Title: The c-index as a measure of a scientist's efficiency and assertiveness

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Abstract

The Cuckoo-index (c-index) is a new index that attempts to measure both the effectivity and the savviness of a scientist. The index is based on the number of publications of the scientist as author on original research manuscripts without contributing to them in any way. In a time of increasingly global competition for resources and funding, it is of great importance to collect scientific merits with the least investment. The c-index takes this into account.

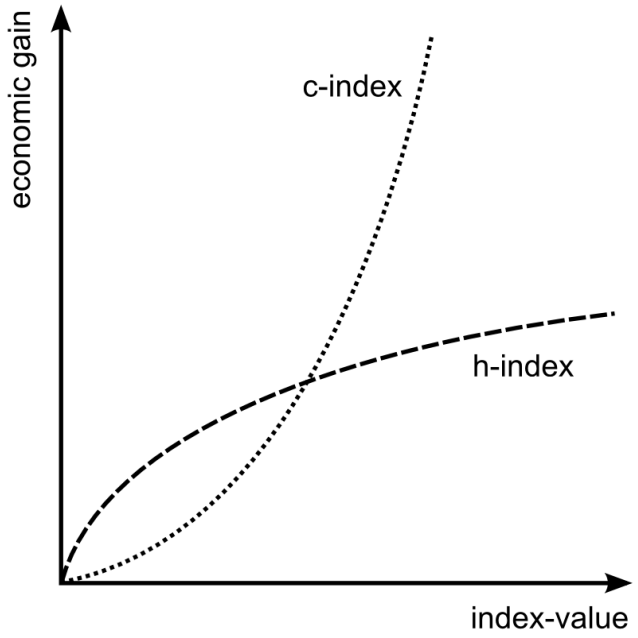
Introduction

In a time of dwindling resources worldwide, it is important to economize. This is especially true for scientists, as government funding is becoming increasingly scarce, while competition with other researchers around the world has become a key qualification in order to advance to highest research success. Here, a new index is proposed to take into account the drawbacks of the more traditional scientific metrics when assessing the productivity (von Bohlen and Halbach 2011) of a particular researcher or group of researchers: the cuckoo or C index.

The index is based on the number of appearances of a scientist as an author on scientific, peer-reviewed manuscripts without contributing to them in any way. The c-index thus offers a way to evaluate the success of researchers who have received authorship appearances with the fewest contributions without wasting resources that would have been better invested in other projects at the same time. The c-index, in contrast, for example, to the most commonly used h-index (Hirsch 2005), comes closer to the contemporary demands made so long ago by Friedrich August von Hayek, one of the most important economists and political philosophers of the 20th century. In his groundbreaking work, Hayek states that “the fact is, of course, that we do not wish people to earn a maximum of merit but to achieve a maximum of usefulness at a minimum of pain and sacrifice and therefore a minimum of merit.” (Hayek 1960; p. 101).

It is supposed that c is a highly predictive value for whether a scientist will receive honors like scientific community memberships, professorships or

institute leaderships (Prathap 2006). The c-index grows as authorship appearances without contribution accumulate and thus it impacts the political and scientific influence of a researcher [see Figure 1]. We recommend a c-value of about 100-120 to be a useful guide for tenure decisions at major research institutes. A c-value of about 180 could mean a full professorship, 150-200 could mean a fellowship in scientific boards, and 450 or higher could mean membership in the United States National Academy of Sciences. So far, little systematic research has been done on how academic recognition correlates with the c-index across different institutions, nations and research areas. This is prompted with the present *Short Communication*.



Figures 1. Illustration of the association between career success and increasing c- vs. h-index

Calculating c

The c-index is calculated as follows: A scientist has index c if he or she has publications without having contributed to them times their respective impact as designated by the respective *journal impact factor*. In other words, a scholar with an index of c has published n papers multiplied by the *ISI impact factor* of these publications (multiplied by §1) of which he or she has not contributed in any form divided by the number of total papers published by the author [see Figure 2].

$$c = \frac{[n_c * \sum_{i=1}^{n_c} IF_i * \S1_i] + \sum_{i=1}^{n_c} \S2_i}{N_T}$$

Figure 2. Formula to calculate the c-index. Abbreviations: nc = number of c papers; IF = *ISI* impact factor; § = paragraph, see section **Rules for calculating c**; N = number of all papers of the author

The c-index can be calculated by the author him- or herself by (self-) announcement of manuscripts that are (co)-authored by the scientist without contributing to them in any form. In a second step the respective *journal impact factor* of each manuscript can be manually determined using *ISI Web of Knowledge* (http://thomsonreuters.com). Depending on the position of the author on the manuscript the impact factor might be doubled or even tippled (see below for rules of calculation).

Rules for calculating c

The author must clearly verify that he or she did neither contribute in the conceptualization process, the writing of the manuscript nor in analyzing the data providing the grounding for the manuscript. Paragraph 1 (§1) verifies that first- or last-authorships are valued equally and double the impact factor of the respective publication. Co-authorships leave the impact factor at its proper value, no matter which position the author holds within an authorship cohort. Shared first- or last-authorships are valued equally, but multiply the respective impact factor of the publication only by 1.5. In case an author manages to be named as shared first- *and* last author on the same manuscript without having supported in the conceptualization, writing or data analysis, the impact factor of the respective manuscript is even tippled. Paragraph 2 (§2) helps boosting authors who accomplish to evict other authors from the author list (i.e. in a cuckoo-type of behavior) that indeed supported the manuscript in writing or analyzing the data. Here, for each evicted author c will be added an extra point at the end of the calculation process.

