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Measuring scientific performance without ties: is scientific leadership the solution?

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For many decisions in science, evaluators have to select, assess, and rank authors based on their scientific achievements. However, the most diffused scientific performance bibliometric metric – the h index – produces many ties, precluding its use to define a full ranking of the authors. In turn, recently, Jorge Hirsch[1] proposes the h_α index (which measures the number of papers of the h core in which the author was the scientific leader)and the associated $r_\alpha$index(percentage of papers belonging to the h core in which the author was leader)to capture the concept of scientific leadership. We suggest using this last measure to break the ties of the h index. The method is extremely simple and provides a complete solution to this critical problem of the h index. To that end, we develop a two steps procedure, which is able to produce a more granulated ranking of the authors.

Key words: scientific performance,ranking, scientific leadership, $h$index.

Introduction

Many decisions in science with strong impact both at personal and institutional levelsrequire to select and rank authors. Bibliometric analysis is increasingly important to support such decisions, including hiring, promotions, awards, and research funds allocation[2,3,4,5]. However, some of the most diffused bibliometric metrics of scientific performance do not allow a full ranking of the authors. This is the case of the most well-known metric of author-level scientific performance: the h index introduced by Jorge Hirsch[6]. While in many cases this is not a problem since the information provided by the h index is enough as a preliminary step and can be complemented through qualitative evaluation by peer review[7], in other situations a full ranking of the authors is needed. Who should be hired among a group of applicants? Who should be promoted? Who deserves to win a given award? To answer this kind of questions we need to select one or a small group of individuals and rank them according to a given criterion, defined by the evaluators and known by all.

The main goal of the present study is to introduce a simple procedure to break the ties generated by the $h$index. We argue that the concept of scientific leadership, evaluatingwhether the authors were (or not) the scientific leaders of their papers, can be useful to reach that objective. Recently, Jorge Hirsch[1]introduces two measures to capture (at the paper level) this concept: the h_α index (which measures the number of papers of the h core in which the author was the leader)and the r_α index ($r_\alpha = \frac{h_\alpha}{h}$). We propose to use this last index to differentiate authors with the same score in terms of the h index. With this method, only authors with exactly the same levels of scientific performance and scientific leadership remain tied.

The remainder of the paper is structured as follows. In Section 2 we discuss the problem of the ties associated to the h index and present the measures of scientific leadership suggested by Jorge Hirsch[1]. In Section 3 we develop our approach to solve the problem of the ties. Section 4 concludes.

Scientific performance and scientific leadership

The h index is the most diffused author-level bibliometric measure[8]. An author has an h index equal to h when he/she has h papers with at least h citations each. This index combines productivity (number of papers) and impact (number of citations) in one single measure. The simplicity of the index in terms of calculation and interpretation is probably its most important advantageand the main reason for its popularity[9].

The several shortcomings of the measure are well known[5,10,11]. Since its proposal, many variants were introduced to correct some of them[12,13,14]. However, one of the most important limitations of the index is also one of the less studied: its low granularity, i.e, the fact that many authors obtain the same h index, therefore precluding their full ranking. Let us consider a simple example. Webometrics[15] compiles the list of authors with $h \geq 100$(highly cited researchers) based on their Google Scholar Citations public profiles. With information for April 2019, a maximum value of $h = 280$ is identified and a total of 2929 authors listed. These authors are classified with 132 different values of h, making immediately clear the problem of the ties, even for this group of highly cited researchers. Table 1 summarizes the distribution of the authors according to their h index.

The problem of the ties is, of course, more pronounced for lower values of the h index. Considering for example that for h indexes as high as $100 \leq h \leq 103$ there are more than 100 authors tied at each of these values, it is easy to verify that for lower values we will have thousands of authors

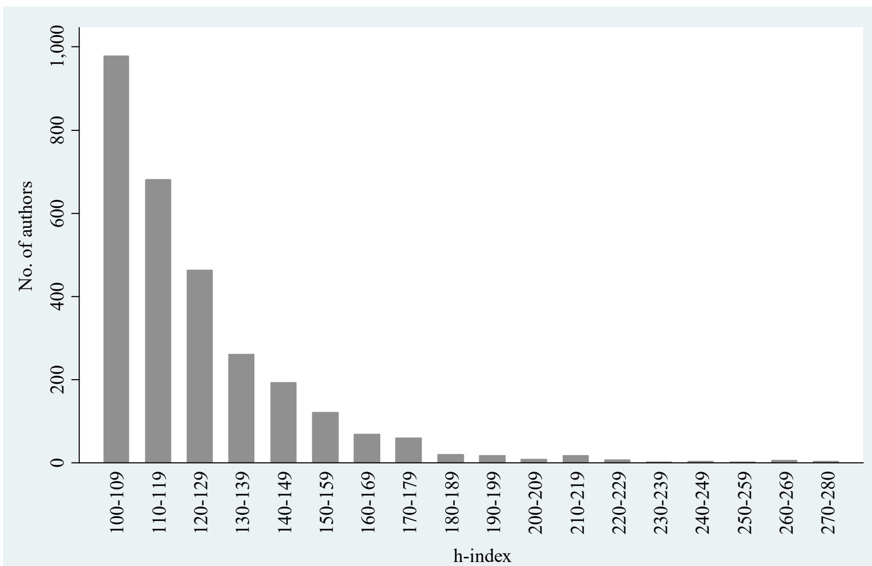

Fig. 1 — Distribution of the h-index for highly cited researchers

Table 1 — Bibliometric results for a sample of 17 physicists

Author	h	h_α	r_α	Number of papers	$h(l)$	Ranking using h	Ranking using $h(l)$
A	25	8	0.320	59	25.320	17	17
B	27	19	0.704	83	27.704	16	16
C	32	8	0.250	127	32.250	15	15
D	34	5	0.147	93	34.147	13	14
E	34	22	0.647	133	34.647	13	13
F	36	16	0.444	104	36.444	11	11
G	36	7	0.194	146	36.194	11	12
H	37	18	0.486	80	37.486	10	10
I	39	4	0.103	130	39.103	8	9
J	39	16	0.410	119	39.410	8	8
K	40	2	0.050	273	40.050	7	7
L	43	12	0.279	104	43.279	6	6
M	47	30	0.638	186	47.638	5	5
N	50	27	0.540	268	50.540	4	4
AA	55	51	0.927	116	55.927	3	3
O	60	1	0.017	160	60.017	1	2
P	60	14	0.233	224	60.233	1	1

obtaining the same score. Summing up, the problem of ties is critical and must be addressed in order to produce a full ranking of authors.

The h index was proposed 15 years ago by Jorge Hirsch[6]. Recently, Jorge Hirsch[1] discuss the concept of scientific leadership and introduce two indexes for its measurement: the $h_\alpha$index and the r_α index. The first one captures the number of the papers of the h core in which the author was the leader. Therefore,$h_\alpha \leq h$. In turn, $r_\alpha = \frac{h_\alpha}{h}$ expresses the percentage of papers belonging to the h core in which the author was leader. By definition, $0 \leq r_\alpha \leq 1$.

The $h(l)$ index

The key question discussed in this paper is the fact that the h index generates many ties, precluding its application to obtain a full ranking of the authors. Aiming to solve this problem, the strategy we adopt is to complement the h index with additional information. Since the h index corresponds to the number of papers of the author with at least h citations each, the differentiation between authors should come from an element related to the papers that comprise the $h$core. We suggest making use of the concept of scientific leadership, evaluating if the authors participate in those papers as leaders or as regular members (non-leaders) of the team. More specifically, we use the $r_\alpha$index to break the ties obtained in the h index. We do that following an extremely simple procedure in two steps.

[S1]: obtain the ranking of the authors according to a new index –$h(l)$. This index can be calculated as follows:

$$h(l) = h + r_\alpha. \quad \ldots(1)$$

Obviously, $h \leq h(l) \leq h + 1$. When the author was not the scientific leader of any of his/her h-core papers, $h = h(l)$. The upper limit for $h(l)$ is reached when he/she was the scientific leader of all papers that comprise the h-core.

The result for each author is easy to interpret. Let us consider as example the case of an author with $h(l) = 12.25$. This value means that the author has an $h$index of 12 (i.e., has 12 papers with at least 12 citations each) and was the scientific leader in 25% of them (i.e., was scientific leader of 3 papers and non-leader in 9).

[S2]: when there are ties between authors for integer values of $h(l)$, the author with the highest h index is ranked first. For example, an author with $h = 8$ and $r_\alpha = 0$ is ranked above another one with $h = 7$ and $r_\alpha = 1$. All the remaining ties correspond to cases of perfect equality in terms of scientific performance and scientific leadership, being the tie the adequate result.

In order to illustrate our method, we consider the evidence provided by Hirsch (2019a). He presents the h index and his measures of scientific leadership for 17 physicists. Table 1shows these results and the $h(l)$ index.

Note: The data is drawn from Hirsch (2019a). Own calculations were carried out afterwards to compute the new measure introduced in this paper.

Some interesting conclusions emerge from Table 1. First, even with a limited number of authors (17) and a minimum h index of 25, there are several ties (two authors with $h = 34$,two with $h = 36$, two with$h = 39$, and two with $h = 60$), which, once again, demonstrates that the h index is not able to produce a full rank of the authors. Second, as mentioned by Hirsch (2019a), similar levels of performance coexist with very different levels of scientific leadership. The case of the two authors with the highest h index perfectly illustrates this aspect. While the level of scientific performance, evaluated through the h index, is the same, the level of scientific leadership is distinct. Author O was the scientific leader of only one of his/her $60h$core papers ($r_\alpha = 0.017$) while P was the scientific leader of 14 ($r_\alpha = 0.233$). Third, the application of the $h(l)$ index allows to break all the ties identified, making possible to build a complete ranking of the 17 authors analysed.

Final remarks

In this study, we introduce a new bibliometric index. It captures the level of scientific performance of a given author adjusted by his/her level of scientific leadership. To that end, we take into account, on the one hand, the traditional h index and, on the other hand, the concept of scientific leadership and the measures introduced by Jorge Hirsch[1] to its evaluation. With this procedure, we solve key shortcomings of both measures.

Concerning the h index, the method proposed in this study allows to build a complete ranking of the authors, eliminating all the ties, with the obvious exception of those that strictly correspond to cases of perfect equality in terms of scientific performance and scientific leadership. This is a major advantage since this low granularity problem represents one of the most critical (and less studied) shortcomings of the *h* index.

It is also interesting to emphasize that our approach solves the main criticism to the metrics of scientific leadership proposed by Jorge Hirsch[1], namely the fact that they reinforce the Mathew effect in science[16,17] (on this issue, see also[18]). The basic idea corresponds to the fact that a “more reputable scientist receives more credit than the less reputable scientist for a scientific contribution, although the contribution is of the same scientific quality. Thus, the credit is not attributed fairly on the basis of the performed contribution, but (unfairly) on the basis of previous contributions”[16]. However, in our approach ther_α index is used to break the ties between authors with the same *h* index, this way avoiding the accentuation of the phenomenon.

A final remark should emphasize that the approach introduced here retains the most appealing characteristic of the *h* index: its simplicity. This is a non-neglecting aspect since, as vastly demonstrated along the last years, the introduction of more complex variants do not reached enough acceptance to replace the *h* index as the standard measure of scientific performance.

References

1 Hirsch J, hα: An index to quantify an individual’s scientific leadership, *Scientometrics*, 118 (2019) 673-686.
2 Gao C, Wang Z, Li X, Zhang Z, and Zeng W, PR-index:Using the h-index and Pagerankfor Determining True Impact, *PloS One*, 11 (2016) e0161755.
3 Hamermesh D, Citations in economics: measurement, uses, and impacts, *Journal of Economic Literature*, 56: (2018) 115-156.
4 Osório A, On the Impossibility of a perfect counting method to allocate the credits of multi-authored publications, *Scientometrics*, 116:(2018) 2161-2173.
5 Schreiber M, A Skeptical View on the Hirsch Index and its Predictive Power, *Physica Scripta,* 93 (2018) 102501.
6 Hirsch J, An index to Quantify an Individual's Scientific Research Output, *Proceedings of the National Academy of Sciences*, 102 (2005) 16569-16572.
7 Hammarfelt B and Rushforth A, Indicators as Judgment Devices: An Empirical Study of Citizen Bibliometrics in Research Evaluation, *Research Evaluation*, 26 (2017), 169-180.
8 BerkerY, Golden-ratio as a Substitute to Geometric and Harmonic Counting to Determine Multi-author Publication Credit, *Scientometrics*, 114(2018) 839-857.
9 Alonso S, Cabrerizo F, Herrera-Viedmac E, and Herrera F, h-index: A Review Focused in its Variants, Computation and Standardization for Different Scientific Fields, *Journal of Informetrics*, 3(2009) 273-289.
10 Egghe L, The Hirsch Index and Related Impact Measures,*Annual Review of Information Science and Technology*, 44(2010) 65-114.
11 Waltman L and Nees J,The Inconsistency of the h-index, *Journal of the American Society for Information Science and Technology*, 63(2012) 406–415.
12 WildgaardL, SchneiderJ and LarsenB, A Review of the Characteristics of 108 Author-level Bibliometric Indicators, *Scientometrics*, 101(2014)125-158.
13 Todeschini R and Baccini A,*Handbook of Bibliometric Indicators: Quantitative Tools For Studying and Evaluating Research*(Weinheim: John Wiley & Sons), 2016.
14 Schubert A and Schubert G, All Along the h-index-related Literature: A Guided Tour. In W Glänzel, H Moed, U Schmoch, and M Thelwall (Eds.),*Springer Handbook of Science and Technology Indicators* (Springer), 2019.
15 Webometrics, 2019.Available: http://www.webometrics.info/en/hlargerthan100.
16 BornmannL, GanserC, TeklesA and LeydesdorffL, Does the Hα index Reinforce the Matthew Effect in Science? Agent-based Simulations using Stata and R’, 2019. Available:https://arxiv.org/abs/1905.11052.
17 Leydesdorff L, Bornmann L and Opthof T, hα: The Scientist as Chimpanzee or Bonobo, *Scientometrics*, 118 (2019) 1163–1166.
18 Hirsch J, Response to Comment ‘hα: The Scientist as Chimpanzee or Bonobo’ by Leydesdorff, Bornmann and Opthof’, *Scientometrics*, 118 (2019) 1167-1172.