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Loet Leydesdorff & Ismael Rafols talk with *ScienceWatch.com* and answer a few questions about this month's Fast Breaking Paper in the field of Social Sciences, general. The authors have also sent along images of their work.

Article Title: A Global Map of Science Based on the ISI Subject Categories
Authors: **Leydesdorff, L;Rafols, I**
Journal: J AM SOC INF SCI TECHNOL
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* Univ Amsterdam, ASCoR, Kloveniersburgwal 48, NL-1012 CX Amsterdam, Netherlands.
* Univ Amsterdam, ASCoR, NL-1012 CX Amsterdam, Netherlands.
* Univ Sussex, Freeman Ctr, Brighton BN1 9QE, E Sussex, England.

SW: Why do you think your paper is highly cited?

First, it offers a simple and comprehensive map of science (view map) in terms of 170+ disciplinary categories based on the aggregated citation patterns of journals included in the *Science Citation Index*. This map can be recognized intuitively in terms of disciplinary delineations and be accessed by mouse-clicking between different levels of aggregation (view map): 14 disciplines at the top level, 172 categories at the intermediate level, and 6,164 individual journals at the bottom.

The delineation of journal sets in terms of disciplines and specialties is relevant in research evaluation because publication and citation practices differ among fields of science. Furthermore, the map helps to identify and locate interdisciplinary research at the borders of or across disciplines. This is important because, although "interdisciplinarity" is a policy objective, its assessment has hitherto remained controversial.

Also, this map of science can be used as a baseline for understanding the cognitive and potentially changing positions of document sets. For example, one can study and visualize the diffusion of emerging fields like nanotechnology. Finally, the paper may be cited for the techniques of clustering large databases.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

The paper offers a synthesis of previous knowledge on the basis of a methodological consideration. Although the attribution of journals to

subject categories remains highly uncertain—and therefore often erroneous—we show that the average attribution at the aggregated level can be used for the mapping of science, because the errors can be expected to average out—like the noise in pixelated pictures.

Previous efforts to use the complete matrix of aggregated journal-journal citations for mapping were not as successful because one had to make a number of assumptions to reduce the data (Leydesdorff, 2006).

A combination of previous investments in the attribution of journals—by indexers at the *Institute for Scientific Information* (*ISI*), now part of Thomson Reuters—and relatively straightforward analytical techniques, enabled us to generate a map from an already reduced set.

Coauthor:
Ismael Rafols

This cannot be considered a discovery because structure has been observed in the citation matrix based on the *Journal Citation Reports*® (*JCR*) since its very beginning (Price, 1965). The question was then how to represent the cognitive structure contained in this textual dimension comprehensively.

SW: Would you summarize the significance of your paper in layman's terms?

Despite considerable uncertainty inherent in the underlying data, the existing classification of journals enabled us to generate a comprehensive map of science that shows the structure of science in terms of 14 disciplines and 172 specialties.

As in the case of Google maps, we provide a user-friendly toolkit to construct an overlay, in order to indicate the position of publications or citations in terms of their disciplinary affiliations and their potential interdisciplinary positions.

These "overlay maps" can be used for various research policy or management purposes. For example, emerging fields can be traced in terms of diffusion patterns (view map) over the cognitive landscape of the sciences (Porter & Youtie, 2009: 1029). Science managers can easily locate the scientific areas in which their organization is most active or into which they might wish to grow.

SW: How did you become involved in this research, and were there any problems along the way?

We are both interested in mapping the emergence of new and interdisciplinary developments (e.g., nanotechnologies, genomics, etc.). How can interdisciplinary dynamics be indicated at the global level of the development of the sciences? First, we had to develop an indicator of betweenness centrality in journal maps (Leydesdorff, 2007), and for the diversity of the knowledge base of a document set (Rafols & Meyer, in press).

The first author (Loet Leydesdorff) has been studying journal-journal citation patterns since the 1980s (e.g., Leydesdorff, 1987). The purpose of his studies is to use the development of journal structures as a baseline for indicating change in science at the global level, that is, beyond the control of individual agency or policy making. Policy interventions can then be calibrated and therefore evaluated in terms of contributions to cognitive advancements (Leydesdorff & Schank, 2008).

Ismael Rafols, the second author, focuses on interdisciplinary developments in the sciences, notably nanotechnology, using both qualitative analyses and bibliometrics (Rafols & Meyer, 2007). The diffusion of new developments across disciplinary boundaries, mergers, and bifurcations can be followed using the proposed technique of an overlay (Rafols & Meyer, in press). Sets of documents (for example, the output of a laboratory) can thus be positioned at each moment and over time (Rafols, Porter, & Leydesdorff, 2009).

[+] details

This map can be recognized intuitively in terms of disciplinary delineations and be accessed by mouse-clicking between different levels of aggregation: 14 disciplines at the top level, 172 categories at the intermediate level, and 6,164 individual journals at the bottom.

SW: Where do you see your research leading in the future?

We have extended this line of research further into a systematic test of the subject categories used for the map in a follow-up paper entitled "Content-based and Algorithmic Classifications of Journals:

Perspectives on the Dynamics of Scientific Communication and Indexer Effects," *JAIST* 60(9), 1823-35, 2009. Here we compare decomposition in terms of subject categories—which are content-based—with decomposition as indicated by fast computer programs. Our conclusion is that despite such differences in approach, a "consensus map" of science can increasingly be retrieved from various possible representations (Klavans & Boyack, 2009).

The advantages of our map are its intuitive user-friendliness and the availability of the overlay technique which allows users to adapt it for their own purposes (freely available here).

In the longer term, one would like to have dynamic Google-like maps of the socio-cognitive space of the sciences in which one could trace one's own fields and/or publications (Boerner & Scharnhorst, 2009; Leydesdorff & Schank, 2008).

SW: Do you foresee any social or political implications for your research?

In a knowledge-based society and a knowledge-based economy, the intellectual organization of knowledge in the sciences is increasingly important because knowledge organizes society together with its coordination by the market and (largely national) political systems.

People connect because of knowledge-based professional ties. Policy interventions often focus on the political economy but not sufficiently on the knowledge structures that change our systems in waves of knowledge-based innovations. The mapping of the origins and contents of these waves may contribute to the shaping of future wealth from knowledge.

Loet Leydesdorff, Ph.D.
University of Amsterdam
Amsterdam School of Communication Research (ASCoR)
Amsterdam, Netherlands
Web

Ismael Rafols, Ph.D.
Research Fellow
SPRU - Science and Technology Policy Research
University of Sussex
Brighton, UK
Web

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KEYWORDS: JOURNAL-CITATION-REPORTS; SCIENTIFIC JOURNALS; INDICATORS; INTERDISCIPLINARITY; COCITATION; DECOMPOSABILITY; CLASSIFICATION; AGGREGATION; PERFORMANCE; RELEVANCE.

PDF

back to top

2009 : December 2009 - Fast Breaking Papers : Loet Leydesdorff & Ismael Rafols on Research Maps of Science

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