

# Where and how knowledge on digital library evaluation spreads: a case study on conference literature

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### Abstract:

Scholarly communication has not remained unaffected by the advance of the social networking culture. The traditional bibliometric paradigm is strongly questioned as a tool that accurately portrays the impact of research outcomes. New metrics, such as download or view rates and shares, have been proposed as alternative ways for measuring the impact of digital content published in the form of articles, datasets, etc. Mendeley's Readership Statistics are one of these metrics, based on the assumption that there is a linkage between a paper in a collection and the interests of the collection owner. The current study explores the 'altmetric' aspects of the literature of the digital libraries evaluation domain, as it is expressed in two major conferences of the field, namely JCDL and ECDL. Our corpus consists of 224 papers, for which we extract readership data from Mendeley and examine in how many

collections these papers belong to. Our goal is to investigate whether readership statistics can help us to understand where and to whom DL evaluation research has impact. Therefore the data are analyzed statistically to produce indicators of geographical and topical distribution of Mendeley readers as well as to explore and classify their profession. Finally it derived that there is a loose correlation between the number of Google Scholar citations and the number of Mendeley readers.

**Keywords:** altmetrics, digital library evaluation, Mendeley, conference literature

### Introduction

The proliferation of sophisticated tools that improve scholarly communication through advanced social connectivity, collective bibliographic management, personal collection development and integration to research practices forms a new environment [Hull et al., 2008]. Dependent on large-scale infrastructures, that manage big data and

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knowledge, it also involves alternative ways of content provision (repositories), alternative/supplementary versions of the content (articles, datasets) and alternative calculations (downloads, views, shares) of its impact. In this environment, the traditional bibliometric paradigm is strongly questioned as a tool that accurately portrays the impact of research outcomes and therefore new metrics, such as download or view rates, have been proposed.

Among the numerous social networking tools, online reference management systems, such as CiteULike, Zotero and Mendeley, are emerged as the most suitable ones for use by academics and researchers, as they convey familiar concepts, such as the bibliographic information of research outputs. Several other similar systems, such as Academia or ResearchGate, provide social networking capabilities, yet with limited effects in the collective building of bibliographic collections. One of the most challenging questions is how these systems can provide reliable data to be used for research assessment, either as a replacement of current metrics, which are critiqued as obsolete, or as an extension of them.

In previous studies [Tsakonias et al., 2013; Afiontzis et al. 2013] we examined how concepts of digital library evaluation are intertwined in two major conferences of the field, namely JCDL and ECDL. In this study we try to investigate how to estimate the impact of this part of literature with the use of altmetrics. In particular we question:

- Can altmetrics, in the form of the readership statistics of Mendeley, reveal knowledge diffusion patterns? This would help to understand the dynamics of a venue and in particular the dynamics of JCDL and ECDL in terms of in-between differences and similarities.
- Can data from altmetrics in combination with traditional metrics, such as citations, and other indicators help us create quality profiles of conference papers? This would identify the impact of scientific assets at the lower level (paper) with vital information from a higher level (conference).

## Background

### *Altmetrics: alternative and complementary*

Altmetrics are proposed as a new portfolio of metrics, which is based on web interactions and transactions that can be automatically processed and produce indicators for the advancement of a different assessment mentality than the existing one. The 'altmetrics manifesto' [Priem et al., 2010] concentrates its critique on almost all aspects of the traditional scholarly communication system, from the peer-review performance rates (questioning also its role in sustaining a conservative scientific system) and the citation counting and analysis norms to the prominent venue assessment factors, such as a journal's impact factor.

The mechanics of altmetrics are both intriguing and challenging. The calculation of altmetrics is immediate, giving an instant view on the spread and the adoption of ideas of a scholar, while the multi-dimensionality they provide can address different notions of acceptance and impact. On the other hand, the current toolkit needs a lot of effort to be truly functional and commonly acceptable. Some metrics, such as a Facebook 'Like', are repeatable, while other actions, like monitoring in Twitter, need careful planning, e.g. a setup for hashtag mentions. Eventually this leaves margins for controversy on the reliability of the processes. Despite this controversy, newly established services, like altmetric.com have been inaugurated aiming at systematically calculating the attention a paper attracts based on persistent identifiers, like DOI or PubMed ID. According to its inventors "...we try to sum up the online attention surrounding a journal article by automatically counting all the relevant mentions from a set of online sources (covering mainstream news outlets, social media and more)." [Lie & Audie, 2013].

