



Mo-Index for multi-authors papers

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h-index takes no care of co-authorship; neither the number of co-authors nor their contributions. Many indices were proposed to take the effect of multiple co-authorship papers. The current Mo-index is based on the idea of distributing the citations of a paper between authors as a weighted value of the h-index of each author. The main advantage of the Mo-index is the distribution of the large number of citations between authors instead of being equally distributed and ignoring the rest of them by the calculation of the h-index.

Keywords: Mo-index, h-index, bibliometric indices, co-authorship papers.

Introduction

h-index is a preferential metric proposed by Professor J. E. Hirsch in the PNAS 2005's research article¹: "An Index to Quantify an Individual's Scientific Research Output". The aim is to measure the scientific output of a researcher (Hirsch 2005). The index is based on the number of peer-reviewed publications and the number of citations received for each of which. Using Hirsch's own words, h-index can be defined as:

"A scientist has index **h** if **h** of his or her **N_p** papers have at least **h** citations each and the other (**N_p - h**) papers have $\leq h$ citations each."

Many papers (Costas and Bordons²; Zhivotovsky and Krutovsky³; Alonso et al⁴; Tol⁵) have reviewed some of the drawbacks of the h-index such as:

1. Ignoring of the actual citations in the h-core.
2. Self-citations inflation.
3. Its unlikeliness to decrease.
4. Its insensitivity to coauthors.

h-index takes no care of co-authorship, neither the number of co-authors nor their contributions. Many indices were proposed to take the effect of multiple co-authorship papers. Batista et al⁶ suggested a simple procedure to take the effect of coauthorship on the h-index. To count for coauthorship effect, the h-index is divided by the mean of the authors of the h-core papers. Schreiber⁷ modified h-index to take multiple co-authorship into account by counting the papers fractionally according to (the inverse of) the number of authors. Hirsch⁸ suggested his second index called

(h-bar index) to consider coauthorship, \bar{h} -index eliminates any paper in the h-core of the author in question if one of the co-authors has h-index greater than the number of citations of that paper. Schubert⁹ proposed the partnership ability index. An actor is said to have a partnership ability index φ , if with φ of his/her n partners had at least φ joint actions each, and with the other $(n - \varphi)$ partners had no more than φ joint actions each. Hirsch¹⁰ proposed the h-alpha-index, he tried to define the main contributor among authors.

Using the concept of alpha-author; the author with the highest h-index; the paper is included in the h-core of an author only if that author is the alpha-author. Other research works in the context of coauthorship: Egghe¹¹, Chai et al¹², Ausloss¹³, and Alex Post et al¹⁴. Figure (1) holds a comparison between the h-index and some of its variant indices from the citation countspoint of view. The current work suggests an index that is based on the idea of distributing the citations of a paper between authors as a weighted value of the h-index of each author.

Mo-Index

Mo-index is based on the idea of distributing the citations of a paper between authors as a weighted value of the h-index of each author. To find these weighted values, the h-indices of authors are summed, then the h-index of each author is divided by that sum to show its weight. The next step is to multiply the citations of the paper by these weights to find the

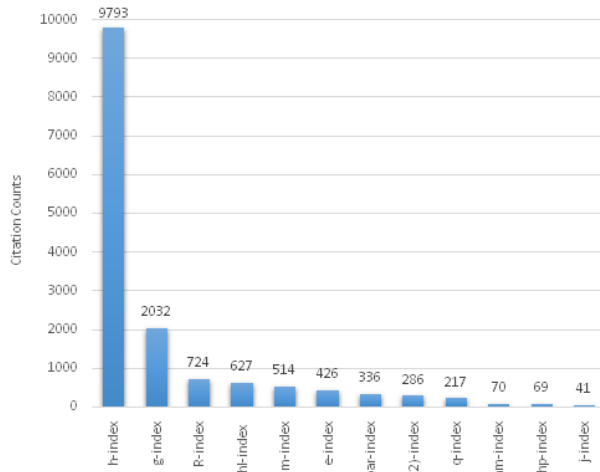


Figure 1 — Citation counts on Google Scholar as of the date of writing this article for some indices compared with the h-index.

share of each author of the citations according to his/her weighted h-index. This procedure should proceed for all papers of that author to obtain her/his share of citations of the published papers according to the weighted h-index in each of these papers.

Upon completing this step, the Mo-index is calculated typically as the h-index, i.e., the new citations of the author should be tabulated in a decreasing order with the rank of the paper. The author has Mo index of Mo value if Mo of his/her papers have been cited at least Mo times using the new h-core. The following example helps to reach a better understanding of the calculation process of the Mo-index.

