Unfolding the Full Potential of H-Index for Bibliographic Ranking

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Abstract

The evaluation of the scientific work of a scientist has long attracted significant interest, due to the benefits from obtaining an unbiased and fair criterion. Although simple it appears to be, defining a quality metric is not an easy task. To overcome the disadvantages of the present metrics used for ranking scientists, J. E. Hirsch proposed the now famous h-index. In this article we demonstrate several inefficiencies of this index and develop effective variants of it to deal with scientist ranking and also with publication forum ranking. We exhibit the effectiveness of the variants with extensive experimental results obtained from the on-line digital library DBLP.

1 Introduction

The evaluation of the scientific work of a scientist has long attracted significant interest, due to the benefits from obtaining an unbiased and fair criterion. Having defined such a metric we can use it for faculty recruitment, promotion, prize awarding, funding allocation, comparison of personal scientific merit, etc. Although simple it appears to be, defining a quality metric is not an easy task, since it must account for the productivity of a scientist and the impact of all of his/her work. Most of the existing methods up-to-date are based on some form of (arithmetics on) the number of authored papers, the number of total citations or the number of citations per papers, etc. Other such metrics, less often used, are the total number of authored papers, the average number of authored papers per year, the total number of citations, the average number of citations per paper, the average number of citations per year, etc. A comprehensive description of many of them can be found at [7].

In fact, all of these metrics present one or more of the following drawbacks [6]:

- They do not measure the importance or impact of papers, e.g., a metric based solely on the total number of papers.

- The are affected by a small number of "big hits" articles, which received huge number of citations, whereas the rest of the articles may have negligible total impact, e.g., a metric based on the total number of citations.
- They can not measure productivity, e.g., a metric based on the average number of citations per paper.
- They have difficulty to set administrative parameters, e.g., a metric based on the number a of article which have received b citations each, or a metric based on the number a of the most cited articles.

To collectively overcome all these disadvantages of the present metrics, last year J. E. Hirsch proposed the h-index [1, 3, 6]. The definition of the h-index is as follows:

Definition 1. *A researcher has index h (h-index) if h of his/her N_p articles have received at least h citations each, and the rest $(N_p - h)$ articles have received less than citations.*

This metric calculates how broad is the research work of a scientist. The *h-index* accounts for both productivity and impact. For some researcher, to have large *h-index*, s/he must have a lot of "good" articles, and not just a few "good" articles. Apparently, young researchers can not have a large *h-index*, because they did not have enough time either to publish a lot of good articles, or time to accumulate large number of citation for their good papers.

Some straightforward observations can be deduced from Definition 1: a) The quantity h will always be smaller than or equal to to the number N_p of the articles of a researcher, b) it holds that $h^2 \leq N_{c,tot}$, where $N_{c,tot}$ is the total number of citations that the researcher has received. Apparently, the equality holds when all the articles which contribute to *h-index* have received exactly h citations each, which is quite improbable. Therefore, in the usual case it will hold that $h^2 < N_{c,tot}$. Based on this relation, we can define the index a as follows:

$$N_{c,tot} = ah^2 \tag{1}$$

The index a can be used as a second metric-index for the evaluation and ranking of authors. It describes the "magnitude" of each author's "hits". A large a implies that some article(s) have received a fairly large number of citations compared to the rest of its articles and with respect to what the *h-index* presents.

A number of other proposals [2, 4] followed the initial introduction of the *h-index*. Deviating from their line of research, we develop in this article variations of the *h-index* for the evaluation of conferences/journals and also a couple of more informative variants of the *h-index* for authors.

2 H-Index for conferences and Journals

Based on the idea of the *h-index*, we define an analogous concept for conferences. For instance, the *h-index* of a journal/magazine or of a conference is h, if h of the

N_p articles it contains, have received at least h citations each, and the rest $(N_p - h)$ articles received less than h. Still, we can not guarantee a fair comparison between conferences or between journals, since their lifes are different, and thus have different number of published articles.

We deal with this problem by calculating the *h-index* per year. In particular, we define that

Definition 2. *A conference or a journal has index h_y for the year y (yearly h-index) if h_y of its articles $N_{p,y}$ published during the year y have received at least h_y citations each, and the rest $(N_{p,y} - h_y)$ articles received less than h_y citations.*

For instance, the h index for the year 1992, denoted as h_{1992}, of the conference *VLDB* is computed as the number of its articles which have received more than h_{1992} citations.

