Research Lines: bibliometrics at team or individual level

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Abstract
The aim of this paper is to demonstrate a method for bibliometric evaluation of individuals, i.e. research staff employed within a university department or other knowledge organisations with research purposes. Based on methods for citation analysis and methods for clustering of papers into research lines (using bibliographic coupling) we present an analysis of one researcher in three dimensions: 1) publication and citation indicators; 2) publication profile, and 3) research lines. One of the features of the method is the benchmark against other researchers within the same research line, i.e. researchers that use the same references and, accordingly, are active in the same field of research. The paper suggests this method as a means to avoid the fallacies of evaluation solely dependent on the static standard bibliometric indicators. The method has been used at universities for Research Assessment Exercises and at several funding agencies.

Introduction
Today, assessments of research groups or individual researchers are more common and usually include the use of publication and citation counts. To a large extent the reward system in science is based on recognition, and this emphasizes the importance of publications and to what extent they are used by colleagues. Simultaneously, these procedures reinforce the strategic position of advanced bibliometric analysis as a fundamental asset for evaluative studies (Glänzel, 1996; van Raan, 2004). There are, however, problems. The basic indicators, such as publication or citation counts, seldom show the full picture. In particular, these basic indicators fail to account for differences between fields. The now very popular h-Index shares the same problem. More advanced indicators provide a solution. Normalized citation indicators (based on field or journal reference values) make it possible to compare individuals, or groups, active in different fields. However, these indicators are often unstable at the micro-level (Costas, Bordons, van Leeuwen, van Raan, 2009). Significant results can seldom be gathered for individuals or small groups. Consequently, at the micro-level, especially with small groups (<10 researchers), or individual researchers, advanced citation analysis, all though desirable, might not always be suitable as description of the actual performance. Thus, regardless of the indicators used, caution is required when using bibliometrics at the micro level. In particular, one should never rely on a single measurement when assessing individuals or small research groups.
The difficulties of micro-level bibliometrics imply the use of multifaceted evaluative approach. In our view, bibliometric mapping techniques can provide an important balancing picture to standard citation analysis. These techniques enable visualizations of the positioning of research groups in relation to their research communities. In our contribution we try to illuminate the activities of the individual researcher by making use of several different methods in combination. Standard bibliometric indicators are still used, but additional techniques complement the picture. The methods are, to some extent, not that transparent to the reader, e.g. clustering techniques rest on thresholds and several other variables, but at the same time the resulting maps are often easier to understand and carry more contextual information of interest to all parties in an evaluation. The purpose of these evaluations is not to provide a simple indicator for ranking purposes. Rather, it is to give more detailed information, suitable for interpretation and re-evaluation of the standard indicators. We will suggest that bibliometrics on the individual level requires a larger portion of human

interpretation. While the assessments can never be completely fair and objective, it is possible to provide more information in order to build better information for assessment of research groups and individual researchers.

The fundamental question of this paper is whether it is possible to use advanced bibliometrics, based on citations, at the micro level. In our tentative answer to this question, we also invite to further discussion on these topics. The methods proposed in this paper are by no means a final solution. They are merely steps towards more in-depth bibliometrics at the individual or group level. Furthermore, the details of the different methods will not be discussed in detail, due to space limitations. This paper should therefore first and foremost be seen as a proposed meta-method for bibliometric assessments where the underlying assumption is that micro-level bibliometrics requires a more careful and in-depth approach than macro-level bibliometrics.