While the term 'alternative' suggests a contradiction with the existing system of calculation and assessment, one of the most interesting topics is the relation of altmetrics with citations. Many researchers have focused on the investigation of relations between citations (traditional) and other web-based metrics. In the study of Thelwall et al. [2013] it was found that "... six of the eleven altmetrics (tweets, Facebook wall posts, research highlights, blog mentions, mainstream media mentions and forum posts) associate with citation counts". The authors further elaborated that "... the coverage of all of the altmetrics, except possibly Twitter, is low (below 20% in all cases and possibly substantially below 20%) and so these altmetrics may only be useful to identify the occasional exceptional or above average article rather than as universal sources of evidence". A study by Bar-Ilan et al. [2012], which focused on the visibility of the Leiden STI Conference presenters and used data from Scopus, Mendeley and CiteULike, revealed medium type correlations between the number of Mendeley readers and Scopus citations. As in the case of citations, there exist differences between the various disciplines. In a recent study by Mohammadi and Thelwall [2014] it was found that the existing correlations between citation and readership figures are stronger in the cases of 'hard sciences' than of those of the humanities.

According to Priem et al. [2012] "... citations only reflect *formal acknowledgment* and thus they provide only a partial picture of the science system" (emphasis on the original). This 'formality' supersedes the concept of what the use of a citation might mean, and extends to the prominent use of traditional publication venues, such as journals. Despite their recent efforts in covering conference literature, the well-known databases hardly cover events that can be considered as primary means of expression for vivid scientific communities. Conferences are often hard to index due to the

differences in periodicity, the unavailability of a commonly agreed quality system, and the superabundance of events. Therefore altmetrics can be indeed one tool to address the challenges posed by the venue types.

### *Conferences as publication venues*

Nowadays the model of scientific publishing seems to be in transition. A journal article does not consist the ‘Ithaca’ for the output of scientific research, but one of the numerous available options. Some researchers have a very positive opinion about the proceedings’ role in the scholarly communication ecosystem and they envisage them as a journal paper’s alternative [Goodrum et al., 2001], while others reject the opinion that they host incomplete or works in immature stages [Drott, 1995]. Their dynamic is based on the notion that “proceedings are a medium of more recent knowledge than are all types of literature in general” [Liséé et al., 2008], despite phenomena of quick obsolescence. Anderson and Haley [1984] attempted to identify the impact of proceedings in the citations of three major marketing journals during 1975-1982. The number of conference citations was steadily growing, but the overall percentage remained at the levels between 3 to 6%. Today the aforementioned type of scholarly communication seems to be consolidated to higher levels. In fact, approximately 9% of the published papers in the field of Information Science are proceeding papers and their citation impact is considered as high, not only because of their scientific importance, but also by the fact that the amount of references per paper has been increased in recent years [González-Albo & Bordons, 2011]. Journal publications delays make conferences contribution the ideal opportunity for Computer Science researchers to publish their work as they gain more citations, preferring to avoid republishing them as articles [Bar-Ilan, 2010]. This remark is in line with opinion that proceedings “represent the intended end product of research rather than a stepping stone to future journal publications” [Goodrum et al., 2001]. The proceedings citation impact is clearly a domain specific issue, as researchers’ communities in different fields have different behavior [Zhang & Glänzel, 2012; Lisée et al., 2008].

Proceedings remain valuable means of expression of research communities, with strong characteristics of rapid information dissemination. Song, Heo and Kim [2014] employed the Markov Random Field based Topic Clustering technique for topic evolution in bioinformatics using as dataset related conferences from DBLP. Daud et al. [2009] applied Latent Dirichlet Allocation in order to highlight conference topics, temporal topic trends and conference correlations. Wuehrer and Smejkal [2012] analyzed proceeding from the Academy of International Business conferences for the year 2006-2011 in order to examine its topic research interests.

