6.3 Local and Global Science Studies

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6.3.1 Mapping the Evolution of Co-Authorship Networks (2004)

By Weimo Ke, Katy Börner, & Lalitha Viswanath (2004)

The presented work aims to identify major papers and their interrelations, topic trends over time, as well as major authors and their evolving co-authorship networks in the IV Contest 2004 data set. Paper-citation, co-citation, word co-occurrence, burst analysis and co-author analysis were used to analyze the data set. The results are visually presented as graphs, static Pajek visualizations, and animated network layouts.

Mapping the Evolution of Co-Authorship Networks


By Katy Börner, Luca Dall'Asta, Weimo Ke, & Alessandro Vespignani (2005)

This article introduces a suite of approaches and measures to study the impact of co-authorship teams based on the number of publications and their citations on a local and global scale. In particular, we present a novel weighted graph representation that encodes coupled author-paper networks as a weighted co-authorship graph. This weighted graph representation is applied to a dataset that captures the emergence of a new field of science and comprises 614 articles published by 1036 unique authors between 1974 and 2004. To characterize the properties and evolution of this field, we first use four different measures of centrality to identify the impact of authors. A global statistical analysis is performed to characterize the distribution of paper production and paper citations and its correlation with the co-authorship team size. The size of co-authorship clusters over time is examined. Finally, a novel local, author-centered measure based on entropy is applied to determine the global evolution of the field and the identification of the contribution of a single author's impact across all of its co-authorship relations. A visualization of the growth of the weighted co-author network, and the results obtained from the statistical analysis indicate a drift toward a more cooperative, global collaboration process as the main drive in the production of scientific knowledge.

6.3.3 Mapping Indiana's Intellectual Space

This project aimed to identify pockets of innovation, pathways that ideas take to make it into products, and existing academia-industry collaborations. Submitted and awarded proposals for 2001-2006 were overlaid on a map of Indiana. Geolocations of academic investigators are given in red, industry collaborators are in yellow. Circle size denotes total award amount per geolocation. Linkages are color and line coded to distinguish within academia, within industry, and academia-industry collaborations. The interactive interface supports the selection of different years resulting in year-specific data overlays; clicking on any circle which brings up a table with all proposals and awards for this geolocation together with their titles, investigators and dollar amounts.
6.3.4 Mapping the Diffusion of Information Among Major U.S. Research Institutions (2006)

By Katy Börner, Shashikant Penumarthy, Mark Meiss, & Weimao Ke (2006)

This paper reports the results of a large scale data analysis that aims to identify the information production and consumption among top research institutions in the United States. A 20-year publication data set was analyzed to identify the 500 most cited research institutions and spatio-temporal changes in their inter-citation patterns. A novel approach to analyzing the dual role of institutions as information producers and consumers and to study the diffusion of information among them is introduced. A geographic visualization metaphor is used to visually depict the production and consumption of knowledge. The highest producers and their consumers as well as the highest consumers and their producers are identified and mapped. Surprisingly, the introduction of the Internet does not seem to affect the distance over which information diffuses as manifested by citation links. The citation linkages between institutions fall off with the distance between them, and there is a strong linear relationship between the log of the citation counts and the log of the distance. The paper concludes with a discussion of these results and an outlook for future work.
Geographic location and number of received citations for the top 500 institutions (top) and log-log plot showing the variation of the number of institutions that cite each other over geographic distance among them for each of the four time slices. The distance was calculated by applying the Euclidean form formulae to xy coordinates obtained using the Albers projection. 1.5 units of geographic distance equal approximately 100 miles (bottom).

6.3.5 Research Collaborations by the Chinese Academy of Sciences (2009)

By Weixia (Bonnie) Huang, Russell J. Duhon, Elisha F. Hardy, & Katy Börner (2009)
This map highlights the research co-authorship collaborations of the Chinese Academy of Sciences with locations in China and countries around the world. The large geographic map shows the research collaborations of all CAS institutes. Each smaller geographic map shows the research collaborations by the CAS researchers in one province-level administrative division. Collaborations between CAS researchers are not included in the data. On each map, locations are colored on a logarithmic scale by the number of collaborations from red to yellow. The darkest red is 3,395 collaborations by all of CAS with researchers in Beijing. Also, flow lines are drawn from the location of focus to all locations collaborated with. The width of the flow line is linearly proportional to the number of collaborations with the locations it goes to, with the smallest flow lines representing one collaboration and the largest representing differing amounts on each geographic map.

Collaboration and knowledge diffusion via co-author networks

6.3.6 Mapping the Structure and Evolution of Chemistry Research (2009)

By Kevin W. Boyack, Katy Börner, & Richard Klavans (2009)
How does our collective scholarly knowledge grow over time? What major areas of science exist and how are they interlinked? Which areas are major knowledge producers; which ones are consumers? Computational scientometrics – the application of bibliometric/scientometric methods to large-scale scholarly datasets – and the communication of results via maps of science might help us answer these questions. This paper represents the results of a prototype study that aims to map the structure and evolution of chemistry research over a 30 year time frame. Information from the combined Science (SCIE) and Social Science (SSCI) Citations Indexes from 2002 was used to generate a disciplinary map of 7,227 journals and 671 journal clusters. Clusters relevant to study the structure and evolution of chemistry were identified using JCR categories and were further clustered into 14 disciplines. The changing scientific composition of these 14 disciplines and their knowledge exchange via citation linkages was computed. Major changes on the dominance, influence, and role of Chemistry, Biology, Biochemistry, and Bioengineering over these 30 years are discussed. The paper concludes with suggestions for future work.
6.3.7 Science Map Applications: Identifying Core Competency (2007)

By Kevin W. Boyack, Katy Börner, & Richard Klavans (2009)

The 2002 base map represents journal cluster interrelations but is invariant to rotation and mirroring. The map was oriented to place mathematics at the top and the physical sciences on the right. The ordering of disciplines is similar to what has been shown in other maps of science: as one progresses clockwise around the map, one progresses from mathematics through the physical sciences (Engineering, Physics, Chemistry), to the earth sciences, life sciences, medical sciences, and social sciences. The social sciences link back to computer science (near the top of the map), which has strong linkages to mathematics and engineering.

Just like a map of the world can be used to communicate the location of minerals, soil types, political boundaries, population densities, etc., a map of science can be used to locate the position of scholarly activity. The profiles for the U.S. NIH (National Institutes of Health) and NSF (National Science Foundation) are shown below, and were calculated by matching the principal investigators and their institutions from grants funded in 1999 to first authors and institutions of papers indexed in 2002. This type of paper-to-grant matching will produce some false positives. On the whole, however, it is a conservative approach in that it only considers a single time-lag between funding and publication (3 years in this case), and it does not match on secondary authors. The 14,367 NIH matches and 10,054 NSF matches are large samples, ensuring that the aggregated profiles are representative of the actual funding profiles of the agencies. It serves as a good example of how journal level, or disciplinary, maps can be used to display aggregated information obtained from paper-level analysis.
Funding Patterns of the National Science Foundation (left) and the National Institute of Health (right).