Citations are important in assessments

The claim that citations are an integral part of advanced bibliometrics, and as such a preferable measure, calls for explanation. In other words, why are citations a suitable and desirable measure of research performance? This, in turn, calls for a theory of citing: a theory that makes it possible to explain why author x cited article a at time t. What factors should be considered when we discuss why researchers cite back to former literature? The need for a theoretical underpinning of citation analysis has been acknowledged for a long time and several theories have been put forward. In short, there are three types of theories: normative, constructive and pragmatic. Normative theories are based on a naïve functionalist sociology, and constructivist theories are opposed to these assumptions. The third alternative, the (Nordic) pragmatist school (e.g. Seglen, 1998, Luukonen, 1997, Amsterdamska & Leydesdorff, 1989; Aksnes 2003), emphasizes utility in research as an important aspect, and cognitive qualities another, and together they are criterions for reference selection. Based on Coles (1992) seminal contributions the Norwegian Aksnes (2003b) have introduced the concepts of quality and visibility dynamics in order to depict the mechanisms involved.

Factors like journal space limitations prevent researchers from citing all the sources they draw on; it has been estimated that only a third of the literature base of a scientific paper is rewarded with citations. Furthermore, citation does not implicate that the cited author was necessarily “correct”, but that the research was useful. We should not forget that negative findings can be of considerable value in terms of direction and method. If a paper is used by others, it has some importance (Cole & Cole, 1973). In retrospect, the idea or method may be totally rejected; yet use of the citation is clearly closer to “important contribution to knowledge” than just the publication count in itself. The citation signifies recognition and typically bestows prestige, symbolizing influence and continuity.

From the view of the pragmatist citation school, a discussion of the limits of citation counting is necessary. As stated above, not all works that “ought” to be cited are actually cited, and not all works that are cited “ought” to be (Narin and Olivastro, 1996). As a consequence, the validity of using citation counts in evaluative citation analysis is contestable. Even if the quality of the earlier document is the most significant factor affecting its citation counts, the combined effect of other variables such as social clubs and networks are powerful and often very complex.

Acknowledging the limitations to citations analysis we, at the same time, underline the view that authors cite earlier work in order to substantiate particular points in their own work. In general, the citation of a scientific paper is an indication of the importance that the community attaches to the paper, or the pragmatic value connected to the paper. If it is used by others there is a cognitive quality in the paper and this quality is measurable by citations. To be able to use these citations as an effective measure, there are, however, several hurdles to overcome. In particular, considering the substantial differences in citation behaviour between fields, the citations have to be normalized or viewed in a more limited context. The question is then in what context they shall be viewed and in relation to what they shall be normalized. These questions increase in importance the more detailed the analysis becomes since the room for error is smaller. Based on this, there is a need for complementary methods that take the problems of citation analysis into account. That is the objective of our paper.

The field and sub-field problematique

In bibliometric studies the definition of fields is generally based on the classification of scientific journals into more than 250 categories, developed by Thomson Reuters. Although this classification is not perfect, it provides a clear and consistent definition of fields suitable for automated procedures. However, this proposition has been challenged by several scholars (e.g. Leydesdorff, 2008; Rafols & Leydesdorff, 2009; Bornmann et al. 2008; Frandsen & Nicolaisen, 2009). Three limitations have been pointed out: (1) multidisciplinary journals (e.g. Nature; Science); (2) highly specialized fields of research; and (3) intradisciplinary differences in database coverage.

The Thomson Reuters classification of journals includes one sub-field category named "Multidisciplinary Sciences" for journals like PNAS, Nature and Science. More than 50 journals are classified as multidisciplinary since they publish research reports in many different fields. Each of the papers published in this category are subject specific, and, therefore, it is possible to assign a subject category to these on the article level – what Glänzel et al. (1999) calls "item by item reclassification". Obviously, to the fist problem there is an acceptable solution.

The second issue of highly specialized fields within sub-fields is less easy to resolve. Lewison, in a debate with van Raan, pinpoints some of the reasons for questioning journal-dependent classifications; e.g. traditional delineation does not distinguish between specialist and non-specialist journals (Lewison, 2005). Bornmann et al. (2008) reports a case study of one neurology group and different relative citations scores depending on if they used Thomson Reuters' sub-fields or used MEDLINEs Medical Subject Headings (MeSH) assignation item-by-item. The latter methodology seems more appropriate than the classification from journals. MEDLINES hierarchical structure is, of course, more fine-grained than the Thomson Reuters classification, but there is no such database for other scientific fields. Therefore, as analysts we are thrown upon the existing resources i.e. the Thomson Reuters classification.