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<sup>2</sup> URL: <https://sci2.cns.iu.edu>

### *Mendeley’s place in the altmetrics quiver*

Mendeley is a reference management system that enables its users to participate in a collective development of a bibliographic database. It is also a social networking activity that involves numerous users around the world that share and contribute records. Despite being organic in its collection development, Mendeley is a quite comprehensive resource of bibliographic data, which currently hosts 420 billion records, while around 500,000 records are added every day. According to Gunn [2013], Mendeley performs periodical diagnostic tests that trace and identify duplicate records; then it processes them to create one canonical record. Based on this record one can calculate its readership data, which apart from the number of readers include (a) the countries of the readers, (b) their professional or academic status and (c) their discipline. Apparently these readership statistics are based on the assumption that there is a linkage of interest between a paper in a collection and the collection owner. This interest might be translated to the use, adoption or rejection of notions and positions in a paper, but certainly it is an indication of interest and potential usefulness of the paper. Moreover the interest is based on the profile information of the Mendeley users. Since not all members have complete profiles, these data might be impartial. Furthermore the shortlist of three entries in each of the Mendeley Readership categories limits its statistical representation.

Despite these limitations we chose Mendeley, because in comparison to other well-known and established databases, such as Web of Science or Scopus, it holds records from many conference events, some of which are covered way back in time. Therefore it stands as a promising option that can provide access to altmetrics data and help us avoid partial sampling. Mendeley’s coverage, especially in cases of very specific venues, has proven to be very broad. Bar-Ilan [2012] states that “The coverage of Mendeley is extremely impressive, especially since the records are not created through systematic indexing as in the other databases, but by the users” and that in the case of JASIST “Mendeley covers 97.2% of the JASIST articles published between 2001 and 2011”.

### **Research Setting**

Our corpus comprises 224 papers from the JCDL and ECDL conferences covering the period from 2001 to 2011 and which have been identified by a well-established procedure as papers strongly related to the digital library evaluation domain [Alfiontzi et al. 2013]. Readership data were extracted from Mendeley and were examined to find in how many collections these papers belong to. Furthermore Google Scholar citations were retrieved for each paper (information valid as of January 15, 2014). We processed our data in Sci2,<sup>2</sup> a tool for network analysis, and Gephi,<sup>3</sup> a

<sup>3</sup> URL: <http://gephi.org>

network visualization platform, in order to create maps of the distribution of readers around the globe, while IBM SPSS Statistics<sup>4</sup> was the main statistics processing tool.

For each conference we built a directed network between the different countries in order to explore the altmetrics-powered knowledge diffusion patterns in the domain of digital library evaluation. A network is defined as  $G=(V, E)$ , where  $V$  is the set of nodes and  $E$  the set of edges. The nodes denote either the readers', or the paper's country. The country of a paper is the country of the majority of the authors; if the countries of the authors of a paper are uniformly distributed, then the country of the paper is the country of the first author. An edge  $(v_{ai}, v_{bi})$  denotes the inclusion of a paper  $b$  in the collection of a Mendeley reader  $a$ . Hence  $v_{ai}$  denotes the reader's country, while  $v_{bi}$  denotes the paper's country.

## Results

Figures 1 and 2 provide a geospatial network that reflects the geographical distribution of Mendeley readers.<sup>5</sup> Each node has two properties: (i) the size of the node denotes the number of readers of the papers in each country (reader's country) (ii) the color density depicts the contributions of each country in the corpus (papers' countries; more papers from a country results to more intense coloring). An edge in the network denotes that in the collections of the readers of a country there exist papers produced by other countries. The thickness of the edge denotes the number of readers from one country that read papers produced by other countries, while the color denotes its direction as it is colored by the target node.

Figure 1 presents a proportional symbol map of the JCDL papers. The corresponding network consists of 47 nodes and 133 edges, with an average weighted degree -the average weight of the edges per node- of 6.213 and a network density degree -the ratio of existing edges to the number of potential edges of the graph- of 0.062. USA, UK and Germany are the countries with the most popular papers of our corpus among Mendeley readers, followed by Singapore and New Zealand. USA and UK are also the ones with the most contributions in our corpus, with US being -expectedly- the most dominant one. The contributions in terms of papers are followed by Canada and New Zealand.

In terms of 'consuming' countries, Greece and Poland are the ones that have more readers of US papers, while Greece has many readers with papers of UK origin. It is also noteworthy that UK readership of German papers is strong. Germany, Greece, USA and UK present self-loop cases, with Germany being the stronger case and UK the weaker one. The aforementioned countries are the most active ones in consuming papers from the producing ones.

Figure 2 presents the ECDL network which is structured by 47 nodes and 109 edges and has an average weighted degree of 5.046 and network density equal to 0.05. Papers from the US and UK have high readership rates, followed by Netherlands, New Zealand and Germany. From the contributing countries, US, UK and Germany are the ones with the highest rates. Other countries that contribute to the digital library evaluation research in ECDL are Singapore, Greece and Netherlands.

Similarly to the case of JCDL, Greek and Polish readers have many US and UK papers in their collections. This time the direction between Germany and UK is inverse, with German readers having several UK papers in their collections. In the case of ECDL it is worth mentioning that there are no self-looping nodes.

Table 1. Top 5 disciplines

ECDL		JCDL	
Computer Science	124	98	Computer Science
Social Sciences	27	29	Social Sciences
Humanities	12	16	Education
Engineering	11	10	Psychology
Education	10	8	Design

Table 1 presents the first five disciplines of the Mendeley readers. The high rates of Computer Science seem reasonable, since both conferences have a strong connection with this scientific area. These rates are followed by Social Sciences for both conferences and Humanities and Education for ECDL and JCDL respectively. This fact possibly occurs due to the lack of an Information Science entry in the Mendeley categorization schema and as a result many readers have selected Social Sciences as their representative discipline. Education and Humanities are also strongly connected topics to digital libraries as fields of application of these technologies.

<sup>4</sup> <http://www-01.ibm.com/software/analytics/spss/products/statistics/>

<sup>5</sup> Higher resolution images and corpus papers are available at <http://gtsak.info/blog/gallery/lida-addendum/>.



Figure 1: A global view of the JCDL readership network

Table 2 lists the ranking of the first five professional statuses of the Mendeley readers. PhD students and Practitioners (aggregating also the Librarian class) are in the first two positions. It is interesting to note that Mendeley does not attract too many Faculty members as well as Students, since their rates are low.



Figure 2: A global view of the ECDL readership network

Table 2. Top 5 statuses

ECDL		JCDL	
Practitioner	97	74	PhD Student
PhD Student	84	66	Practitioner
Researcher	53	64	MSc Student
MSc Student	48	27	Faculty
Faculty	26	25	Researcher

Figure 3 shows the relation of Google Scholar citations and Mendeley's readers from both conferences. Papers from both conferences are scattered based on these two metrics and the size of their points denotes the 'age' of publication, where small sized points depicting older papers. The pattern of the relation of the two metrics, even in this small scale, is similar to other studies [Gunn, 2013]. Statistical analysis confirms that there is a significant type positive correlation between the number of GS citations and the number of Mendeley readers. Spearman  $\rho$  was found to be 0.620 ( $p > .001$ , 2-tail) for both conferences and the corresponding coefficient was 0.629 for JCDL and 0.493 for ECDL (both  $p > .001$ , 2-tail).

## Discussion

### *A tale of two conferences*

Our research shows the spatial dissemination of the digital library evaluation knowledge. We used a small sample of

papers, which is carefully selected, and as such it cannot claim representation of general patterns. The fact that we exploit a well defined corpus by two community events, which can be considered as prime means of communication, is also a critical parameter for its strong disciplinary character. These two differentiate our study over other similar studies like Thelwall and Maflahi's [in press], who compared the proportion of readership rates within the countries of origin. Despite having other methodological differences, i.e. in sample selection and adopted approach (statistical versus network analysis), the findings are somehow convergent, especially in the relevant category of Information and Library Science. Thelwall and Maflahi's findings demonstrate strong readership linkages between UK to US, Canada to US and UK to Germany. Their study suggests that in-country readership is quite strong in Mendeley, something that in our study applies only the case of the self looping phenomena of US, UK, Greece and Germany in JCDL.

From another view, our results reflect the impact of research in digital library evaluation. Through network analysis measures, we conclude that US, UK and the Netherlands have - in both conferences - strong research teams that their works attract the interest of the community. Regarding ECDL the above mentioned countries are closely followed by Germany, New Zealand and Singapore, which have also many readers, while as far as JCDL concerns these three countries are joined by Italy. The Eigenfactor Centrality, a measure to identify how strongly connected are some countries to other strongly connected ones, shows that in JCDL US, New Zealand and UK are the best linked ones, while in ECDL the list includes also Italy and Germany.