Practical Example:

The table below lists the published papers of a researcher A and her/his co-authors in each paper.

The h-indices of researchers A-G are: 10, 10, 25, 40, 35, 20, and 5 respectively.

Sample of calculation for the distribution of the citations of the first paper:

$$\begin{aligned} \text{Number of Citations of Author A} &= 50 \times \frac{10}{45} \\ &= 11.11 = 11 \end{aligned}$$

$$\begin{aligned} \text{Number of Citations of Author B} &= 50 \times \frac{10}{45} \\ &= 11.11 = 11 \end{aligned}$$

$$\begin{aligned} \text{Number of Citations of Author C} &= 50 \times \frac{25}{45} \\ &= 27.78 = 28 \end{aligned}$$

Table 1 — The published papers of the virtual researcher A and his/her co-authors

Paper number	Citations	Authors
1	50	A, B, C
2	45	A
3	39	D, A, B
4	30	A, E
5	26	A, B, C
6	20	C, A
7	19	A
8	15	A, G
9	14	A, E, F
10	10	C, F, A
11	5	A
12	3	A, B
13	1	A, C
14	1	A, E

Step 1: Distributing of citations according to the weighted h-indices shown above.

The problem in the distribution of the citations is the case when one citation is equally divided between two authors with same h-indices as the case of the third and the twelfth papers (6.5, 6.5). To solve this problem this citation is added to the senior author; the one with the highest h-index (paper #3, 26, 6.5, 6.5 → 27, 6, 6; since D is the senior author). If there is no senior author, this citation is added to the main author of the paper (paper #12, 1.5, 1.5 → 2, 1; A is the main author here). The same problem raised in the fifth paper, but since the fraction part of the citations of authors A and B is larger than that of C, they can both be rounded up.

In order to calculate the Mo-index of researcher A, the shares of citations that were founded in the first step should be tabulated in a decreasing order with the corresponding paper as the case in the calculation of the h-index.

Step 2: Calculating Mo-index based on the normal procedure of calculating h-index

Since six of her/his papers have been cited at least six times, the Mo-index of researcher A is (6) against h-index of (10). The distribution of citations led to decrease the number of papers that can be included in the h-core from ten papers to six papers only.

Discussion

The main advantage of the Mo-index is the distribution of the large number of citations between authors instead of being equally distributed and ignoring the rest of them by the calculation of the h-index.

Table 2 — the first step of calculating the Mo-index

Paper number	Citations	Authors	Distribution process	Shares
1	50	A, B, C	28,11,11	28,11,11
2	45	A	45	45
3	39	D, A, B	26,6.5,6.5	27, 6, 6.
4	30	A, E	6.67, 23.33	7,23
5	26	A, B, C	5.77, 5.77, 14.44	6,6,14
6	20	C, A	14.29,5.71	14,6
7	19	A	19	19
8	15	A, G	10,5	10,5
9	14	A, E, F	2.15,7.54,4.30	2,8,4
10	10	C, F, A	4.55,3.64,1.82	4,2,2
11	5	A	5	5
12	3	A, B	1.5,1.5	2,1
13	1	A, C	0.29,0.71	0,1
14	1	A, E	0.22, 0.78	0,1

Table 3 — The shares of citations of researcher A from the first step. (Mo-index=6)

Paper number	Citations
1	45
2	28
3	19
4	10
5	7
6	6
7	6
8	6
9	5
10	2
11	2
12	2

Mo-index adopts the h-index of authors in a fairer way than the h-bar and the h-alpha indices which transfer the paper with its citations to the senior or the alpha author ignoring completely any role of the other co-authors. Another advantage of the Mo-index is that it is prone to decrease since the share of citations of an author is reduced with the growth of any co-author's h-index, which means increasing her/his share of citations if the other h-indices are still the same.

The distribution of the citations in the Mo-index affects senior researchers in the papers at the bottom of the h-core which have citation counts close to the current h-index. For junior researcher highly-cited papers that is co-authored with senior researchers are the most affected papers.

The difficulty of calculating Mo-index is the step of obtaining the h-index of all authors, especially researchers with large number of publications.

Conclusions

This work suggests an index to consider the citations of a paper from the point of view of the

weight of each author's h-index. Citations are distributed between authors according to the weight of the author's h-index. Then, the new h-index (Mo-index) will be evaluated using the same procedure of calculating h-index. The number of the papers included in the h-core after the distribution process may decrease and, hence, the new h-index (Mo-index) will decrease accordingly. Mo-index adopts the h-index of authors in a fairer way than the h-bar and the h-alpha indices do. The difficulty of calculating Mo-index is to obtain the h-index of all authors, especially researchers with large number of publications.

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