Discussion

In this *Short Communication* a new index, the cuckoo-index, is presented as a new measure to account for a researchers efficiency and assertiveness. Especially in a time of increasing global competition for resources and funding it is of great importance to demonstrate one’s university or institute that one manages to receive scientific merits with fewest

investments (von Bohlen and Halbach 2011). This is accounted for with the c-index, reflecting both, the number of publications a scientist manages to be named as an author (without wasting resources) multiplied with the *ISI impact factor* of the respective scientific journal.

The c-index was intended to address the main disadvantages of other bibliometric indicators, such as total number of papers, total number of citations (Kovacic and Misak 2004), impact factor (Nature Editorial 2005; PLoS Medicine Editorial 2006) or h-index (Lehmann, Jackson et al. 2006). The total number of publications neither does account for the quality of the scientific work nor for the (economic) efficiency in the process to accumulate these. The total number of citations can be disproportionately affected by participation in a single publication of major influence and has therefore been regarded as unsuitable in evaluating scientific success.

The c-index is intended to measure simultaneously the efficiency and assertiveness of scientists, as well as, to some extent, the savviness of assignment of resources. The c-index is much less affected by single extremely highly cited manuscripts or single high impact papers as it gives a value for a continuous indulgent handling of resources. Further, the c-index, while sometimes unjustified being regarded as a negative index for cuckooic scientific behavior, must be assessed inversely as the index for describing excellence (Jacsò 2006). Researchers with high c show their capability in adjusting to more complex environments with fewer and fewer resources. This is especially true for the scientific community where governments shorten grants and financial support and thereby risk the worldwide

forthcoming in science and development. A high c accordingly must be viewed as one of the most excellent signs of career focus and therefore is even more predictive for one’s future economic success as e.g. compared to the h-index (Hirsch 2007). Applications for professorships or institute leaderships including one’s c-index should be valued as superior in future. The applicant demonstrates with a high c that the university he or she applies carries no risk in engaging the professor/institute leader as even with fewest financial resources, as it has to be expected in near future, the high c-indexed professor will nevertheless survive scientifically and receive credits. Further, a high c-index will facilitate a professor to receive additional third-party funding and thereby help to hire new staff members, post docs etc. In the following, the new members of the research group can help to increase one’s c and so forth.

Notably, there are a number of situations in which c may provide misleading information about a scientist's performance. For example, the c-index does not account for the number of authors of a paper, thus tending to favor fields with larger groups, e.g. experimental over theoretical (Jayant 2005). Further, the c-index does not account for different research cultures, thus making it easier in some fields to achieve a high c. The c-index is moreover bounded by the total number of publications. This implicates that scientists with a short career are at an inherent disadvantage, regardless of the value of their resource handling. For example, if a young investigator accomplishes to evict other co-workers from a manuscript and by doing so eventuates to gain an authorship without any contribution, this early career achievement is not

adequately appreciated by c (for a more detailed review on co-author contributions see Sekergioglu 2008). Therefore it is important to value the c-index as a tool to evaluate researchers at the same stage of their careers. It is neither meant as a tool for historical comparisons, nor for comparing scientists working in different research communities, as c-conventions may differ widely among scientific communities (Batista, Campiteli et al. 2006). However, the implementation of c for other professional employments besides science such as arts, sports, politics etc. makes sense as well. Finally, as with all other publication or citation metrics, the c-index is affected by the accuracy and honesty of the researcher for which it is computed. Although the c-index has not been studied in greater detail by the scientific community, its importance is obvious in our globalized world. Until now, ISI Web of Knowledge was found to have strong coverage of journal publications, h-index or the impact factor, but poor on coverage of economic effectivity in times of dwindling resources. This gap is now closed with the introduction of the c-index.

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quality" or "scientific productivity"?"." Annals of Anatomy **193**(3): 191-196.

Box 1. History and origin of the c-index

According to Wikipedia, “the cuckoos are a family of near passerine birds. The cuckoos feed on insects, insect larvae and a variety of other animals, as well as fruit. Many species are brood parasites, laying their eggs in the nests of other species. In addition, yet others sometimes engage in non-obligate brood parasitism, laying their eggs in the nests of members of their own species in addition to raising their own young. The best-known example is the European Common Cuckoo. The shells of the eggs of brood-parasites are usually thick. They have two distinct layers with an outer chalky layer that is believed to provide resistance to cracking when the eggs are dropped in the host nest. The cuckoo egg hatches earlier than the host's, and the cuckoo chick grows faster; in most cases the chick evicts the eggs or young of the host species. The chick has no time to learn this behavior, so it must be an instinct passed on genetically. The chick encourages the host to keep pace with its high growth rate with its rapid begging call and the chick's open mouth which serves as a sign stimulus. Parasitic cuckoos specialize and lay eggs that closely resemble the eggs of their chosen host. This has been produced by natural selection, as some birds are able to distinguish cuckoo eggs from their own, leading to those eggs least like the host's being thrown out of the nest. Host species may engage in more direct action to prevent cuckoos

laying eggs in their nest in the first place - birds whose nests are at high risk of cuckoo-contamination are known to mob cuckoos to drive them out of the area. Parasitic cuckoos are grouped into gentes, with each gens specializing in a particular host. There is some evidence that the gentes are genetically different from one another. Host specificity is enhanced by the need to imitate the eggs of the host" (for a more detailed analysis the interested reader is referred to Payne 2005).