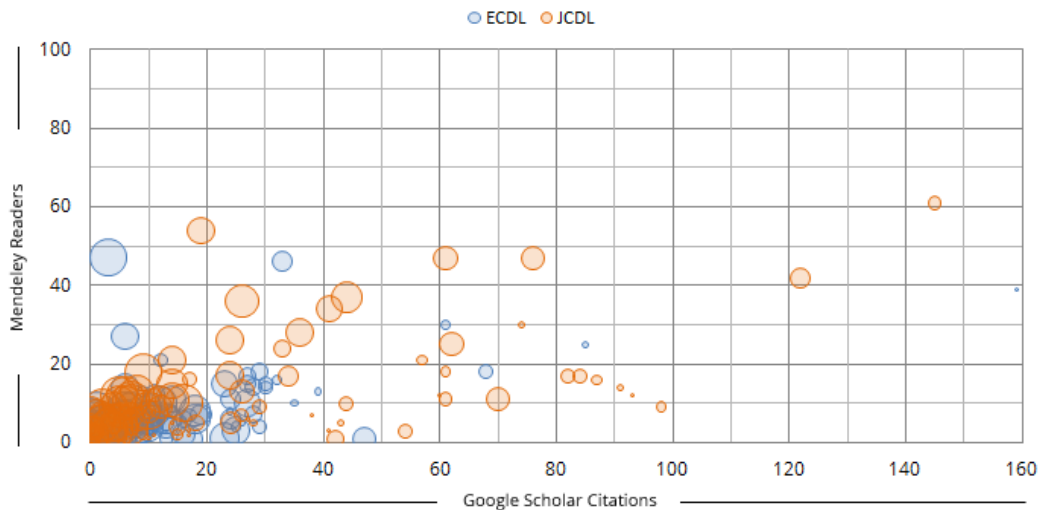


Figure 3: Scatterplot of Mendeley Readership statistics and GS citations





$\frac{y}{(1-a) \times r}$ . We define the impact ( $i$ ) of a paper as the harmonic mean of the two quality rates:

$$i = 2 \times \frac{q_r \times q_c}{(q_r + q_c)}$$

Table 3 presents the data for the two papers and the resulting indicator. The data are all quantifiable and machine traceable to be included in a potentially automated calculation process, which can be further aggregated for the entire conference. In a potential exercise one could also use, as an additional normalization factor, a numerical quality indicator for the conference. However the lack of a transparent and commonly agreed ranking system diminishes such opportunity.

Table 3. An example of an altmetrics powered impact indicator for conference papers.

	Conf.	Cites	Reads	Year	Acpt. Rate	Indic.
a	ECDL	61	30	2003	29%	0.34
b	JCDL	61	47	2007	36%	0.18

## Conclusions

Altmetrics is a promising area of research that is subject not only to its own aspects of development, but also to the dependencies to other existing systems. Our study showed that when combined with traditional metrics, such as citations, they can complement the view we have on the impact of a scientific work. Indeed Costas et al. [2014] mention that “they could actually represent an interesting relevant complement to citations, particularly in order to inform other types of impact (e.g. societal or cultural impact) and especially in those fields where they have a higher presence, mostly the humanities and social sciences.” The correlation between citations and readers was found to be important, either in aggregating, or in individual mode, showing that the Mendeley readership score can be a predictor of use of scholar works.

This study explored the use of altmetrics indicators -in our case of Mendeley Readership data- as a tool to understand the dynamics of knowledge diffusion in the domain of digital library evaluation. We managed to portray where and to whom the knowledge of the digital library evaluation field is spread and we reaffirmed the evidence found in other studies that altmetrics scores are somehow correlated to traditional metrics, such as citations. Despite being limited by its size and nature, the methodology we applied can be implemented in larger corpora of papers and it can extend from the lower

level, that of a paper, to higher level in order to study the impact of conferences in the scholar community.

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## Curriculum Vitae

Leonidas Papachristopoulos is a PhD student in at the Department of Archives, Library Science and Museology. He received his MSc in Library management with a special focus on new technologies from the same University working on the evaluation of digital libraries services His doctoral work is focused on the exploration of methodological patterns within Digital Libraries Evaluation field using various approaches like network analysis, altmetrics and topic modeling. Among his research interests are ontology management and evolution, digital library evaluation and methodology assessment in digital libraries. Currently he is working at Digital Curation Unit as an external researcher.

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Christos Papatheodorou is an Associate Professor and Chairman of the Department of Archives, Library Science and Museology, Ionian University, Corfu, Greece. His research interests include digital libraries evaluation, metadata interoperability, digital curation and personalization. He is the Chair of the Steering Committee of the International Conference on Theory and Practice of Digital Libraries and a fellow researcher in the Digital Curation Unit, Institute for the Management of Information Systems, "Athena" Research Centre, Athens, Greece. He has participated as evaluator and researcher in several projects, and as chair or programme committee member in international conferences.