The drawbacks though of the aforementioned metric are the following:

1. The conferences/journals do not publish exactly the same number of articles. Thus, for a conference which published around 50 articles, the upper bound for its h-index is 50. Another conference which published 150 the upper bound for its h-index is 150, and it also has much more stronger probability to exceed the limit of 50. The number of articles which appear in year in a conference or journal reflects the preference of the researchers to this publication forum. If we consider that the forum published 50 articles, because it could not attract more valuable articles, then it correctly has as upper bound the number 50 and it is not a problem that it can not overrule forum B. On the other hand, perhaps we are interested in the average "quality" of the articles published in a forum, no matter what the volume of published articles is.

2. The h_y index constantly changes. Even though we examine a conference which took place in 1970, the h_y index that we can calculate today, is possible to change a few year later. Thus, the drawback of this index is that we can not have a final evaluation for the forums of a year, no matter how old are they.

To address the first drawback, we define a "parallel" index, which is normalized with respect to the number of articles published in a forum. Its formal definition is given below:

Definition 3. *The normalized index h_y^n for a conference or journal for the year y, is denoted as (normalized yearly h-index) and it is equal to h_y, if h_y of its $N_{p,y}$ articles in the year y have received at least h_y citations each, and the rest $(N_{p,y} - h_y)$ articles received less than h_y citations, and it holds that $h_y^n = h_y / N_{p,y}$.*

In the next section, we proceed to define variants of the *h-index* for ranking authors.

3 Variants of the H-index for Authors

Following the same lines of thought, we can apply our previous ideas to define appropriate index for authors. This way we are able to evaluate not only the broadness of their research work, but also the percentage of their successful works. Thus, we define the following index:

Definition 4. *A researcher has index h^n (normalized h-index), if h of its N_p articles have received at least h citations each, and the rest $(N_p - h)$ articles received less than h citations, and it holds that $h^n = h/N_p$.*

The drawback of the aforementioned cases is that we do not take into account the year when an article was published and/or the year when an article acquired a particular citation. For instance, consider a researcher who contributed to the research community a number of really brilliant articles during the decade of 1960, which apparently got a lot of citations. This researcher will have a large *h-index* due to the works done in the past, and, since these articles continue to get citations (under the assumption that they are relevant to today trends), its *h-index* will keep growing.

The classical *h-index* though does not reflect the researcher's contribution in the present years. It may be the case that the researcher is inactive or retired. Thus, arises the need to define another variant of *h-index* to distinguish the researchers which keep contributing nowadays or, they are expected to contribute significant works, even though they did not do so during the past years.

Thus, we define a new index for the authors, which is based upon the ideas of the *h-index*

$$Y(i) = \text{Publication year of article } i$$
$$C(i) = \text{The articles citing the article } i$$
$$S^c(i) = b * (Y(now) - Y(i) + 1)^{-a} * |C(i)|$$

Setting a=1, $S^c(i)$ is the number of citations that article i has received, divided by the "age" of the article. Since, we divide the number of citations with the time interval, the quantities $S^c(i)$ will be too small to create a meaningful *h-index*; thus, we use the coefficient b. In our experiments, reported in subsequent sections we use the value of 4 for the coefficient b. Thus, for an article published during the current year, its citations account four times. For an article published 4 year ago, its citations account only one time. For an article published 6 year ago, its citations account $\frac{4}{6}$ times, and so on.

This way, an old article gradually loses its "value", even if it still gets some citations. In other words, for the calculation of *h-index* we mainly take into account the newer articles[1]. Therefore, the *contemporary h-index* of a researcher is defined as:

Definition 5. *A researcher has index h^c (contemporary h-index) if h^c of its N_p articles get a score of $S^c(i) \geq h^c$ each, and the rest $(N_p - h^c)$ articles get a score of $S^c(i) < h^c$.*

[1]Apparently, if a is close to zero, then the impact of the time penalty is reduced, and, for $a = 0$, this variant coincides with the classical *h-index*

Another option is to estimate the impact of a researcher's work in a particular time instance. In this case, we are not interested in how old are the articles of a researcher, but whether they still get citations. This way, we characterize how diachronic is the researcher. With the aid of the above terms, we define:

$$S^t(i) = b * \sum_{\forall x \in C(i)} (Y(now) - Y(x) + 1)^{-a}$$

The quantities a and b are as above, and thus:

Definition 6. *A researcher has index h^t (trend h-index) if h^t of its N_p articles get a score of $S^t(i) \geq h^t$ each, and the rest $(N_p - h^t)$ articles get a score of $S^t(i) < h^t$ each.*

Having defined all these variants of the basic *h-index*, we will evaluate in the subsequent sections their success in identifying authors or forums with extraordinary performance. For the evaluation, we will exploit the on-line database of DBLP.

