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Original article

Modification of h-index in the context of the author's contribution to writing of the article

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Abstract: The given article displays a modified *h*-index in the context of the author's contribution to writing of cited article. Each author has his/her own counting number in the authors list. These numbers are suggested as a criterion of co-authors' individual contribution to articles. The presented method does not also give the authors any advantages in *h*-index determination with account of their research portfolio. This balances odds of young specialists in improving their scientific grade evaluated in *h*-index. It is evident that the most effective is the article which was written be no more than 6 authors. At more number of co-authors, the *h*-index of only the first three and the last authors has the significant value of the article.

Keywords: *h*-index, citations, ranking, co-authorship, author contributions, multi-authored articles

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Introduction

Scientometric indices, especially total citedness and Hirsch index (*h*-index), have become an object of interest recent years. *h*-index [1] is based on ranking of the author's publications in the descending order of their citation (the most cited article has the rank r=1). The next is an article with the number of citations (h) not less than the value of its rank (r), $h \geq r$; all further articles (with bigger rank) fulfill conditions $h<r$. The rank of that article is value of the author's *h*-index.

There are some arguable points regarding the accuracy of *h*-index calculation: i) self-citation [2, 3], ii) the number of co-authors and their role in writing of an article [4-6].

As for the self-citation, my opinion is that it should not be taken to an account in the author's *h*-index calculation. The given opinion is agreed upon by other authors who consider the author's self-citations as 'noise' or bias for citation analysis [7-9].

The necessity of *h*-index modification with the number of co-authors in articles is still open to question. Various methods of *h*-index correction are suggested in the analysis of multi-authored articles [1, 10-12]. In particular, there is a method based on the number of quotations of a paper should be weighted according to the number of co-authors of this paper, thereby reducing the *h*-index of an author having many co-authors [6]. No less interesting the method which gives an *h*-index measure to a group leader higher than usually accepted [13]. The method let estimate the role of co-authors, as the additional value to an author papers' popularity [13]. However, the present methods in *h*-index calculation do not let take into account an individual contribution to the writing of an article.

When co-authors determine their number in the authors list, they refer to their contribution to the writing of an article. Authorship Criteria are well-known and stated in guidelines [14]. The order of authors in the list is formed by their agreement and with account of their opinion on their own contribution to the article and co-authors' opinion. From there, the authors list is a coherent (with all of the co-authors) contribution criterion of each of the co-authors.

The value of the authors' position in multi author articles is usually perceived as follows. The first author is the one responsible for the whole manuscript. The second and the third authors traditionally are also the key authors in the article. Last author is a group (or department) leader (or head). The other authors' contribution is considered as less in order of importance.

It is evident that the first author is the most cited one especially in multi author articles which are generally cited as, for example, 'Ivanov A., et al.'. The second and the third authors are sometimes mentioned in the same breath with the first one.

Method Description

In this article, there is an alternative method of *h*-index calculation with account of the co-author's counting number in each of cited article. The following parameters are used in a method description:

- r – rank number of the article. All the author's articles are ranked in the descending order of their citedness, as in calculation of a simple *h*-index. The most cited article has the rank r=1, less cited – r=2, etc.
- n – the number of authors of the article.

- h – the number of citations to the article.
- p – conditional point (c.p.) for each article citation with account of the co-author position in the authors list.
- h_p – integral estimation of the citedness of the article with account of its p-index.
- r_p – rank number of the article, according with h_p-index
- h_m – modified h-index with account of the co-author position in the authors list of cited articles.

The base of proposed method is the value estimating of p for each article of the author, which is important to calculate h_m-index. The basic criteria of this method are:

- One citation cannot give the author more than 1 c.p. in h_m-index calculating.
- The sum of the conditional points at each of the co-authors for one article cannot be more than 4 c.p.
- The first and the last authors always get 1 c.p. for the citation of the article (1 c.p. for each of them).
- The second and the third authors get 1 c.p. summarily for the citation of the article (0.5 c.p. for each of them).
- Other authors get 1 c.p. in equal shares, but no more than 0.5 c.p. for a person.

Table 1 displays the scheme of the p-index estimating with account of the co-author position in the authors list.

Order of calculating:

1) The citedness (h) of each of the author's articles is determined.
2) The p-index of each article is determined with account of the co-author position in the authors list (*Table* 1).
3) Integral estimation of the citedness (h_p) of the article with account of its p-index is calculated: $h_p = p * h$.
4) All of the author's articles are ranked in the descending order of the h_p-index. The article with the biggest h_p value gets the rank r_p=1, with the less one – r_p=2, etc.
5) We should determine the article in which the h_p-index value is no less than its rank (r_p): $h_p \geq r_p$; and all the further articles (with bigger r_p-rank) fulfill condition $h_p < r_p$. The r_p-rank of this article is the h_m-index value for the author.

An empirical example

In *Table* 2 there is an example of the h_m-index calculation for the author who, personally or coauthored with someone else, published 10 articles. h_m-index was 4 where classical h-index would be 5 (*Table* 3). As we can see in the example, the value of the articles in h_m-index calculation has also been changed, in relation to h-index.

Discussion

The given method of h-index calculation, unlike any of the other ones [1, 2, 4-6], stimulates the increase of impact a scientist's publications, and first of all at key authors of the article (the first three and the last ones). Schreiber (2008) suggested an effective rank of the article, although we do not take it into account in our method [4].

The presented method does not also give the authors any advantages in h-index determination with account of their research portfolio (general popularity of their articles), unlike the method of Ausloos [13]. This balances odds of young specialists in improving their scientific grade evaluated in h-index.

It is evident that the most effective is the article which was written be no more than 6 authors. At more number of co-authors, the h-index of only the first three and the last authors has the significant value of the article. It is interesting to note that in reference lists of some journals there are all authors are cited if there are no more than 6 of them. If there are more than 6 authors there only the first three authors are cited.

Wait fir specialists to discuss advantages and disadvantages of the suggested method of h_m-index calculation.

Conclusion

The presented modified h-index can be the ground of the estimation of the impact of a scientist's publications in terms of the citations received with an account of the author's contribution to the writing of cited articles. As a criterion of an agreed personal contribution of each of the authors to the article, their order in the authors list is used.

Conflict of interest: none declared.

Table 1. p-index of the article with account of the co-author position in the authors list

Number of authors (n)	*Order of co-authors*				
	1st	2nd	3rd	Last	Other
1	1	-	-	-	-
2	1	1	-	-	-
3	1	1	-	1	-
4	1	0.5	0.5	1	-
5	1	0.5	0.5	1	0.5
≥6	1	0.5	0.5	1	1/(*n*-4)

Table 2. Example of h_m-index calculation of a conditional author based on the analysis of his position in author lists of his articles

r_p	n	*The author's order*	p	h	h_p
1	3	2	1	12	12
2	5	1	1	7	7
3	5	4	0.5	11	5.5
4	**4**	**4**	**1**	**5**	**5**
5	2	2	1	4	4
6	7	5	0.33	10	3.3
7	4	2	0.5	2	1
8	1	1	1	1	1
9	10	6	0.17	2	0.3
10	6	3	0.5	0	0

Table 3. Classical h-index calculation of a conditional author from *Table* 2

r	n	*The author's order*	p	h	h_p
1	3	2	1	12	12
2	5	4	0.5	11	5.5
3	7	5	0.33	10	3.3
4	5	1	1	7	7
5	**4**	**4**	**1**	**5**	**5**
6	2	2	1	4	4
7	4	2	0.5	2	1
8	10	6	0.17	2	0.3
9	1	1	1	1	1
10	6	3	0.5	0	0

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