

Indicators of the Interdisciplinarity of Journals: Diversity, Centrality, and Citations

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Introduction

A citation-based indicator for interdisciplinarity has been missing hitherto among the set of available journal indicators despite the high policy-relevance of “interdisciplinarity” (Laudel & Origg, 2006; Wagner *et al.*, 2010). None of the more recent additions to the set of journal indicators has focused specifically on interdisciplinarity (Zitt, 2005). Leydesdorff (2007) experimented with betweenness centrality as an indicator of interdisciplinarity in aggregated journal-journal citation networks.

Stirling (2007; cf. Rao, 1982) proposed a diversity measure as part of “a general framework for analyzing diversity in science, technology and society” (Rafols and Meyer, 2010). The indicator integrates the (in)equality in a vector with the distance metrics of the network. In this study, we compare (i) this indicator with (ii) betweenness centrality as a network indicator, and (iii) the Gini and probabilistic entropy as vector-based indicators of specificity/diversity for the case of journals.

Method

The analysis is based on the aggregated citation matrix among the 8,207 journals contained in the JCRs of the Science and Social Science Citation Indices 2008. This asymmetrical matrix is normalized using the cosine, both cited and citing. Euclidean distances were normalized as *relative* frequencies in order to prevent effects of differences in size causing spurious distances. Additionally, $(1 - \text{cosine})$ can be used as a measure of dissimilarity.

The three sets of indices—(i) Rao-Stirling diversity, (ii) matrix-based, and (iii) vector-based—are evaluated against one another. The structure of the set is explored using factor-analysis, and in relation to other journal indicators (e.g., the impact factor).

Results

On the citing side, one expects peripheral journals such as Chinese university journals to integrate different knowledge bases and thus to rank high on an indicator for “interdisciplinarity.” On the cited side, a crucial question is how and to which extent an indicator corrects for the size effect of multidisciplinary journals such as *Science* and *Nature*.

The results based on Euclidean distances *versus* $(1 - \text{cosine})$ were not or negatively correlated: the diversity measure is highly sensitive to the choice of similarity criterion. The results using Euclidean distances were difficult to interpret; the results based on $(1 - \text{cosine})$ were size-dependent despite the normalization implied.

Table 1: Top 10 journals in the ISI-category Library and Information Science ($N = 61$) sorted on betweenness centrality in the being-cited patterns after normalization.

	Diversity (cosine)	Diversity (Euclidean)	Betweenness (not-normalized)	Betweenness (normalized)	Gini	Entropy
<i>J Am Soc Inf Sci Tec</i>	33	1	1	1	18	8
<i>Scientometrics</i>	48	9	2	2	33	24
<i>Int J Geogr Inf Sci</i>	2	32	4	3	17	5
<i>MIS Quart</i>	10	38	3	4	3	1
<i>Inform Manage-Amster</i>	5	28	6	5	8	3
<i>J Am Med Inform Assn</i>	4	51	7	6	22	4
<i>J Manage Inform Syst</i>	13	35	8	7	5	2
<i>Inform Process Manag</i>	31	4	5	8	19	9
<i>J Inf Sci</i>	41	6	11	9	28	16
<i>Soc Sci Comput Rev</i>	7	24	12	10	26	13
(...)
<i>J Informetr</i>	51	40	48	51	49	51

The top 10 journals in the ISI-category Library and Information Science ($N = 61$) are listed in Table 1 sorted on betweenness centrality in the being-cited patterns after normalization. We added the *Journal of Informetrics* as a lower-ranked journal. With the exception of diversity measured on the basis of (normalized) Euclidean distances, all other indicators rank this journal between 48 and 51 on a list of 61. The journal therefore is ranked as disciplinary, and is in this respect very different from *JASIST* or *Scientometrics*.

Conclusion

The factor analysis teaches us that betweenness centrality and Rao-Stirling diversity indicate different aspects of interdisciplinarity (Wagner *et al.*, 2010). The Gini coefficient does not qualify as an indicator of interdisciplinarity since the latter is not just the opposite of (disciplinary) specificity. Although sensitive to size, the journals top-ranked by the entropy measure are recognizable as intuitively the most interdisciplinary among the journals. An algorithm that would weigh the cosine values as a basis for the computation of betweenness centrality would perhaps improve our capacity to indicate interdisciplinarity (Brandes, 2001).

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