4 Experiments

In this section we will present the rank results for authors, conferences and journals based on the basic *h-index* definition as well as the variations defined in this paper. Our dataset consists ([7, 8, 9]) of the DBLP collection (DBLP timestamp: 10/3/2006). The database snapshot used contains 451694 inproceedings, 266307 articles, 456511 authors, 2024 conference series and 504 journals. Also, the number of citations in our dataset is 100205. Although this number is relatively small, it is a satisfactory sample for our purposes. Almost all citations in the database are made from publications prior the year of 2001. Thus, we can assume that the results that are presented here are corresponded to the year 2001. From now on, with the term "now" we actually mean sometime near 2001.

4.1 Experiments with h-index for Authors

In Tables 1, 2, 3 and 4 we present the resulting ranking using the method *h-index*, as well as the defined variations. At a first glance, we can see that the values computed for *h-index* (Table 1) are much lower than the values presented in [6] for physics scientists. This happens because the DBLP collection includes a relatively small number of citations compared to the real number. On the other hand, the resulting ranking is indicative. This is due to the fact that the majority of the citations included in the database comes from the most important conferences and journals.

By examining Tables 2, 3 and 4 we remark that the only ranking that differs significantly from the rest ones, is the *normalized h-index*. This happens because the authors with few and good publications take advantage. Practically,

Name	h	a	$N_{c,tot}$	N_p
1.Michael Stonebraker	24	3.78	2180	193
2.Jeffrey D. Ullman	23	3.37	1783	227
3.David J. DeWitt	22	3.91	1896	150
4.Philip A. Bernstein	20	3.39	1359	124
5.Won Kim	19	2.96	1071	143
6.Catriel Beeri	18	3.16	1024	93
7.Rakesh Agrawal	18	3.06	994	154
8.Umeshwar Dayal	18	2.81	913	130
9.Hector Garcia-Molina	17	3.60	1041	314
10.Yehoshua Sagiv	17	3.52	1020	121
11.Ronald Fagin	17	2.83	818	121
12.Jim Gray	16	6.13	1571	118
13.Serge Abiteboul	16	4.33	1111	172
14.Michael J. Carey	16	4.25	1090	151
15.Nathan Goodman	16	3.37	865	68
16.Christos Faloutsos	16	2.89	742	175
17.Raymond A. Lorie	15	6.23	1403	35
18.Jeffrey F. Naughton	15	2.90	653	123
19.Bruce G. Lindsay	15	2.76	623	60
20.David Maier	14	5.56	1090	158

Table 1: Rank of Authors using *h-index*

Name	h_n	h	a	N_{c_tot}	N_p
1.Rajiv Jauhari	1	5	3.72	93	5
2.Jie-Bing Yu	1	5	2.36	59	5
3.L. Edwin McKenzie	1	5	2.04	51	5
4.Upen S. Chakravarthy	0.88	8	2.60	167	9
5.James B. Rothnie Jr.	0.85	6	6.55	236	7
6.M. Muralikrishna	0.85	6	5.47	197	7
7.Stephen Fox	0.83	5	4.12	103	6
8.Antonin Guttman	0.8	4	20.43	327	5
9.Marc G. Smith	0.8	4	4.81	77	5
10.Gail M. Shaw	0.8	4	4.37	70	5
11.Glenn R. Thompson	0.8	4	4.37	70	5
12.David W. Shipman	0.75	6	11.16	402	8
13.Dennis R. McCarthy	0.75	6	5.30	191	8
14.Spyros Potamianos	0.66	4	10.43	167	6
15.Robert K. Abbott	0.66	4	4.68	75	6
16.Edward B. Altman	0.66	4	3.06	49	6
17.Brian M. Oki	0.66	4	2.56	41	6
18.Gene T. J. Wuu	0.66	6	2.25	81	9
19.Marguerite C. Murphy	0.66	4	1.62	26	6
20.Gerald Held	0.62	5	9.84	246	8

Table 2: Rank of Authors using *normalized h-index*

we cannot evaluate the reasearch work of an author by taking into consideration only the *normalized h-index*. The *normalized h-index* can be used in parallel to *h-index* and as a second criterion. We can easily assume that the majority of the authors presented in Table 2 are probably Phd or MSc students that made a good research with a "famous" professor and after that, they stopped their reseach career. The second possibility is that the main number of their publi-

Name	h_c	a_c	h	$N_{c,tot}$	N_p
1.David J. DeWitt	14	3.10	22	1896	150
2.Jeffrey D. Ullman	13	3.44	23	1783	227
3.Michael Stonebraker	12	3.98	24	2180	193
4.Rakesh Agrawal	12	3.24	18	994	154
5.Serge Abiteboul	11	4.08	16	1111	172
6.Jennifer Widom	11	3.23	14	709	136
7.Jim Gray	10	3.93	16	1571	118
8.Michael J. Carey	10	3.79	16	1090	151
9.Won Kim	10	3.00	19	1071	143
10.David Maier	10	2.93	14	1090	158
11.Hector Garcia-Molina	9	5.30	17	1041	314
12.Jeffrey F. Naughton	9	3.85	15	653	123
13.Yehoshua Sagiv	9	3.76	17	1020	121
14.Christos Faloutsos	9	3.68	16	742	175
15.Catriel Beeri	9	3.59	18	1024	93
16.Philip A. Bernstein	9	3.49	20	1359	124
17.Umeshwar Dayal	9	3.39	18	913	130
18.Hamid Pirahesh	9	3.34	14	622	67
19.H. V. Jagadish	9	2.88	12	503	151
20.Raghu Ramakrishnan	8	5.05	14	818	147

Table 3: Rank of Authors using *contemporary h-index*

Name	h_t	a_t	h	$N_{c,tot}$	N_p
1.David J. DeWitt	20	2.73	22	1896	150
2.Michael Stonebraker	17	3.61	24	2180	193
3.Jeffrey D. Ullman	17	3.45	23	1783	227
4.Rakesh Agrawal	17	3.06	18	994	154
5.Jennifer Widom	16	2.81	14	709	136
6.Serge Abiteboul	14	4.07	16	1111	172
7.Hector Garcia-Molina	14	4.03	17	1041	314
8.Christos Faloutsos	14	3.15	16	742	175
9.Jim Gray	13	4.46	16	1571	118
10.Jeffrey F. Naughton	13	3.36	15	653	123
11.Won Kim	13	3.23	19	1071	143
12.Michael J. Carey	12	4.79	16	1090	151
13.Yehoshua Sagiv	12	3.96	17	1020	121
14.Umeshwar Dayal	12	3.41	18	913	130
15.Catriel Beeri	12	3.12	18	1024	93
16.Raghu Ramakrishnan	11	4.41	14	818	147
17.Philip A. Bernstein	11	4.03	20	1359	124
18.David Maier	11	3.94	14	1090	158
19.Hamid Pirahesh	11	3.87	14	622	67
20.H. V. Jagadish	11	3.58	12	503	151

Table 4: Rank of Authors using *trend h-index*

cations is not included in the DBLP collection - probably bacause they actually belong to a scientific domain other than Databases and Logic Programing. Finally, it is always possible to track "promising" researchers among them, who will continue their valuable research work.

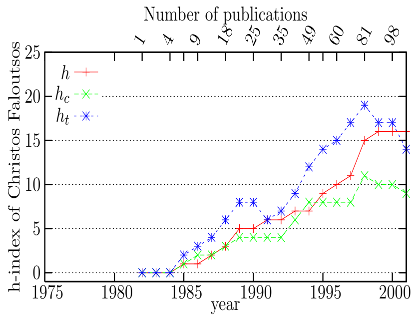
At a first glance to Tables 3 and 4, we cannot see any major difference in the rank ordering presented in Table 1. In this case, a very small differnce in the ranking, may give us valuable information for each researcher. For example, Christos Faloutsos is at the 16^{th} place of *h-index* table. In *contemporary h-index* table he climbs to the 14^{th} position. This means that the major amount of his good publications is published in the resent years (relatively to the rest of the authors). Also, in *trend h-index* table, Christos Faloutsos climbs to the 8^{th} place. This shows that his publications get citations during the resent years. That finally means that the work of professor Faloutsos is "trendy". With the term "trendy", it is obvious that we mean that a general interest exists for the work of the specific author by the rest of the research community during the particular time period.

