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Exploring paths for the normalization of altmetrics: applying the Characteristic Scores and Scales

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Introduction

The probability of a paper being mentioned on Twitter, Facebook, in a blog post or the news or being saved to Mendeley depends on its discipline. For example, 31.7% of recent biomedical and health sciences journal articles get tweeted, while the Twitter coverage in mathematics and computer science is as low as 7.5% (Haustein, Costas, & Larivière, 2015). The coverage, density and distribution of various altmetrics differ substantially across disciplines (Costas, Zahedi, & Wouters, 2015). The need to take these field differences into account in the calculation of altmetric indicators represents a critical item in the agenda of altmetric research (Wouters & Costas, 2012). Recently there have been some suggestions of normalization approaches for Mendeley similar to the normalization of citations (Haunschild & Bornmann, 2016) as well as for Twitter (Bornmann & Haunschild, 2016). However, a broader discussion about the potential problems that the distribution of metrics across fields can pose for the extensive normalization of altmetric indicators is still missing. This paper addresses these issues and specifically answers the following research questions:

1) How are Mendeley readership counts, tweets and blog mentions distributed per paper across fields?

2) What are the implications of the specific distributions for the development of field-normalized indicators?

Methodology

We apply the Characteristic Scores and Scales method (hereafter CSS) suggested by Schubert, Glänzel and Braun (1987) to analyze citation distributions (see also Crespo, Li, & Ruiz-castillo, 2012), for the analysis of selected altmetrics, that is Mendeley readership counts, tweets and blog mentions. As a comparison to how these altmetric events differ from citing patterns, CSS is also applied to citations. The CSS method analyzes a distribution by partitioning publications in a given field by their frequency of citations or altmetrics. Papers are first divided by being below and equal or above the mean (*m1*). For those papers above *m1,* a second mean (*m2*) is calculated to further subdivide them into two parts. Thus, the publications are partitioned into three groups:

- Type1: publications with a score $< m1$
- Type2: publications with a score $\geq m1$ and $< m2$
- Type3: publications with a score $\geq m2$

Based on this classification it is possible to determine the percentage of publications as well as of the frequency of citations or altmetrics that belong to each type.

Web of Science publications from 2012 with a DOI have been considered, as they represent a good compromise between altmetrics and citations. The NOWT CWTS classification with 35 disciplines has been used to determine the disciplinary lanscape. As papers can be assigned to more than one of the 35 fields, the final dataset consisted of almost 1.8 million publication-discipline combinations. Mendeley readership counts were obtained through the Mendeley API, while tweets and blog mentions were obtained from Altmetric.com, both via DOI.

Results

Table 1 presents the main results of the distribution of publications by CSS type. For each metric we present the average values ('Avg') of the 35 disciplines, their Standard deviation ('stdev') and their coefficient of variation ('CV'). The average *m1* and *m2* values are also presented.

Table 1. Summary values of the distributions of publications by different metrics across 35 disciplines by CSS typologies

Metric	**Indicator**	**Percentage of publications**			**Percentage of metrics**			**Mean of metrics**	
		Type 1	**Type 2**	**Type 3**	**Type 1**	**Type 2**	**Type 3**	***m1***	***m2***
Citations	Avg	69.6%	21.3%	9.1%	21.5%	33.9%	44.7%	7.41	18.44
	Stdev	3.41	2.39	1.37	6.84	1.31	6.30	4.39	11.31
	CV	4.90	11.24	15.10	31.85	3.86	14.10	0.59	0.61
Mendeley	Avg	69.4%	21.5%	9.0%	24.4%	33.2%	42.3%	16.73	40.78
	Stdev	3.37	1.84	1.65	4.45	1.46	4.04	8.67	21.96
	CV	4.86	8.56	18.31	18.22	4.39	9.54	0.52	0.54
Twitter	Avg	86.5%	10.4%	3.0%	4.8%	35.1%	60.1%	0.93	5.39
	Stdev	5.81	4.54	1.47	6.01	6.05	5.87	1.09	5.03
	CV	6.71	43.47	48.46	124.31	17.24	9.77	1.17	0.93
Blog mentions	Avg	97.7%	1.7%	0.6%	0.0%	50.8%	49.2%	0.04	1.56
	Stdev	2.21	1.55	0.69	0.00	10.62	10.62	0.06	0.31
	CV	2.26	91.49	109.61	#DIV/0!	20.92	21.59	1.38	0.20

