Measuring Interdisciplinary Performance By Analyzing Mixed Node Publication Networks

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Introduction

As Campbell (2005) states, "scientific knowledge is social". It exists as the union of individual knowledge with individual languages and idiosyncrasies. Due to effects like the confirmation bias, differences between mental models of terminology and their linguistic use are rarely recognized in interdisciplinary exchange but much more perceived in their differential occurrence and experienced as "friction" between team members. This can go as far as teams not being successful at the interdisciplinary goals they have set for themselves and external goals that have been set by funding organizations.

But what can one do in order to reap the benefits of interdisciplinary cooperation? Effective interdisciplinary research clusters need to rely on approaches to measure, steer and regulate their success with regard to the expectations of single researchers, funding agencies or industrial actors.

In the cluster of excellence (CoE) at RWTH Aachen University so-called Cross Sectional Processes (CSPs) are established to aid integration of the participating cluster domains, research fields and interdisciplinary researchers (Jooß et al. 2012). The CSPs provide and investigate services for the researchers within the cluster while at the same time enabling measuring scientific success and supporting steering and regulating of the cluster. A prospective outcome of this on-going process is a better understanding of how measurement of research processes can stabilize and increase scientific output by testable interventions, thus transforming scientific efforts into scientific outcomes. One measure is explained in this paper.

Criteria for interdisciplinary scientific performance

In order to establish a direction for steering to success one must first define success. In this case what is interdisciplinary scientific success? Success is surely multifaceted or multi-dimensional when looking at scientific success in general.

Welter et al. (2012) found that the overall objectives of scientific collaboration, such as for clusters of excellence or collaborative research centers, could be derived from the funding criteria of the DFG and the Wissenschaftsrat. Core criteria e. g. comprise:

(a) research quality,
(b) originality and coherence of the scientific program,
(c) interdisciplinary collaboration,
(d) influence on the field of research in future,
(e) options for transferability into practice,
(f) quality of scientists and their further options for development,
(g) integration of local research capacities,
(h) structural development of the university,
(i) international visibility.

Individual scientific disciplines though may define success in regard to these criteria differently. How does one determine research quality? The CSPs elaborate on these criteria using an approach that uses both qualitative and quantitative measures to triangulate the subject. In the following section a network-based approach for analyzing publication relationships is presented in the context of the CSP as a part of the CoE at RWTH Aachen University.

Mixed-Node Publication Network Analysis

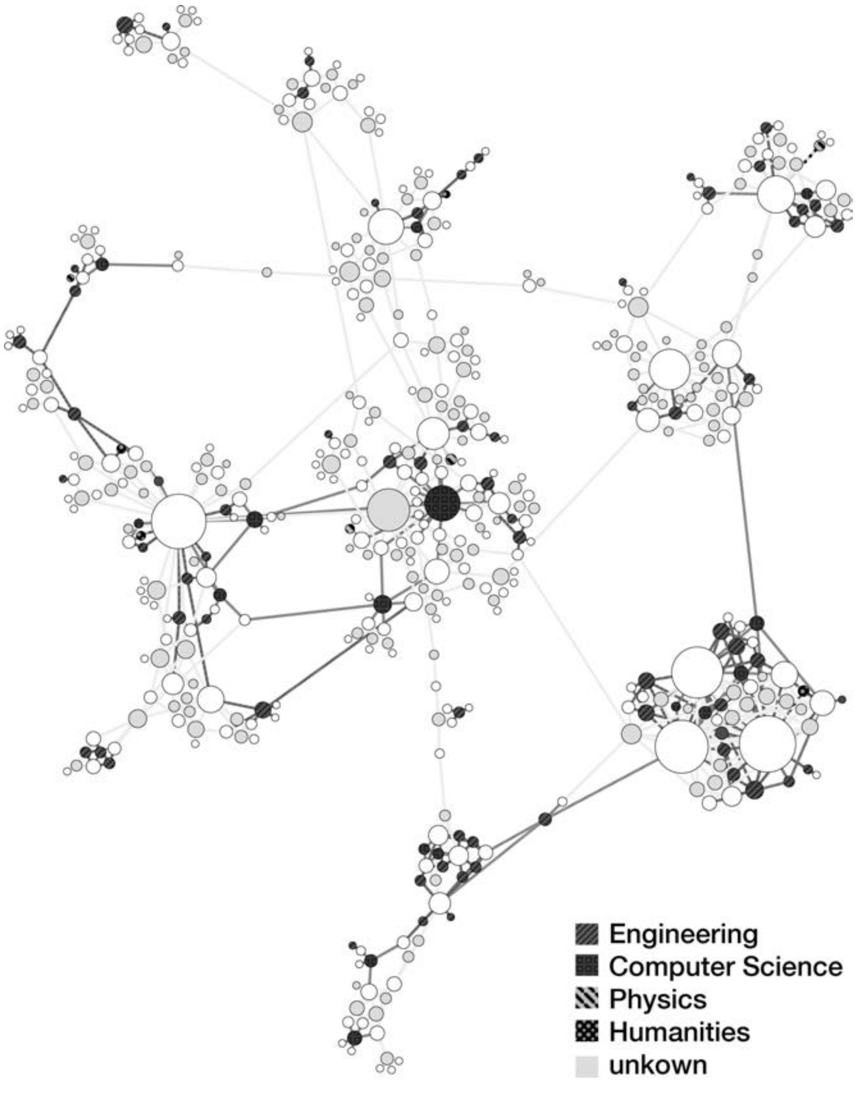
Publication analysis uses publication data in order to determine the quality of the output of scientific teams. Under the assumption that the peer review process works, publications are a natural indicator of performance (addressed criteria: a, d, and i).

Since no single metric seems to capture interdisciplinary performance well enough (Wagner et al. 2011), we try to implement a web-based self-measurement/self-management tool, which focuses on visualizing publication relationships using a bipartite author/publication graph. This data is furthermore enriched with sociometric data, spatial data and citation data, which is analyzed and evaluated for the individual researchers that logs into the web-application.

For this purpose various network metrics are used and visualized such as centrality measures (betweeness, degree, eigenvector) as well as graph entropy measures. Centrality measures enable detection of important weak connections (people that connect otherwise unrelated work groups). Possible candidates for entropy measures are topological information content as in Mowshowitz (1968), parametric graph entropies (Dehmer 2008), network entropies as in Solé (2004) and graph entropies based on ER models as in Ji et al. (2008). These measures are applied on the micro level in contrast typical outlet-focused analyses (Leydesdroff et al. 2011). Several of these measures can be compared between workgroups or even automatically detected communities in order to detect self-similarity, symmetry and connectedness.

Preliminary results show a high level of connectedness between authors in the cluster (Calero Valdez et al. 2012). A preliminary analysis of the partaking disciplines in the cluster is shown in Figure 1.

Figure 1. Example visualization of all publications in the CoE. White circles denote publications; colored circles denote authors and their discipline; circle size denotes degree centrality.



Furthermore the applicability of these graph visualizations as a self-measurement tool for the researchers will be investigated from an acceptance point of view.

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