interactive, and combined profile of research impact for a group of authors. Each clickable bubble is generated with SVG programming and is scaled in size proportionate to the value of the corresponding data point. This visualization provides a simple way of displaying research metrics that provides more information to users than text values alone.
Figure 4: Each research mentor has their own group of clickable data points.

The center bubble provides a link to a list of articles indexed in Scopus for each research mentor (see Figure 4). Bibliographic information is included for each publication, including title, authors, source title (publication), and abstract text (see Figure 5).

Figure 5: An index of articles is provided for each author.

Three links are provided for each publication, including a link utilizing the Digital Object Identifier (DOI) for each publication to take you to the full text version of the article (see Figure 5). The remaining two links point to Scopus for each publication, including the cited references and the article record with references. The records are by default sorted by date but can be resorted by number of times each publication is cited.
For visualizations that include larger group of authors, a search tool is included and is linked from the main page (see Figure 6). This page allows a user to search by author or by bibliographic article information. This is particularly helpful if a user is searching for information on specific subjects or areas of research within a group of authors.

Two of the clickable bubble data points are included for each author that provide information on co-authors for the publications in this harvested dataset.

Each co-author is listed along with their affiliation (see Figure 7). This information provides a quick glance view of the number of collaborations for each research mentor, including data on where these institutions/organizations are geographically located. This information is particularly vital for colleges and departments that emphasize or require collaborations. A second data point groups co-author information and limits it to collaborations within the group of research mentors. This information is displayed with further interactivity by allowing a user to see the number of publications co-authored with other research mentors.
A link is provided for each collaborative relationship between research mentors that includes a list of co-authored publications.

While articles are considered a reflection of research impact, there is other data available that can help provide a broader understanding of the impact of a mentor on scholarship in general. Grant information is increasingly being made available in major abstract and indexing services such as Scopus. This data is still largely not provided in bibliographic records and when included, does not connect to related grant records on the funding agency’s website.
Grant information can give a user another data point to assess research areas of interest for each mentor. As the NSF and NIH are the largest funders of natural and applied science research, grants funded from these two agencies are included for each research mentor. Each result includes base information on each grant, including a link to a more comprehensive record on the corresponding funding agency’s website.

As the Carle Illinois College of Medicine emphasizes an engineering and innovation-focused curriculum, patents can give a simple but effective way of measuring the entrepreneurial impact of a research mentor. This data is limited to patents granted by the USPTO to each research mentor while they were affiliated with the University of Illinois at Urbana-Champaign. Each result includes the list of inventor(s), date the patent was filed, affiliation (organization), and abstract text. Each result includes a link to the full text version of the patent in Google Patents, including figures. These links were generated by a server-side script that automatically appended the patent number to the end of the standard Google Patent’s URL.
5. Conclusions:

While scholarship is multifaceted, there is a lack of tools that bring together heterogeneous data points to help you understand the scholarly impact of a researcher. Those tools that do exist provide only limited connectivity between these different facets of scholarship. As the corpus of scholarship increases each year, it is critical that tools are developed and iterated upon to build meaningful connectivity between the siloed bibliometric data points. By bringing bibliometric data together on number of publications, citation counts, co-authors, grants and patents, the Grainger Engineering Library developed a simple, effective, and interactive visualization web-tool that brings together a holistic view of scholarship. With this information available, faculty, administrators, and students in the Carle Illinois College of Medicine can review, assess and understand the scholarly impact of their research mentors.

References:


