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Alternative Impact Measures for Open Access Documents?
An examination how to generate interoperable usage information from distributed open access services

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Abstract:

Publishing and bibliometric indicators are of utmost relevance for scientists and research institutions as the impact or importance of a publication is mostly regarded to be equivalent to a citation based indicator, e.g. in form of the Journal Impact Factor or the Hirsch-Index. Performance measurement both on an individual and institutional level depends strongly on these impact scores. This contribution shows that most common methods to assess the impact of scientific publications often discriminate open access publications – and by that reduce the attractiveness of Open Access for scientists. Assuming that the motivation to use open access publishing services (e.g. a journal or a repository) would increase if these services would convey some sort of reputation or impact to the scientists, alternative models of impact are discussed.
Prevailing research results indicate that alternative metrics based on usage information of electronic documents are suitable to complement or to relativize citation based indicators. Furthermore an insight into the project Open Access Statistics OAS is given. OAS implemented an infrastructure to collect document-related usage information from distributed open access repositories in an aggregator service in order to generate interoperable document access information according to three standards (COUNTER, LogEc, IFABC). The service also guarantees the deduplication of users and identical documents on different servers. In a second phase it is not only planned to implement added services as recommender features, but also to evaluate alternative impact metrics based on usage patterns of electronic documents.

Scientific Publishing and Performance Measurement: a critical review

A researcher's performance and reputation is mainly determined by the impact of his publications. The higher his impact scores are the higher are his reputation and career prospects. Impact itself is mostly (and especially within the domain of Science, Technology and Medicine) defined by citation measures as citation rates or citation frequencies.

The **Journal Impact Factor (JIF)** is probably the most prominent and influential citation based metric. It is based on citation rates and calculated as follows: *In year X, the impact factor of a journal Y is the average number of citations to articles that were published in Y during the two years preceding X.*

Even though it is designed to measure the impact of scientific journals and not to measure the impact of scientists or single scientific information items as articles it is often misunderstood as an indicator for a scientist's quality. Also from a methodological perspective the JIF can be easily challenged (Campbell, 2008; Dong, Loh & Mondry, 2005; Herb, 2010a; Seglen, 1997; Seglen, 1998). The statistical universe (the Web of Science WoS respectively the Journal Citation Reports JCR) for the calculation of the JIF scores is restricted and more or less arbitrarily defined by the Thomson Scientific's Institute for Scientific Information (ISI). The JIF's two years span disadvantages publications from several disciplines like Humanities, Social Sciences or Mathematics and disciplines that prefer other publication types. Several studies indicate that the JIF seems to create some sort of *scientific free-rider-effect* because they prove for several contexts that a small number of highly cited articles produces a high JIF-score for the whole journal. Seglen (1997; 1998) reports for biochemical journals that 15% of the articles generated 50% of a journal's citations and that 50% of the articles generated 90% of a journal's citations. Campbell (2005) found out that 25% of the articles published in Nature in 2002 and 2003 generated 89% of the citations in these years, making a great contribution to the JIF-score of 32.2 for the year 2005. Furthermore a *matthew-effect in science* (Merton, 1968 and 1988) exists: The higher a journal's JIF, the more often it will be cited – these citations in turn will cause a higher JIF score.

Unlike the JIF the **Hirsch-index** (or **h-index**) is a performance index that is based on citation frequencies and that is related to scientists. The h-index is calculated as follows: *A scientist has index h if h of N papers have at least h citations each, and the other (N − h) papers have less than h citations each.* Accordingly an author has an h-index of 8, if he published 8 articles that were cited at least 8 times. This implicates that the citation count of one single highly-cited publication can not distort a scientist's score, but it also depreciates innovative concepts. The h-index' calculation is not tied to a proprietary database (as the JIF is), nevertheless some of its peculiarities are strongly criticisable: For instance the handling of documents in Non-English languages and of documents from multiple authors have to be mentioned. Additionally it neglects context variables as the author's age or discipline that strongly influence his h-index. Campanario (1996) reports that longer articles or articles that appear at the beginning of a journal issue reach higher citation counts. Since Fröhlich (2009) states that both a prominent positioning and a higher number of pages are privileges for reputated authors also the h-index fosters a *matthew-effect in science*: The higher an authors reputation is, the more privileges he enjoys within a publication – and these privileges in turn will cause higher citation frequencies and h indices.

Even though Jensen, Rouquier & Croissant (2008) found out that a scientist's h-Index seems to correlate with the likelihood of his promotion, they advise to use it with caution because only for 48% of the persons a correlation between high h-index and career advancement could be found: "a 'mechanical Objectivity' procedure, which ranks candidates by their h would disagree with actual promotions for half of the promoted people, a very significant difference." (Jensen, Rouquier & Croissant, 2008, p. 477)

Beyond the methodological critique also the opacity and lacking transparency of the common citation based metrics must be taken into account. Editors at Rockefeller University Press tried to check the JIF-scores of three of their journals and several competing journals (Rossner, Van Epps & Hill, 2007; Rossner, Van Epps & Hill, 2008). As they found repeatedly errors within the data provided by Thomson Scientific's Institute for Scientific Information they concluded: „Just as scientists would not accept the findings in a scientific paper without seeing the primary data, so should they not rely on Thomson Scientific's impact factor, which is based on hidden data." (Rossner, Van Epps & Hill, 2007, p. 1092).

Impact as an incentive to publish Open Access

Most studies comparing citation advantages or citation disadvantages of open access and toll access documents provide arguments pro Open Access. Alma Swan (2010) compiled results from 31 studies focussing on open access citation effects. Even though disciplinary effects, born open access documents and born toll access documents, self-archived versions of toll access documents and the formal publication in a toll access journal or other parameters are very hard to compare 27 of the studies reported a positive open access citation advantage while 4 studies report no open access citation advantage or even an open access citation disadvantage.

Nevertheless due to the restrictions and the scope of the relevant databases (Web of Science, JCR, Scopus etc.) that are typically used to calculate JIF-scores or h-indices there are many (open access or toll access) publications of great scientific value that will never feature any citation based impact score because they are not indexed by these databases. Hence a lack of tools and indicators to measure the impact of (open access) publications can be stated. Especially documents that are self-archived on open access repositories (and not published in an open access journal) are excluded from the databases mentioned. Open access journals in turn may have impressive JIF-scores, anyhow many of them tend to be discriminated by the JIF-formula and the JCR scope:

- Since many open access journals are often quite young publications, they are lacking the citation history a journal needs to be indexed by the JCR and to reach an attractive JIF-score.
- Open access journals are published above average in developing countries (Haider, 2005). Due its unbalance towards the English language these journals usually attain minor JIF-scores – if they are indexed at all by the JCR.
- Accordingly Packer and Meneghini (2007) found out that the JIF-scores of journals from the so-called developed countries are significantly higher than the JIF-score of journals form the so-called developing countries.

open access services (no matter if in the form of journals or repositories) apparently would

benefit from alternative impact indicators because the common methods to assess the impact of scientific publications often discriminate open access publications – and by that reduce the attractiveness of Open Access for scientists. Assuming the motivation to use open access publishing services would increase if these services would convey reputation, impact or scientific capital to the scientists (Herb, 2010b), alternative indicators and models of impact could be strong incentives for scientists to publish their documents Open Access.

Considering the critiques on the JIF and the h-index in scientific publishing as a whole could benefit from such indicators; at least alternative metrics would facilitate multifaceted assessments of scientific information.

Usage based metrics as alternative impact metrics

Usage based performance indicators seem to be complementary to citation based methods (Herb 2010a) because they are reader-centred: document usage is a reader's action, whereas citation is an author's action. Usage based indicators are not only suitable to predict the results of citation-based indicators (Brody, Harnad & Carr, 2006): According to Bollen et al. (2009) they express a distinct sort of impact. Basically there are two models how usage information on scientific electronic content can be utilized for performance measurement: On the one hand metrics based on the usage frequency of documents, on the other hand metrics based on the patterns or structure of document usage.

Metrics based on the frequencies of document usage

Some examples for metrics that are based on the frequencies of document usage are

- COUNTER (Counting Online Usage of Networked Electronic Resources)[1]
- LogEc[2] (the statistics module of the network RePEc[3])
- the standard of the International Federation of Audit Bureaux of Circulations [4] (IFABC)

The COUNTER Code of Practice for Journals and Databases (COUNTER, 2008) measures usage on the level of journals. It is mainly used by libraries to monitor the cost-effectiveness of their journal subscriptions, why it focuses predominantly on Toll Access content. Accordingly the *List of Internet Robots*[5] that COUNTER uses to eliminate non-human accesses on articles is hardly applicable to count the usage of open access content that is accessible for every robot as it is not hidden behind a firewall or IP-check. There are also initiatives tightly connected to COUNTER that are also following the same approach of counting the pure frequency of document usage: Whereas PIRUS (2009) aims at developing a standard to count the usage of single articles, the United Kingdom Serials Group undertook a study (Shepherd, 2007) to investigate the feasibility of developing and implementing journal Usage Factors (UFs).

[1] http://www.projectcounter.org
[2] http://logec.repec.org/
[3] http://repec.org/
[4] http://www.ifabc.org/
[5] http://www.projectcounter.org/r3/r3_K.doc

LogEC in turn monitors usage on the article level, non-human hits are eliminated according to robots lists and with thougt-out statistical procedures.[6] The method of the IFABC wants to monitor the usage of single websites in order to calculate the number of views embedded advertisement attained and also measures the usage of single documents.

DRIVER (2008, p. 131-135) gives a brief outline of these different approaches revealing their considerable differences regarding e.g. the detection and elimination of non-human accesses and the definition of doubleclick-intervals. In summary it can be stated that there is no accepted standard to monitor the frequency or ratio of document usage, especially in an open access environment.

Metrics based on context information of document usage

The methods mentioned in 3.1 neglect the context of the document usage, especially the co-usage of documents. Bollen et al. (2005) suggest surveying also the *structure* of document usage, a procedure that is known from download graphs or clickstream analysis.

Bollen and his colleagues undertook several research projects in this environment (Bollen, Van De Sompel, Smith & Luce, 2005; Bollen, Van De Sompel & Rodriguez, 2008; Bollen, Van De Sompel, Hagberg & Chute, 2009) by collecting information on both frequencies of document citation and document usage and structural information as networks of document citations and document usage. With sociometric methods and network analysis techniques they produced rankings that were evaluated by scientists from different scientific communities: Surprisingly rankings based on the context of document usage mirrored the scientists' preferences better than the JIF.

Bollen et al. (2009) sum up their findings by saying: „Our results indicate that the notion of scientific impact is a multi-dimensional construct that can not be adequately measured by any single indicator, although some measures are more suitable than others. The commonly used citation Impact Factor is not positioned at the core of this construct, but at its periphery, and should thus be used with caution." The authors favour usage based information to some extent and resume: „Usage-based measures such as Usage Closeness centrality may in fact be better ‚consensus' measures."

Résumé

Apparently usage information can be utilized to measure the impact of scientific content. Bollen and his colleagues designed the most promising and the most complex procedure. But beyond the missing standardization the procedures mentioned ignore issues like the deduplication of users and documents, both is necessary to build clickstreams and to calculate doubleclick frames in a network of open access services, where users may jump from one repository to another and where they can find several identical versions of the same document. To gather information on the context of document usage it would also be necessary to detect what different documents user X downloaded from different servers.

[6] http://logec.repec.org/about.htm

Besides it should be possible to sum up hits on different files of the same content on different servers.

It also needs an elaborate infrastructure to generate and exchange interoperable usage information within such a network. This includes the logging of usage events on open access repositories that are indexed by legions of robots and that contain multi-file documents and duplicate documents (maybe in different file formats). An infrastructure like that would have to face all the hurdles known from weblog analysis in digital libraries as described by Jamali, Nicholas & Huntington (2005). This is also true for the research of Johan Bollen and his colleagues that aims explicitly at impact measurement. The infrastructure they use mostly does not know empirical noise like double-click intervals, elimination of duplicate users or documents and the detection and elimination of non-human document accesses. Additionally Bollen and his colleagues are focussing on impact measurement on the level of journals, not single items.

From promise to practice: Open Access Statistics

It is the aim of the project „Open Access Statistics (OAS)“[7] (funded by the German Research Foundation DFG[8]) to make the impact monitoring of open access content on the article level possible. The project partners[9] built a test-infrastructure for the exchange of document-related usage information between distributed open access services. OAS is one of three projects initiated by the Electronic Publishing working group of DINI[10] (Deutsche Initiative für Netzwerkinformation / German Initiative for Network Information): While Open Access Statistics addresses usage description, Distributed Open Access Reference Citation Services (DOARC)[11] addresses the issue of tracking citations between electronic publications. Open Access Network[12] wants to build a network of repositories; it also brings together the results of DOARC and OAS in one user interface[13]. Additionally it offers tools and services for DOARC and OAS, especially the deduplication of documents which is based on an asymmetric similarity of full text documents.

In a first step OAS implemented a network to collect and exchange usage information between different services and to process this information according to the standards of COUNTER, LogEc and IFABC. OAS also developed implementation guidelines for services that want to join the OAS network.

[7] http://www.dini.de/projekte/oa-statistik/english
[8] http://www.dfg.de
[9] Georg-August Universitaet Goettingen (State- and University Library), Humboldt-University Berlin (Computer- and Mediaservice), Saarland University (Saarland University and State Library), and the University Stuttgart (University Library)
[10] http://www.dini.de
[11] http://doarc.projects.isn-oldenburg.de/
[12] http://www.dini.de/projekte/oa-netzwerk/
[13] http://oansuche.open-access.net/findnbrowse/pages/start.faces

The open access services or data providers at the four partner institutions

- generate logs about document usage
- pseudonymize user information (e.g. IP-addresses)
- process usage information (e.g. they add unique document ID, transform the data into OpenURL ContextObjects, …)
- transmit the information via OAI-PMH to the aggregation server (central service provider)

The central service provider in turn processes the data received:

- it deduplicates documents: e.g. it sums up the hits on files with the same content on different servers
- it deduplicates users, so it is possible to create download graphs and to conduct clickstream analysis
- it processes the data according to the standards COUNTER, LogEc and IFABC: this includes the removal of non-human accesses, the consideration of standard-specific parameters like doubleclick spans and the calculation of doubleclick intervals across the borders of the participating servers.

Data providers have to fulfil rather simple requirements to take part in the OAS infrastructure: the services' web servers have to use an easy to handle specified configuration (Herb et al., 2009), they must pseudonomyze user information, isolate the local document identifier and they have to offer the information as OpenURL Context Objects containers via an OAI-PMH-interface to the central service provider. DSpace- or OPUS-repositories may use modules developed by OAS, other products can easily be configured to be OAS-ready.

In order to get feedback about utilization scenarios for usage information OAS conducted several surveys: *Information professionals* (database designers, information scientists, retrieval specialists) interviewed during May and June 2009 emphasized strongly the need for relevance rankings of documents based on usage information and the need for recommender services. *Repository Users* taking part in an online survey during October and December 2009 rated the value of the following functionalities high:

- display of single document's usage
- display of the usage of one author's documents
- display of the repository's usage
- recommendation services based on the usage of documents
- application of document usage information as a criterion to refine search result lists

The third survey (conducted via email from September to October 2009) tried to investigate *Repository Managers'* requirements for usage information based reports and repository features. This target group focussed very much on the quality of statistical information, especially the need for interoperable statistical information on both document and repository usage, cleaned from the noise of non-human access by robots and computed according to reliable standards. Considering the utilization of statistical information repository managers primarily had rankings features based on document usage in mind. Other scenarios mentioned the utilization of information on document usage as impact scores and the development of recommender services. They also often aimed at an analysis

of their repositories based on usage information.

By now OAS strives for a second funding phase (OAS 2). The project aims especially at the standardization and evaluation of indicators that are based on the absolute frequency of document usage. Another core point is the standardization of workflows, data storage formats and interfaces for the exchange of usage information as well as the integration of new contributing services/ data providers (in form of journals or repositories) in order to generate sound statistic reports. Based on these analysis usage based features and added-value services for repositories - inspired by the survey results mentioned - will be developed.

For instance OAS 2 intends to offer several added value services that are of relevance for different stakeholders:

- readers will be able to use information about the frequency of document usage as a ranking (or relevance) criterion or to resort result lists
- readers will be able to assess the impact of a document
- as OAS defines a standardized log format, repository managers may use the data to evaluate the impact of their repository
- authors and administrative departments will be able to assess the relevance of research topics
- relevance rankings and recommender services based on the patterns of document usage or on a combination of the download frequency of a document *and* the documents content.

As a basic prerequisite for the transition from a test infrastructure to a productive one OAS 2 has to take intensively heed of privacy issues. Accordingly the OAS infrastructure will have to be developed in close exchange with privacy experts. OAS also wants to clarify whether it will be possible to offer its data under Creative Commons Licenses. The infrastructure's sustainability is not only one of the main issues OAS 2 has to tackle in order to offer a trustworthy and reliable service. Beyond the topics mentioned (repository evaluation, usage based impact metrics, topics related trend analysis based on document usage, recommender featured etc.) it is also an incentive for new partners to take part in OAS. As each partner is responsible for the sustainability of his data provider, on this level sustainability is less critical for the infrastructure as a whole. However OAS has to draw up scenarios for the sustainability of:

- the central service provider
- the support of the data providers
- the further developments (e.g. new standards, metrics or reports) that bring along new routines, workflows, technical adaptations, tests and evaluations.

OAS will deal both with the durability of the service, that is also of importance for the trust in OAS, and with possible business models. Two scenarios are:

- running the service provider at a supraregional institution, e.g. a library network or consortium
- giving non-profit institutions access to the OAS data free of charge, but providing only fee-based access to commercial partners as database producers.

The OAS project team is also looking forward to involve in international approaches and to exchange project results with international projects. It is already involved in several meetings and workshops that deal with the content of usage statistics in order to create productive dialogue between the international projects and identify fields where a common approach would be feasible and bring synergy effects. OAS 2 will also strive for internationalization, because all the work packages mentioned (and especially standardization) need an intense exchange of information with other projects tackling related issues as SURFsure, COUNTER, PIRUS, NEEO, PEER or OAPEN and Knowledge Exchange, the cooperation of Denmark's Electronic Research Library (DEFF), the German Research Foundation (DFG), the Joint Information Systems Committee (JISC) and the SURFfoundation.

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