According to Table 1, on average, 70% of all publications lie below *m1* in their number of citations, accounting for on average 21% of the citations in their fields. 21% are between *m1* and *m2*, accounting for 34% of all the citations, while just 9% of all the publications have an impact higher than *m2* and gather about 45% of all citations. For Mendeley, we observe remarkably similar patterns as for citations, with a pattern of on average 69% publication below *m1* (with 24% of all the readership), 22% above *m1* and below *m2* (accounting for 33% of all the readership) and 9% of the publications with readership above *m2* (accounting for 42% of the readership). In the case of Twitter, the pattern is different due to its lower coverage. 87% of all the publications have a Twitter impact below *m1*, accounting for about 5% of all the Twitter mentions and 10% of publications accumulate 35% of tweets and as few as 3% receive 60% of tweets. Blog mentions exhibit an even more skewed pattern, with as few as 1% of papers accumulating almost half of all blog mentions. Figures 1 to 4 graphically illustrate the similarity between the distributions per fields, allowing to identify fields and metrics that present the most deviant patterns.

Figure 1. CSS distribution graphs for Citations (the dotted lines represent the average of all fields)

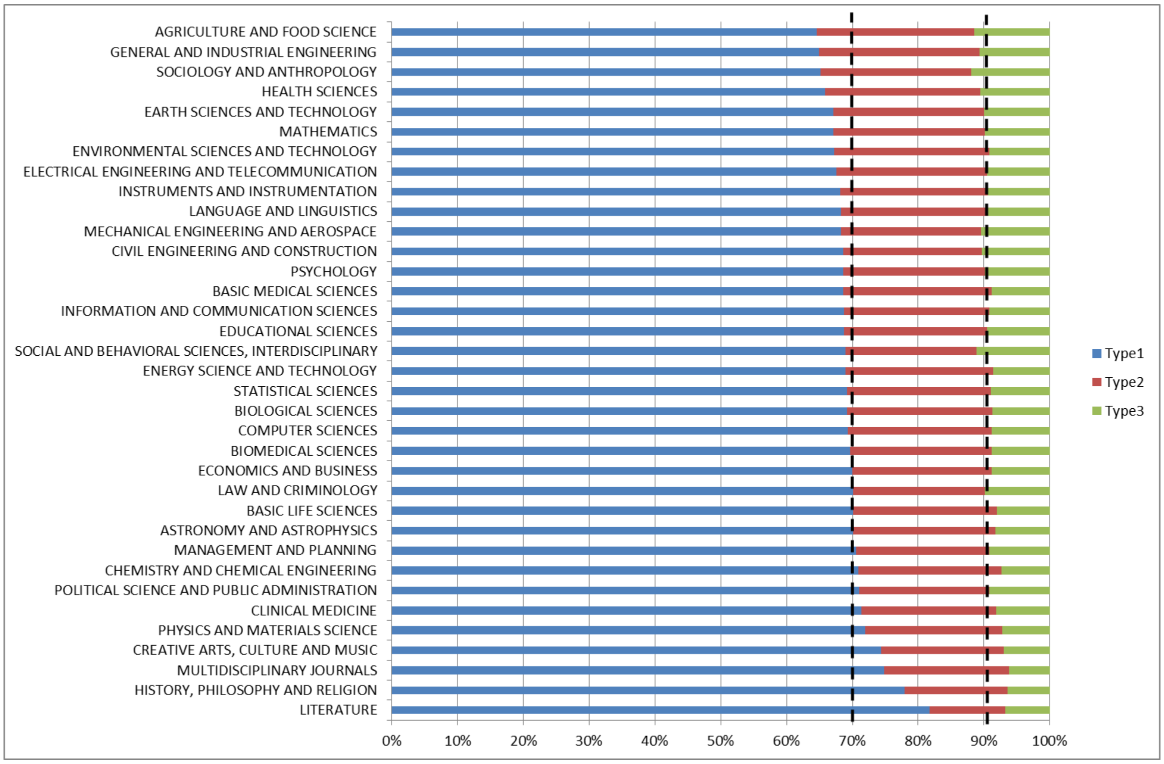


Figure 2. CSS distribution graph for Mendeley (the dotted lines represent the average of all fields)

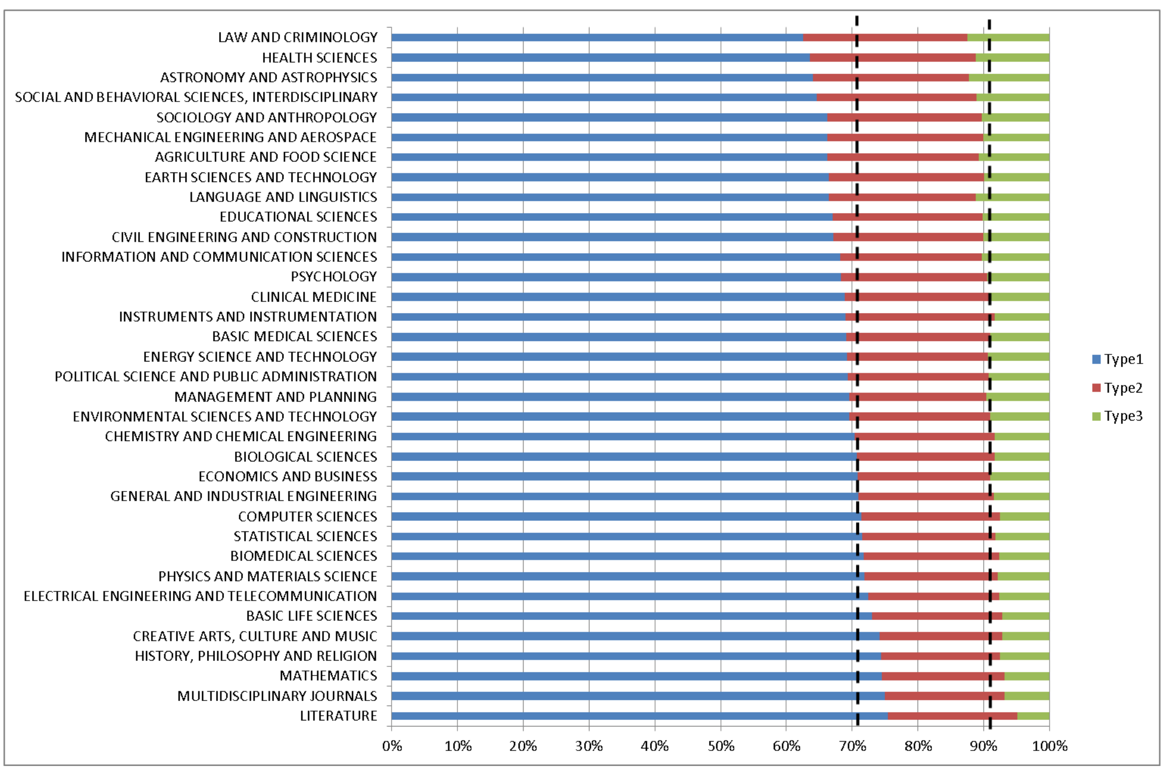


Figure 3. CSS distribution graph for Twitter (the dotted lines represent the average of all fields)

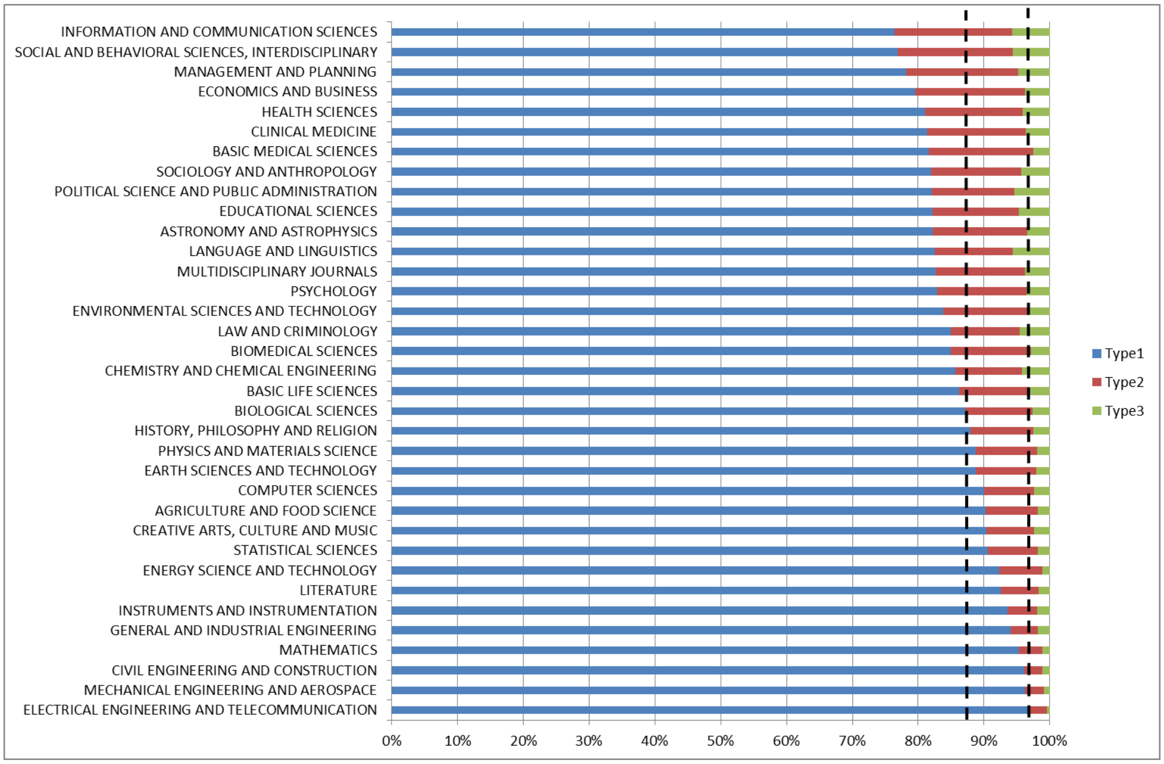
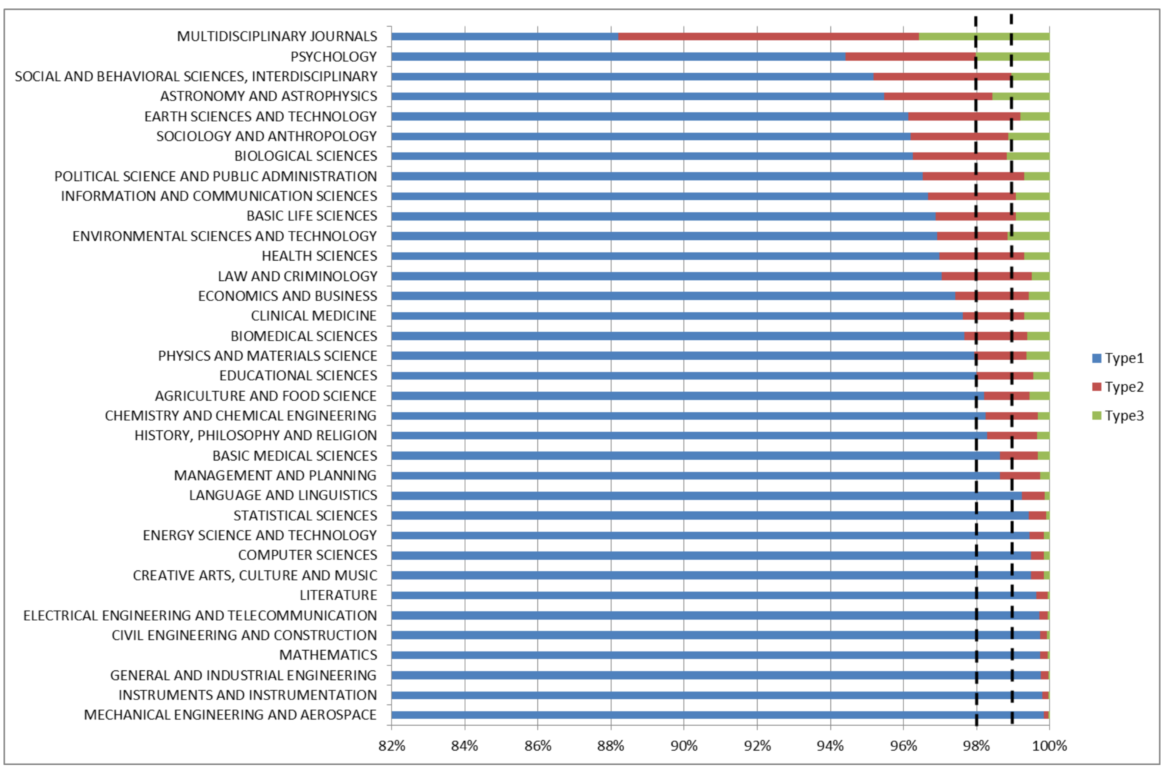


Figure 4. CSS distribution graph for blog mentions (the dotted lines represent the average of all fields)



Figures 1 and 2 show a remarkably similar pattern in the distribution of citations and Mendeley readership counts per publications by fields. On the other hand, Figures 3 and 4 show how the distribution of number of tweets and blogs per CSS class differ across fields. This is emphasized by the higher coefficients of variation for these two indicators (Table 1).

Conclusions and further research

This study demonstrates the different distribution patterns of citations and altmetrics and particularly the extremely skewed distribution of Twitter and blog mentions. This is largely caused by a large share of publications without any mentions on these platforms.

From a normalization point of view it can be suggested that the remarkable similarity between Mendeley readership counts with citation distributions support the possibility of developing normalization approaches similar to those applied for citation analysis. For Twitter and blog mentions, however, the unequal distributions across fields supports the idea that normalization is more problematic and the traditional normalization methods in bibliometrics (as for citations) is not suitable for these metrics. More research is necessary to develop suitable methods of normalization for extremely skewed distributions.

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References

Bornmann, L., & Haunschild, R. (2016). How to normalize Twitter counts ? A first attempt based on journals in the Twitter Index. *Scientometrics*, 1–29. http://doi.org/10.1007/s11192-016-1893-6

Costas, R., Zahedi, Z., & Wouters, P. (2015). The tematic orientation of publications mentioned on social media: large-scale disciplinary comparison of social media metrics with citatios. *Aslib Journal of Information Management*, *67*(3), 260–288. http://doi.org/10.1108/AJIM-12-2014-0173

Crespo, J. A., Li, Y., & Ruiz-castillo, J. (2012). Differences in citation impact across scientific fields, (December), 1–32.

Haunschild, R., & Bornmann, L. (2016). Normalization of Mendeley reader counts for impact assessment. *Journal of Informetrics*, *10*(1), 62–73. http://doi.org/10.1016/j.joi.2015.11.003

Haustein, S., Costas, R., & Larivière, V. (2015). Characterizing social media metrics of scholarly papers: The effect of document properties and collaboration patterns. *PLoS ONE*, *10*(3), e0120495. http://doi.org/10.1371/journal.pone.0120495

Ruiz-Castillo, J., & Costas, R. (2014). The skewness of scientific productivity. *Journal of Informetrics*, *8*(4), 917–934. http://doi.org/10.1016/j.joi.2014.09.006

Schubert, A., Glänzel, W., & Braun, T. (1987). Subject field characteristic citation scores and scales for assessing research performance. *Scientometrics*, *12*(5), 267–292.

Wouters, P., & Costas, R. (2012). *Users , narcissism and control – tracking the impact of scholarly publications in the 21 st century*. (M. Van Berchum & K. Russell, Eds.), *Image Rochester NY*. SURFfoundation.