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# Bibliometric approximation of a scientific specialty by combining key sources, title words, authors and references



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## ABSTRACT

Bibliometric methods for the analysis of highly specialized subjects are increasingly investigated and debated. Information and assessments well-focused at the specialty level can help make important decisions in research and innovation policy. This paper presents a novel method to approximate the specialty to which a given publication record belongs. The method partially combines sets of key values for four publication data fields: source, title, authors and references. The approach is founded in concepts defining research disciplines and scholarly communication, and in empirically observed regularities in publication data. The resulting specialty approximation consists of publications associated to the investigated publication record via key values for at least three of the four data fields. This paper describes the method and illustrates it with an application to publication records of individual scientists. The illustration also successfully tests the focus of the specialty approximation in terms of its ability to connect and help identify peers. Potential tracks for further investigation include analyses involving other kinds of specialized publication records, studies for a broader range of specialties, and exploration of the potential for diverse applications in research and research policy context.

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## 1. Introduction

### 1.1. Research policy context

Science and innovation policies increasingly focus on highly specialized subjects such as individual scientists, specific research programmes, research proposals, emerging specialties, and scientific breakthroughs. The related ‘specialties’ are coherent sets of subject-related research problems and concepts, focused on by an interacting research community of specific scientists and research teams. To answer many kinds of concrete questions posed at this level, research management and evaluation procedures typically seek advice from peers belonging to the particular specialty, possibly supported by quantitative material. Both for the identification of peers and for the production of quantitative material, bibliometric information and techniques can be helpful if these can sufficiently adequately capture the particular specialty. The aim of the method proposed in this paper is to produce a set of publications that approximates a subject’s specialty sufficiently closely for such practical purposes in research management (not to generate an exhaustive representation of a specialty or to define it). This paper presents the general principles of the method, already indicating certain possibilities for further development, tuning and potential applications. Further research targeting particular practical purposes can subsequently lead to translations into protocols or tools for research policy makers and administrators.

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## 1.2. Bibliometric context and debate

Sufficient bibliometric focus at the specialty level requires an aggregation of publications that is more fine-grained than the broad subject categories grouping interrelated journals (Pudovkin & Garfield, 2002) that form the backbone of the commonly used global publication and citation indexes (Clarivate Analytics' – formerly the IP & Science business of Thomson Reuters – Web of Science, and Elsevier's Scopus). A need to study the fine structure of science was felt already soon after the development of the first science citation index (Garfield, 1955), as summarized by Small and Griffith (1974). Recent studies still point to observations of important internal heterogeneity within broad disciplines, in general (Zitt, Ramanana-Rahary, & Bassecouard, 2005) and within a wide-spread variety of specific domains (Chemistry: Neuhaus & Daniel, 2009; Engineering: Lillquist & Green, 2010; Economics: van Leeuwen & Calero-Medina, 2012; Medical subject categories: Schmidt & Sirtes, 2015; Library and Information Science and Science & Technology Studies: Leydesdorff & Bornmann, 2016). These observations call for caution in interpreting indicators and propose to use more fine-grained classifications at the specialty level. Specialties described in various terms have been the subject of studies from sociological, bibliographical, communicative, and cognitive approaches (as for example reviewed in a specialty mapping context by Morris & Van der Veer Martens, 2008), but a standard, generally applicable fine-grained method that can sufficiently closely approximate the specialty of a single scientist or a team to represent its specific publication and citation characteristics, has not yet been established. In its absence, broad subject category structures are still used in analyses concerning much more specialized entities. In the particular context of individual scientists, recent debates on challenges and ethical issues in bibliometric applications mainly focus on properties following from the design of current indicators. An adequate delineation of specialties, drawing a frame within which investigated entities and their performances can be confidently positioned, is a less debated but equally important issue (Leydesdorff & Bornmann, 2016).

## 1.3. Proposed method and paper outline

This paper presents a novel method that approximates the scientific specialty to which a given highly specialized 'seed record' of publications belongs. Four sets of key values are determined from the seed record (for the data fields containing source, title, authors and references) and partially combined to approximate the specialty by the set of publications associated to key values determined for at least three of the four data fields. The selection of the four data fields is founded in concepts defining disciplines, and the determination of key values is founded in empirically observed regularities.

A preliminary test of the method's added value compared to coarser domain delineations was the verification of its capability to keep related specialties apart. This test was successfully performed for two scientists in Theoretical and Experimental Particle Physics, closely related specialties in terms of publication venues but strongly differing in other publication and citation characteristics (Rons, 2016). The case used in the present paper to concretely illustrate how the method works adds a second, complementary test, verifying whether produced results can be confirmed to belong to the specialty. This paper's test material consists of known peers in a specialty in the domain of Biology. Both tested abilities are essential for the method's aim. An extension to other types of cases and other specialties requires further research and possibly different operationalizations than the ones used in this paper.

The next section describes the method's conceptual and empirical foundations, situated in diverse areas in philosophy of science, information science and linguistics. It refers to particular literature from these areas that addresses the aspects discussed and built upon. It is followed by the section describing the different phases of the method itself, discussing the choices that were made from different options for the method in general and for the particular application shown in this paper. The principles of the method and the choices described are not complex, enabling the interested researcher in the field to further explore the method's potential and limitations for different purposes (the overall complexity of an investigation will also depend on specificities of the chosen publication database). The section on the illustrated application and data describes how the application is used to test the method, its relevance in a research policy context, and the sample of peers used. The results section describes the results obtained in the different phases of the method and the implications for the performed test. The discussion section summarizes the outcome of the test of the method, and points to a range of potential application areas and to possibilities for more advanced criteria designs than those used in this paper in a 'proof of concept' context.

## 2. Foundations

### 2.1. Conceptual foundations

The term 'specialty' has been used in literature for different levels of aggregations of publications. In this paper it refers to a specialty as regarded by Braam, Moed, and van Raan (1991, p. 234), at the introduction of a combined co-citation and word analysis approach, from a problem-solving perspective (Laudan, 1977): a "coherent set of subject-related research problems and concepts upon which attention is focused by a number of scientific researchers", irrespective of their social and intellectual backgrounds. The associated "self-organized network of researchers" tends "to study the same research topics, attend the same conferences, read and cite each other's research papers and publish in the same research journals" (Morris & Van der Veer Martens, 2008, p. 214–215). These definitions correspond to a scientific specialty as typically dealt with in

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