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Construction of a pragmatic base line for journal classifications and maps based on aggregated journal-journal citation relations

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ABSTRACT

A number of journal classification systems have been developed in bibliometrics since the launch of the Citation Indices by the Institute of Scientific Information (ISI) in the 1960s. These systems are used to normalize citation counts with respect to field-specific citation patterns. The best known system is the so-called "Web-of-Science Subject Categories" (WCs). In other systems papers are classified by algorithmic solutions. Using the Journal Citation Reports 2014 of the Science Citation Index and the Social Science Citation Index (n of journals = 11,149), we examine options for developing a new system based on journal classifications into subject categories using aggregated journal–journal citation data. Combining routines in VOSviewer and Pajek, a tree-like classification is developed. At each level one can generate a map of science for all the journals subsumed under a category. Nine major fields are distinguished at the top level. Further decomposition of the social sciences is pursued for the sake of example with a focus on journals in information science (LIS) and science studies (STS). The new classification system improves on alternative options by avoiding the problem of randomness in each run that has made algorithmic solutions hitherto irreproducible. Limitations of the new system are discussed (e.g. the classification of multi-disciplinary journals). The system's usefulness for field-normalization in bibliometrics should be explored in future studies.

1. Introduction

If bibliometricians wish to normalize for differences in publication and citation behavior among fields of science, they use one field classification scheme or another. Since both WoS and Scopus are based on sets of journals, a classification of these journals provides an obvious candidate. For this purpose Thomson Reuters tags the journals with the "Web-of-Science Subject Categories" (WC), e.g. "chemistry, applied" or "biophysics." More than a single WC can be attributed to each journal

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in WoS.[1] An analogous journal classification system in terms of fields and subfields has been made available by Scopus (Wang & Waltman, 2016).[2] The use of these journal categories for normalization purposes has become accepted as "best practice" among bibliometricians (e.g., Rehn, Gornitzki, Larsson, & Wadskog, 2014).

For example, InCites—a customized, web-based research evaluation tool developed by Thomson Reuters—routinely provides normalizations of citation impact using WCs for the delineation of the reference sets (e.g., Costas, van Leeuwen, & Bordons, 2010; at p. 1567). The Flemish ECOOM unit for evaluation in Leuven (SOOI), however, has developed another classification system for journals (Glänzel & Schubert, 2003). Other authors have refined the journal lists within specific WCs to enable a more precise evaluation of a given discipline (e.g., van Leeuwen & Calero Medina, 2012; cf. Bordons, Morillo, & Gómez, 2004; Katz & Hicks, 1995).

Elsevier's *Scopus* introduced the SNIP indicator as an alternative to Thomson Reuters impact factor; SNIP is largely independent of structural assumptions about disciplines and specialties because the citing papers are used as the reference sets (Moed, 2010). Researchers at the Center for Science and Technology Studies in Leiden (CWTS) went one step further and proposed clustering the WoS at the level of documents as an alternative to journal classification and mapping (Waltman & van Eck, 2012). However, the 4000+ resulting clusters cannot easily be validated or reproduced (Klavans & Boyack, 2015; Leydesdorff & Bornmann, 2016).

Glänzel and Schubert (2003) distinguish among (1) a cognitive approach when one classifies journals in terms of disciplines and specialties, (2) a pragmatic approach using journal classifications for the delineation of fields and subfields, and (3) a scientometric approach at the article level in which one tries to capture also the complexity of the system. This study can be considered as belonging to the second, that is, pragmatic approach. Using the Journal Citation Reports (JCR) 2014 of the Science Citation Index and the Social Science Citation Index (*n* of journals = 11,149), we examine options for developing a new system based on journal classifications into subject categories using aggregated journal–journal citation data. Ideally, a classification should be transparent and reasonably easy to reproduce outside the context of its production. As a second objective, a hierarchical classification can also be coupled to maps of the sciences at different levels of granularity (Zitt, Ramanana-Rahary, & Bassecoulard, 2005), so that one would be able to zoom in and out in order to distinguish among fields, sub-fields, sub-sub-fields, etc. Combining routines in VOSviewer and Pajek, a tree-like classification is developed in this study. At each level one can generate a map of science for all the journals subsumed under a category.

2. Algorithmic classifications

The further development of computer power and software makes it possible nowadays to generate algorithmically a comprehensive map and classification of the aggregated journal–journal relations provided by the Journal Citation Reports (JCR) of the (Social) Science Citation Index or similar data of Scopus (e.g., Gómez-Núñez, Batagelj, Vargas-Quesada, Moya-Anegón, & Chinchilla-Rodríguez, 2014). Using 2006 data and two new algorithms (Newman & Girvan, 2004; Rosvall & Bergstrom, 2008), Rafols and Leydesdorff (2009) compared the resulting classifications with the WCs and with Glänzel and Schubert's (2003) revision as two content-based classifications. They found that the correspondences among the main categories are sometimes as low as 50% of the journals included; most of the mismatched journals appear to fall in areas in close proximity to the main categories. The results of the various decompositions are roughly consistent, but the overlap is imprecise (cf. Klavans & Boyack, 2009). The algorithmic constructs are more specific than the content-based classifications of WoS and SOOI, but the algorithms produce much more skewed distributions in terms of the number of journals per category.

In addition to the skew in the distributions generated in the algorithmic solutions—with potentially large tails of singletons—the randomness in each run makes the algorithmic classifications irreproducible from year to year (Lambiotte, *personal communications*, from 10 October 2008–16 December 2009). Consequently, it is unclear whether the differences in outcomes between two runs are due to relevant changes in the data or the randomness factor in the algorithm. This problem seemed unsolvable at the time. However, more recent developments in software development encourage us to make another attempt to construct the envisaged classification.

Among these new developments are:

1. The algorithms for the decomposition of large networks have been further developed since Newman & Girvan (2004). The programs of Blondel et al. (2008) and Waltman, van Eck, and Noyons (2010) for VOSviewer are seamlessly integrated in the context of Pajek, a program for the analysis and visualization of networks available in the public domain. These programs also provide modularity measures (*Q* and *VOS Quality*, respectively) as indicators of the decomposability of the data.
2. Pajek-files can function as a kind of currency for the transport of files among network programs such as Gephi, ORA, VOSviewer, UCInet, etc., each with their specific strengths. Moreover, in addition to its clustering and mapping algorithms, VOSviewer specifically allows for visualizing large networks, because the labels fade in and out with the level of granularity

[1] In the alternative classification developed since 1972 by Computer Horizon's Inc. for the *Science & Engineering Indicators* series of the NSF (Carpenter & Narin, 1973; Narin, 1976; Narin, Carpenter, & Berlt, 1972), a single category was attributed to each journal.

[2] The field/subfield classification of Scopus is available in the journal list from http://www.elsevier.com/online-tools/scopus/content-overview. WCs are available (under subscription) at http://images.webofknowledge.com/WOKRS56B5/help/WOS/hp_subject_category_terms_tasca.html.

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