The Subject-Area Quadrant-Allocation – Classification of research into Stokes’ Quadrants

Miloš Jovanović\textsuperscript{1,2}

\textsuperscript{1}milos.jovanovic@int.fraunhofer.de

\textsuperscript{1}Fraunhofer INT, Appelsgarten 2, 53879 Euskirchen (Germany)

\textsuperscript{2}Heinrich-Heine-University, Universitätsstr. 1, 40225 Düsseldorf (Germany)

Conference theme and session: Innovation indicators

Type of contribution: Oral presentation or poster

Introduction

One of the many endeavours of bibliometric studies is the classification of scientific and technological topics into different categories of the research landscape. One classic division of this landscape was published in the influential report “Science, the endless frontier” (Bush, 1945). This author divided science roughly into “basic science” and “applied science”. In the following decades, many more classifications were suggested, e.g. by the Organisation for Economic Co-operation and Development (OECD, 2002). The author Donald Stokes pointed out in his book “Pasteur’s Quadrant” that these kinds of classifications introduced a model of science that in reality was blurry at best and not at all sharp and distinct (Stokes, 1997). He proposed a different kind of classification, dividing science into four so-called “quadrants” on two dimensions. These included “Edison’s quadrant” for applied science, “Bohr’s quadrant” for basic science and “Pasteur’s quadrant” for a mixture of both. The fourth quadrant remained nameless in Stokes’ book. This classification by quadrants has been used by other bibliometricians in their studies (e.g. Babaa, Shichijo & Seditec, 2009).

In previous papers, a new kind of analysis called “Footprint analysis” has already been introduced which also employs these quadrants (Jovanovic, 2007 and Jovanovic, John & Reschke, 2009). However, because of new and upcoming results, I wish to focus in this paper on one part of the Footprint analysis called “Subject-Area Quadrant-Allocation” (SAQA). With it the classification of different scientific and technological topics is possible by using the results of an expert survey, the quadrants as proposed by Stokes and the Subject Areas of the Web of Science.

Method

The basis of a SAQA is a data set which is downloaded from the Web of Science. This set should contain all publications which are relevant to a scientific or technological topic. With the SAQA the topic’s place in the research landscape can then be determined. For this an online survey was conducted. From July 2009 to March 2010 scientists from the Fraunhofer-Society, the Max-Planck-Society and the Helmholtz Association were asked to answer two questions for each Subject Area of the Web of Science in which they felt they were either experts of or had worked in considerably:

1. Does this Subject Area deal with the understanding of fundamental processes?
2. Does this Subject Area deal with the development of concrete applications?

They had the possibility to answer “yes”, “mostly yes”, “so-so”, “mostly no” and “no”. The answers corresponded to a value ranging from -2 (“no”) to +2 (“yes”). In total, 53 completed questionnaires were analysed. Since every journal of the Web of Science has at least one Subject Area, every publication from the Web of Science was given at least two values (one
for each of the two questions answered). Values from question 1 correspond to a Subject Area’s orientation towards fundamental science while values for question 2 correspond to an orientation towards applied science.

With the help of a Perl-script, the mean values for each publication of a data set were calculated. For this, the following formulas were used:

\[
\langle FP_s(A) \rangle = \frac{\sum_{i=1}^{N_s(A)} FP_{s_i}(A)}{N_s(A)} \quad (1)
\]

\[
\langle KA_s(A) \rangle = \frac{\sum_{i=1}^{N_s(A)} KA_{s_i}(A)}{N_s(A)} \quad (2)
\]

\(N_s(A)\) describes the number of Subject Areas of a publication, while \(FP_{s_i}(A)\) is the value for the orientation towards fundamental science. \(\langle FP_s(A) \rangle\) stands for a publication’s average value of the orientation towards fundamental processes. Equally, \(KA_{s_i}(A)\) stands for the value of the orientation towards concrete applications and \(\langle KA_s(A) \rangle\) is a publication’s mean value for this orientation. After having calculated the average values for each article, the mean values of the two orientations for each given topic’s publication years \(t\) needed to be calculated:

\[
\langle FP(t) \rangle = \frac{\sum_{i=1}^{N_t} (FP_{s_i})_t}{N_t} \quad (3)
\]

\[
\langle KA(t) \rangle = \frac{\sum_{i=1}^{N_t} (KA_{s_i})_t}{N_t} \quad (4)
\]

After this procedure, all years of an analysed topic’s data set had two values for each publication year. These two values could then be entered into a two-dimensional quadrant model as inspired by Stokes.

**Results**

To show that the SAQA produced plausible results, we tested the methodology on two topics whose position in the research landscape was already clear. The first topic was “string theory”. Figure 1 shows the results of a SAQA for a data set on this topic.

![SAQA of the topic “string theory”](image_url)
Obviously, this topic has a strong orientation towards fundamental science and can thus be found in “Bohr’s Quadrant”. The second test was conducted with the topic “Biodiesel”. The SAQA shows that, as expected, this topic is clearly in “Edison’s quadrant” and thus part of applied science (see figure 2).

Figure 2. SAQA of the topic “Biodiesel”.

Conclusion
Our test results show that the SAQA produces plausible results for topics whose position in the research landscape is already clear. The SAQA is at the moment being tested on other topics like “spherical fullerenes”, “self-healing materials” or “metamaterials” where the position in the recent years is not clear. The results show that a more precise classification of these topics is possible with this new methodology.

Acknowledgment
My thanks go to my colleagues Marcus John for programming the online survey and Frank Fritsche for programming the Perl-script used to calculate the values for the SAQA.

References