The third issue concerns coverage problems with the ISI database. Frandsen & Nicolaisen (2009) study two disciplines that include research communities relying on publications in journals with divergent coverage in the ISI. When two research communities are compared using relative indicators based on the sub-categories used by Thomson Reuters this will negatively affect the communities with a lower coverage. Therefore, a method that builds on the identification of research communities and uses that as basis for comparison could provide additional insights.

As there usually are no other alternatives, the Thomson Reuters subject categories are used in standard bibliometrics for "comparing like with like". However, many contributors to the debate, e.g. Leydesdorff, have expressed their doubts. Leydesdorff's interpretation is that the categories are assigned by the Thomson Reuters staff on the basis of the journals "citation patterns" (see further discussion in Rafols & Leydesdorff, 2009:1825). An obvious problem is that the classification matches poorly with classifications derived from the database itself on the basis of citation clustering analysis. Using such methodologies it has been found that in half of the cases the Thomson Reuters classification of journals did not correspond closely with the clusters based on inter-journal citation relations (Leydesdorff, 2008).

Furthermore, we sometimes find groups of researchers that are in between of fields; these groups might come into a “citation shadow” of dominate research areas within the field, e.g. a group in Mathematics that publishes in Physics and hence is compared with other publications in physics (sub-field “Physics, Mathematics”). If we compare the groups within this specific area of research and separate the addresses from Physics departments and those from Mathematics we find that articles with the latter addresses systematically have a lower citation rate (Sandström, forthcoming). Clearly, we should be cautious when it comes to field normalization. The dynamics of science constantly opens up new research lines that often are combinations at the border between research areas (or disciplines). The Thomson Reuters journal classification has to be quite stable over time; consequently this will produce inconsistencies.

In their article on dimensions of citation analysis, Leydesdorff & Amsterdamska (1990), showed that comparing “like with like” (Martin & Irvine, 1983) is very hard to achieve. Although they had similar research teams with similar performances the detailed analysis gave a conclusion that pointed in a critical direction: “Our analysis suggests, however, that the criterion of what constitutes sufficiently similar groups is itself problematic. Despite the fact that the four papers we compared originated from the same small laboratory, they were clearly addressed to four distinctly structured communities. The local institutional identity of the papers’ origin is not sufficient to assure the similarity of their audiences, nor does it provide clues for explaining the papers’ perceived significance and reception.” (pp. 324-325)

In order to handle the above mentioned problems we propose a method that makes it possible to compare a team of researchers or individuals and their production and citations scores in different research lines with the relevant research community. Consequently, we can answer questions like these: Is the group performing better, on par with or less well than their colleagues in that specialized area of research? What are the characteristics of the research line in comparison to the larger field of research? We continue to use the fields proposed by Thomson Reuters for field normalized measures. The proposed method should not be seen as an alternative to standard indicators. Instead, field normalized indicators can still be used on the individual level but, given the above mentioned limitations, with prudence. In particular, additional information has to be supplied that can either falsify or support the results of the standard indicators.

Clusters and research lines

We have seen that there are no perfect measures for evaluations of research. Probably, the best way to handle this dilemma is to develop complementary indicators or to develop other indirect measures that illuminate the performance of researchers and research groups in different ways. In the following we have chosen to focus on visualizations as a means to enhance the evaluative properties of the analysis.

Thereby we use clustering and mapping techniques to illuminate research team’s activities over the period 2000-2006. The goal of cluster analysis is to divide data into a number of subsets (clusters) according to some given similarity measure (Chen, 2006). As already indicated it is quite problematic to delineate a research field with journals or journal categories; evidently, a researcher is often active in several of the more than 250 subject fields.

Why is mapping important to evaluative bibliometrics? The obvious answer is, firstly, that mapping can provide us with a profiling of the research group or the individual researcher. Accurate maps of the actual articles and their related research lines can give us a description of what is going on in that field of research; how articles are related to each other; which research lines that are closer to each other and how they are connected. Secondly, and as important as the first, it can give a complementary illumination of the activities of the research group in relation to their closest colleagues. Mapping techniques makes it possible to compare the individual/group – regarding citation performance – with its nearest neighbours; i.e. other researchers working on the same topics and in the same research lines.

Our methods owe much to the work of Chaomei Chen at Drexel University and to the work of Dick Klavans and Kevin Boyack at SciTech Strategies Inc. We have developed a methodology based on bibliographical coupling in order to build accurate and coherent maps of areas and research lines (Boyack, Klavens & Börner, 2005; Chen, 2006; Boyack & Klavans, 2006; Klavans & Boyack, 2005) and this methodology to a large extent relies on the algorithms of the DrL-software (Martin, Brown, Klavans & Boyack, 2007).

The procedure was performed as follows: A large material was selected to form the basis for the clustering. This material should include all, or almost all, papers that could be relevant for the given group or individual in the chosen time period. It should, in other words, be the group's or individual's larger field of research. This can be achieved is several different ways. One is to select relevant subfields from the Thomson Reuters classification. A different method, used in this paper, is to select a set, or sets, of journals. Journal sets where created based on clustering using the average link clustering algorithm with journal inter-citation as the similarity measure. A minimum and maximum cluster size (in terms of number of underlying papers) where applied to make sure that the clusters where neither too large nor too small. Journal sets that included papers from the group/individual where selected to form the clustering base material. A clustering of all papers within the chosen journal sets was then performed to form research lines. The clustering was carried out using the clustering procedure proposed by Boyack and Klavans (2007), i.e. using the DrL algorithm with the "edge cut" set high and with bibliographic coupling as similarity measure.

The procedure aims to identify clusters of articles in correspondence to the underlying thematic groupings (research lines); hopefully as they are perceived by scientists themselves. Obviously, the core of our method relies on bibliographical coupling of documents (=articles, not journals) into research lines; groups of documents that cite the same base documents. This established bibliometric method has been shown, by Jarneving (2007), to work well for the purpose of clustering of related papers into coherent groups. We consider research as an activity conducted by "small groups of people attacking equally small and intensely focused sets of shared problems" (Morris et. al., 2003: 413). The highly cited papers of these research lines are the research fronts of that specific research area.

The immediate nature of bibliographic coupling makes it convenient to use for constructing research lines over a time period (Morris et al. 2003: 414). In our presentations each research line is described, to the left, with the most frequent terms (keywords), and to the right, the most frequent individual authors and their number of articles. This information makes research lines open for direct validation by the researchers themselves. We consider this method a valuable asset for evaluative bibliometrics as it visualizes the development of the research line (community) over time – growth, decline or stability. But, we should mention that the time line is rather short in the reported analyses; periods up to seven years is in most cases rather short.

We propose that the most frequent research lines, in which the research teams/individuals are active, should be considered as representative for their overall research. We try to avoid measuring too many of the single and more casual lines of research in which a team of researchers publish. Instead, we propose that one should focus evaluative interest on the larger and more stabile research lines. Moreover, in addition to the general performance of the research communities our analysis also provides the field normalized citation score for the specific articles from the research group under consideration. Those figures can be compared with the score of the research line as a whole.

It should be noted that the interpretation of the results is not self-evident. In particular, the citation score of the research lines can either be seen as a basis for normalization, showing whether the individual or the group is more or less cited than its closest colleagues, or as an indicator of the importance of the individual's or group's research line. These two interpretations can appear to be contradictory. In the first case a low citation score of the research line indicate that the individual or the group is conducting more valuable research, in the latter it indicates the opposite. Despite this, we suggest that both interpretations should be accounted for. A high score in relation to a top performing research line is ideal, but a low score in the same research line could, for example, indicate that although the assessed publications are not highly cited, the conducted research has a high potential interest. These characteristics also make the material suitable for strategic, not only evaluative, use. Research groups, individual researchers as well as programme officers can, based on the given information, discuss strategic action, e.g. on directions of future research.

Illustration: Professor Åke Bergman

In order to illustrate our method we been authorized to present the work of Professor Åke Bergman at Stockholm University. Bergman is active at the Department of Environmental Chemistry, one of the six departments in chemistry at the university. Bergman has his basis in chemistry with strong interdisciplinary and multidisciplinary links to research, teaching and international activities on chemicals and the environment. His and the department work is in particular focused on chemical synthesis, characteristics, exposure of chemicals, human health and wildlife effects. The research encompass the transport, fate and biological effects of environmental pollutants and trace substances, including the development and use of chemical, biological and physical methods as well as numerical models. We have chosen an outstanding researcher as it much more pleasant and interesting to present "excellent" research than the other way around. Results are illustrated in Figure 1-3 with information showing performance at individual, or personalized, level.

Figure 1 – 3 about here.

Illustration 1 BIBLIOMETRIC INDICATORS

The first figure, Figure 1, gives the bibliometric indicators for the individual. At the bottom there are two graphs, to the left number of papers per year, to the right vitality (reference age). It is hard to find relevant data for time series on the individual level. Vitality (Klavans & Boyack, 2008) might be a viable indicator as it has other features than the citation indicators. Number of references are more or less stable within research areas and the reference age might not deviate over time that much. But, if we see a lowering of the reference age (higher vitality) it might indicate that the researcher is getting closer to research at the front.

These commonly used indicators will not be discussed in detailed in this paper. The purpose is not to suggest a fixed set of indicators to use. The indicators page shall merely serve as an illustration in the context of our discussion.

Illustration 2 PUBLICATION PROFILE

Figure 2 show a map that includes all articles that belong to the research lines (see next paragraph) to which the individual has been assigned by his or her articles. The map is constructed using the GraphViz (www.graphviz.org) implementation of the Kamada-Kawai (1989) algorithm. Papers written by the individual under consideration are marked black. Relations are based on similar references (bibliographic coupling). Papers characterized by high impact scores (>4.00) are highlighted by dark rings; a group with a number of high impact papers will have many dark nodes in the picture. Dark lines between nodes indicate a low reference age (high vitality). We interpret higher vitality as tendency to be closer to the research front and a higher probability to impact on knowledge production at this front. Below the map is found the most frequent keywords on articles from the individual, the most frequent co-author names, and the most frequent co-authoring institutions.

Illustration 3 RESEARCH LINES

Research lines are shown in Figure 3. These are built via a clustering, based on bibliographical coupling, of all articles in the Thomson Reuters database from 2000–2006 (following the method outlined above). These small communities of articles use the same references and should, therefore, deal with more or less the same topic. The idea is to demonstrate the distribution of articles (grey fields) and citations (black lines; 2yr citation window); thereby we make it possible to follow the development over time for the respective research lines.

The total number of articles, the Field Normalized Citation Score, NCSf, and the Vitality score, of the full research line are displayed on the line. The contribution of the individual, in terms of papers, is showed above the line. Presented under the line are the Field Normalized Citation Score and Vitality for the individual's publications in that line of research.

To the left we show the most frequent keywords in the research lines and to the right the most frequent authors. Above the line is shown the individuals number of papers within the research line and below is displayed the field normalized citation score (since only one person is included in the analysis, the number of publications above and below the line is identical).

The innovative function of these research lines are that researchers can compare and benchmark themselves with their closest colleagues, those that are in the same field of research and are utilizing the same references in their research. The publication profile gives the researcher his or her positioning within the field of research. From the information given it is possible to discuss strategic action, e.g. on directions of future research.

Going deeper into the research lines the visualization show the growth of the line over time. If the grey area is expanding there are a growing number of papers per year. Inversely, there are diminishing numbers of papers if the grey area is becoming smaller over time. Analogously, the black lines show the development of the normalized number of citations over time. Several of the Bergman research lines seem to be expanding over time.

As stated above, one important feature of the research line method is that we can compare the citation score of Åke Bergman with his closest colleagues and simultaneously receive information about the relative importance of the different research lines. We find that Bergman is well above the mean citation rate in all lines. The most frequent research line for Bergman is a very highly cited topic and he has co-authored a high number of papers. Obviously, Bergman is active in a number of fields which receive citations from other lines/areas.

Discussion

Acknowledging the influence from Chen, Boyack, Klavans and Morris we underline that this is the first and preliminary version of the proposed method. Certainly, there is room for further methodological (and theoretical) development. In our view, meeting the micro-level challenge is a much needed issue for evaluative bibliometrics. Whether we like it or not publication analysis will be applied to individual researchers as long as there is need for such measures from granting offices and from university management. Micro-level analysis is one of the weak spots in the arsenal of methodologies supported by the bibliometric society. We find some movements toward solving the problem, e.g. Costas, van Leuween & Bordons (2009), but on the general level few have the ambition of creating reliable bibliometrics for individuals and for small research teams.

During 2008/2009 we have conducted several reports using the method described, e.g. in assessments of researchers at institutions like Royal Institute of Technology in Sweden and Aalto University in Finland, as well as assessments of programs granted by the Swedish Environmental Protection Agency (SEPA) and the Swedish Foundation for Strategic Research (SSF). The method seem to work well in productive environments, but results from social scientist or other areas with few papers per person indicate that the method works better if there is a cumulative knowledge production in the areas under study. Validation studies show that if the input papers are correctly assigned to persons in the evaluation the individuals recognize themselves and in general find the information interesting. The detailed level of information makes it usable for programme officers as they can identify the research topics which they intended to support and can see how the performance within those research lines has evolved over time.

The main advantage of the proposed method is that it provides more contextual information than standard bibliometric analyses. We have developed a bibliometrics that identifies the communities of researchers based on their shared references, and that is a bibliometrics with the potential of giving a more fair evaluation of researchers as well as material for strategic discussion.

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BERGMAN, ÅKE - BIBLIOMETRIC INDICATORS

NUMBER OF PAPERS (P) — **97**
Number of papers (articles, letters and reviews) published by Bergman, Åke during 1998-2006.

NUMBER OF FRACTIONALIZED PAPERS (Frac P) — **18.4**
Sum of author fractionalized papers.

CITATIONS PER PAPER (CPP) — **29.4**
Number of citations per paper (31 December 2007).

JOURNAL NORMALIZED CITATION SCORE (NCSj) — **2.15**
CPP normalized in relation to the Bergman, Åke journal set (average=1.00).

NORMALIZED JOURNAL CITATION SCORE (NJCS) — **1.53**
The impact of the journal set normalized in relation to its sub-fields (average=1.00).

FIELD NORMALIZED CITATION SCORE (NCSf) — **3.40**
CPP normalized in relation to the Bergman, Åke sub-field set (average=1.00).

SUM OF FIELD NORMALIZED CITATION SCORE (Sum NCSf) — **62.8**
NCSf times Frac P.

STANDARD FIELD CITATION SCORE (SCSf) — **1.02**
Z-score standardized citation score in relation to the Bergman, Åke sub-field set (N.B! average=0.00).

TOP 5% (TOP5%) — **31**
Percentage of papers above the 95th citation percentile.

VITALITY — **1.17**
Mean reference age normalized in relation to the sub-field set (average=1.00, higher=younger).

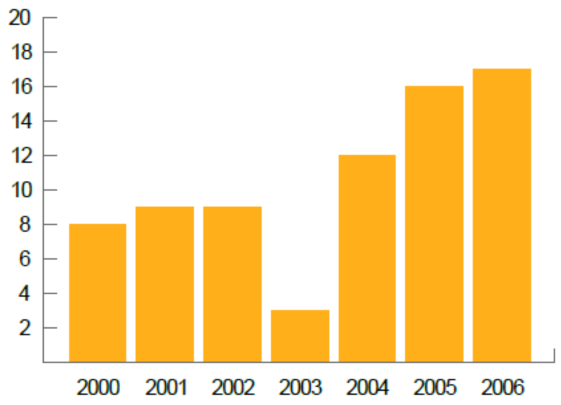
PERCENTAGE SELF CITATION (SelfCit) — **6**
Percentage self-citation.

PERCENTAGE NOT CITED PAPERS (Pnc) — **5**
Percentage of not cited papers during the period.

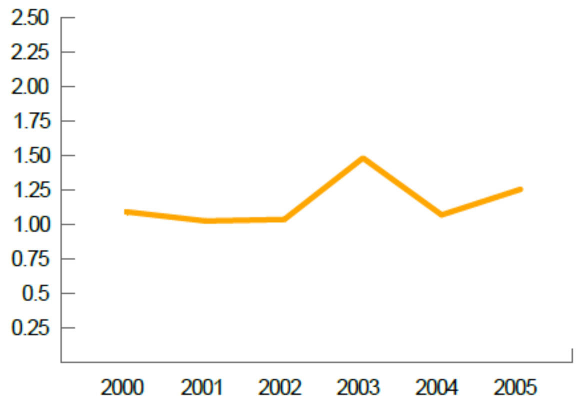
HIRSCH INDEX (H-INDEX) — **29**
The h number papers that have at least h citations each.

AUTHOR MEAN (AUm) — **5.3**
Mean number of authors per paper.

INTERNATIONAL COLLABORATION MEAN (IntCOLLm) — **1.8**
Mean number of countries per paper.



Number of papers per year



Vitality per year

Figure 1. Bibliometric Indicators for Åke Bergman.

BERGMAN, ÅKE - PUBLICATION PROFILE

The map shows papers (nodes) in research lines where Bergman, Åke has been active.
Relations (edges) are based on bibliographic coupling.
Most frequent keywords are displayed for groups of related papers.
Papers with high field normalized citation score (>4) are marked with a pink border.
Edges between publications with high vitality (>1.2) are drawn in pink.

MOST FREQUENT KEYWORDS
(in publications belonging to Bergman, Åke)

POLYCHLORINATED-BIPHENYLS (25)
POLYBROMINATED DIPHENYL ETHERS (17)
BROMINATED FLAME RETARDANTS (16)
EXPOSURE (15)
IDENTIFICATION (13)
GAS-CHROMATOGRAPHY (13)
PCB (11)
BROMINATED FLAME RETARDANTS (10)
PLASMA (10)
BLOOD (9)
POLYCHLORINATED-BIPHENYLS PCBS (8)
PBDE (8)

MOST FREQUENT CO-AUTHORS
(in publications belonging to Bergman, Åke)

ATHANASIADOU, M (16)
BROUWER, A (14)
SJODIN, A (10)
MARSH, G (10)
VAN DEN BERG, M (8)
LARSSON, C (8)
HAGMAR, L (8)
BRANDT, I (7)
ATHANASSIADIS, I (7)
VISSER, TJ (6)
THURESSON, K (6)
SCHUUR, AG (6)

MOST FREQUENT COLLABORATORS
(in publications belonging to Bergman, Åke)

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UTRECHT UNIV (13)
UPPSALA UNIV (12)
LUND HOSP UNIV (10)
KAROLINSKA INST (10)
WAGENINGEN & RES CTR UNIV (9)
WAGENINGEN UNIV AGR (7)
SWEDISH MUSEUM NAT HIST (7)
ERASMUS UNIV (7)
SWEDISH UNIV AGR SCI (6)
VRIJE UNIV AMSTERDAM (4)
HAMBURG UNIV (4)

Figure 2. Publication Profile for Åke Bergman.

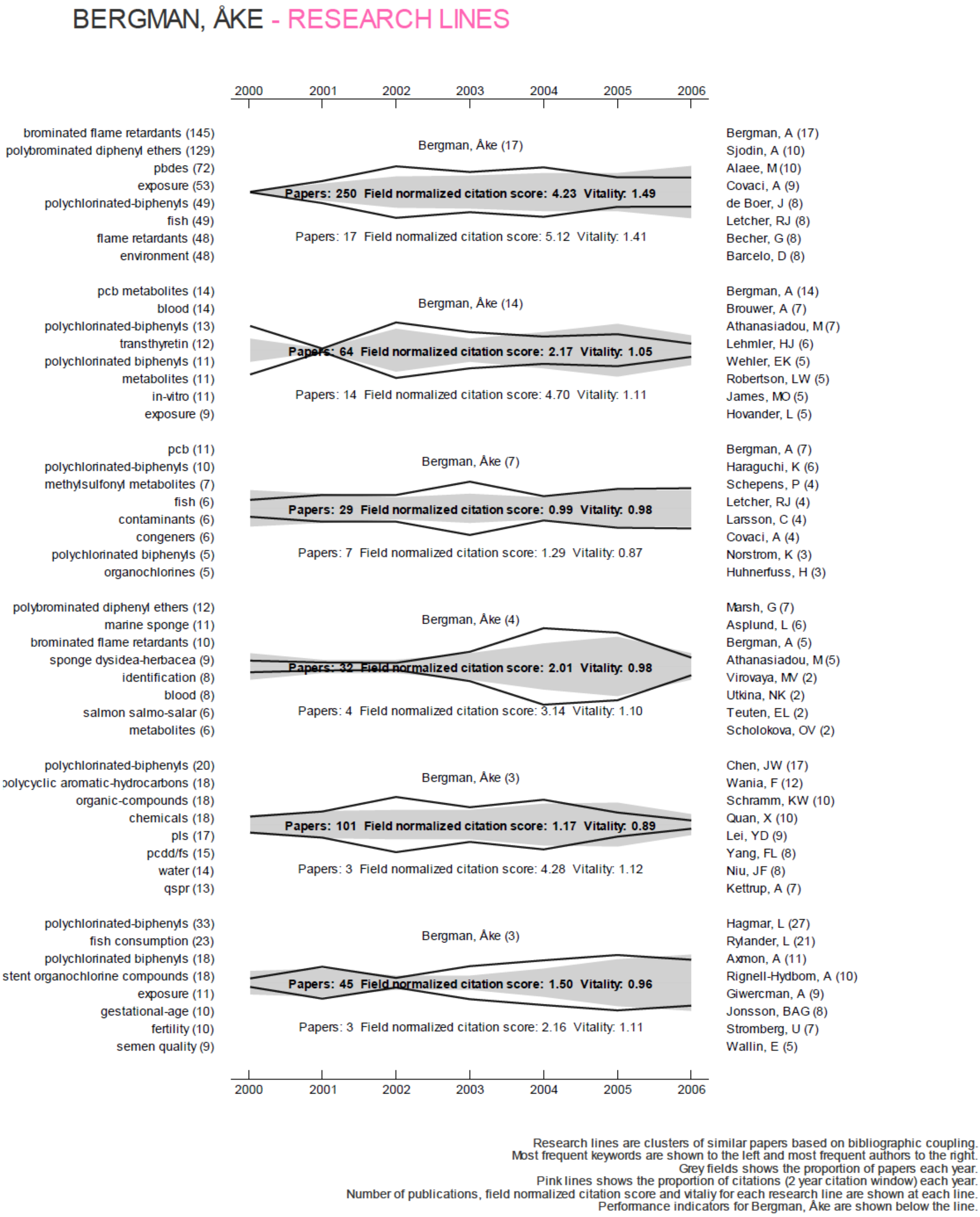

Figure 3. Research Lines for Åke Bergman.