Oval table discussion

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The K-index and the hubs of science

A simple way to overcome Hirsch's h-index deficiencies is discussed by physicists from Brazil

How to determine the most central scientists of a research area?
Is it possible to determine if a scientist has opened up new research avenues or established new paradigms?

In our immediate research areas, we usually know who are the creative contributors and scientific leaders. Qualitative indicators of scientific status include scientific prizes; however, such prizes are often awarded decades after researchers have achieved their main discoveries. In addition, the awardee is usually chosen among many similarly qualified peers; gender, nationality, scientific social network, and other biases might influence the final awarding decisions.

The prime criteria for article acceptance by good scientific journals are originality and relevance to the advancement of a research field. Recognition comes in two steps: first, by the journal editor and referees; second, if the article is deemed relevant in one or another aspect by other researchers, it will be cited in the literature. Indeed, the traditional evaluation of the importance of a paper or researcher has been the citation counts. This tradition has been criticized due to the inertial dynamics of scientific citations: a well-cited paper has a higher chance of being cited again, a phenomenon known as the Matthew effect.[1] Besides, the importance of receiving citations from papers that turn out being unimportant or weakly cited, which corresponds to a significant fraction of citations, is disputable.[2]

In 2005, physicist Jorge Hirsch proposed a simple index that lessens the weight that a few highly cited papers would have in the citation counts of researchers.[3] The so-called Hirsch h-index is defined as follows. You rank your papers from the most cited one to the least cited one. Your h-index is h if you have h papers, each one with at least h citations. Therefore, the h-index measures both your citation impact and productivity, since $h \leq N$ where N is the researcher's number of papers.

Hirsch's contribution launched an avalanche of papers proposing new bibliometric indexes, most of them trying to overcome deficiencies presented by the h index, such as the g-index[4] and the individual h_I-index.[5] By now, we have over one hundred of such indexes, as found in the handbook of Todeschini and Baccini.[6] However, most of these new indexes have a substantial drawback: involved calculations, sometimes very lengthy, that cannot compete with the ease of calculation of the h-index. People prefer an index that is easy to obtain: a convoluted calculation, generating a metric that is marginally better than the h-index is not attractive.

Recently, we have proposed a new index that is as easy to calculate as the h index and that overcomes several of its drawbacks.[7] The K-index is the number of articles citing a researcher that have at least K citations each. Notice that K does not refer directly to the number N of papers published by the researcher, as does the h-index; K is related to the quality of the citations received.

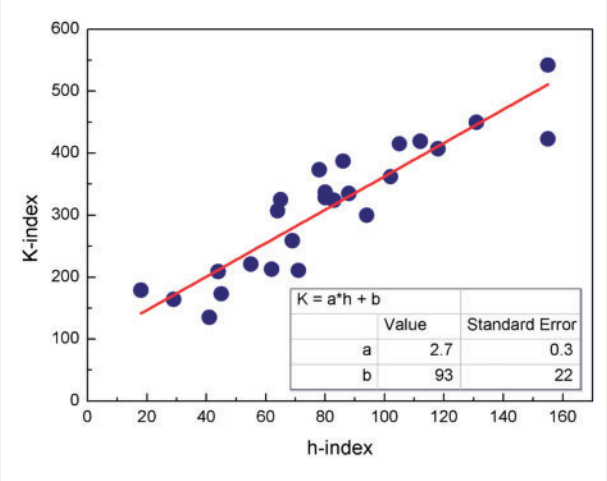

Figure 1 K vs. h plane for Physiology and Medicine Nobelists in the period 2008–2017. Notice that some of the laureates have a moderate h, but all have K above 100. We used citing articles (CA) without self-citations, but the inclusion of self-citations would keep K-indexes approximately unchanged.

One can determine the K-index in a simple two-step process:

(1) In your Web of Science platform (WoS) page, in the citation report, click on the link 'CA = citing articles' (without self-citations, if desired), which gives the articles that have cited you. This operation provides a list ranked from the most cited CA to the least cited one;
(2) In the ranked list, compare the number of citations found on the right-hand side of each CA, to its rank shown on the left. Your K index is determined by the K-th paper that has at least K citations, while the (K + 1)-th paper has less than K + 1 citations.

Besides the convenience of calculation, the K-index has several advantages over the h-index:

- The K-index is not limited by *N*. This means that a researcher with few papers can still have a high K. For example, physicist Paul Dirac (Nobelist, 1933) has h = 15 and K = 130.
- The K-index is very robust to spurious self-citations and citations by irrelevant papers.
- Researchers with very similar h but clearly different scientific recognition have different K. A example is Hirsch (h = 55, K = 200) and Einstein (h = 51, K = 299).
- The K index correlates better with scientific prizes, e.g. the Nobel Prize.

A good strategy to measure the standing of a researcher in a group is to use a plane K vs. h for clustering the researchers.

In *Figure 1*, we present the K and h indexes for the Physiology or Medicine Nobel Prizes of the last 10 years. Notice that we find Nobelists with a relatively low h but all with a high K. We have a coefficient of variation (standard deviation divided by the average) CV(h) = SD(h)/< h > = 0.4 for the h-index and CV(K) = SD(K)/< K > = 0.3 for the K-index. The lower CV for K denotes less dispersion in K results, indicating that K is a better metric to establish whether an individual belongs to the Nobelists group. Also, as can be seen in *Figure 1*, a linear fit indicates that Nobel prizes have at least K ≈ 100. The fact that the trend line still shows a large K when h tends to zero is consistent with the nature of K, that can be large even for very low h.

The K-index can be generalized. For example, we can measure the K-index of a single paper: a paper has index K if it has K papers that cite it, each one with at least K citations. This K-index for papers is easily obtained by the recent introduction, in Google Scholar, of links to the number of its citing articles in Web of Science. If one is interested in the impact of a researcher's production over the last n years, one can restrict the WoS search in an *n*-year window, obtaining the K(*n*) index. Finally, one can use the WoS to get a K(*n*) index for journals, countries, etc.

In conclusion, the K-index seems to overcome several deficiencies of the h-index with a minimal cost for its calculation. We suggest that given K-index's simplicity, usefulness and intuitive meaning, bibliometric platforms such as WoS, Google Citations, Scopus, and Harzing.com could offer K-index as an alternative metric, as already occurs with the h-index and others.

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References

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