Being motivated by the differences on the above tables, we present Figure **??**. In these figures, we can see the case history *h-index* for each researcher and we choose those that have differences over the *h-index* variations and those having a rapid upwards slope at their plot curves. Here, we should note that our data set is rather incomplete for the years of 1999-2000, and it appears a downwards pitch for all the researchers during these two years. Thus, while reading these figures, let's keep in mind that the data are indicative, but not real.

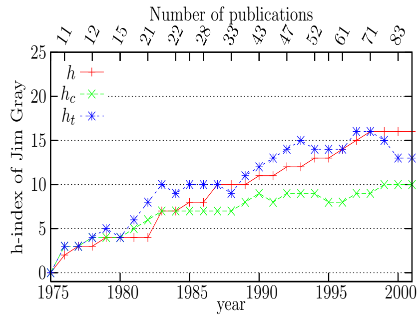
If we compare Figures 1(a) and 1(b), we can see that the 2 researchers now have the same *h-index*. But, Christos Faloutsos has a more ascending slope than Jim Gray, since he started being cited on 1984, while Jim Gray on 1976. Also, the *trend h-index* (h_t) curve of Christos Faloutsos stays constantly over the *h-index* (h) equivalent. This means that Christos Faloutsos is getting cited very often and thus, we expect his *h-index* to get higher than Jim Gray's *h-index*. Finally, Jim Gray's *contemporary h-index* (h_c) is constantly below h since 1985 and it's getting away during time. This indicates that since 1985 he has not presented really extraordinary papers (relatively to his older ones) and after this point the progress is degressive.

Figures 1(c) and 1(d) correspond to Michael Stonebraker and David J. DeWitt. Both of these researchers are on the top of our list. We can notice that David J. DeWitt' *contemporary h-index* is very close to his *h-index*, which means that he keeps publishing very good papers. On the contrary, Michael Stonebraker has started to deflect since 1985. This helps us understand that Michael Stonebraker' *trend h-index* will also decrease after some years, as it is shown in the same figure. Thus, while Michael Stonebraker is in higher position than David J. DeWitt at the *h-index* ranking, David J. DeWitt comes first when examining the other two variations. This means that, if the productivity level of the two researchers keeps on the same pace, the second will soon surpass the first one at the *h-index* as well.

In Figure 1(e), we see the progress rate for Jennifer Widom. While Jennifer Widom is not even among the first 20 researchers using the *h-index*, she's on the 6th and 7th position using the *contemporary h-index* and *trend h-index* respectively. She's the only researcher from our list that presents such a big difference on the timing rates compared to the basic *h-index*. As we can also see from the diagram, this difference is justifiable, since the increase speed of the basic *h-index* is high. She's also the only researcher that her *contemporary h-index* is constantly close to *h-index* and not below. Finally, even if the *trend h-*



(a)



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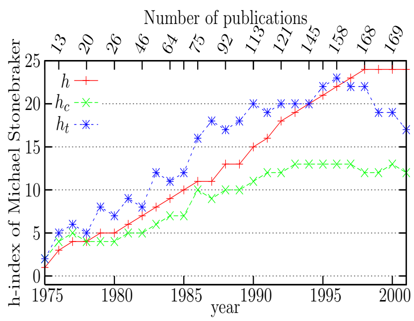
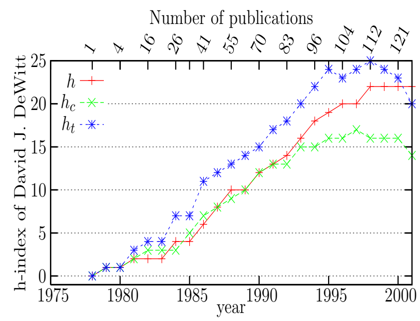


(c)



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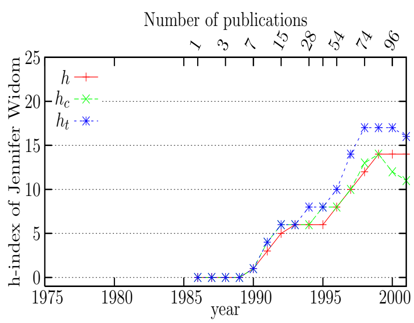

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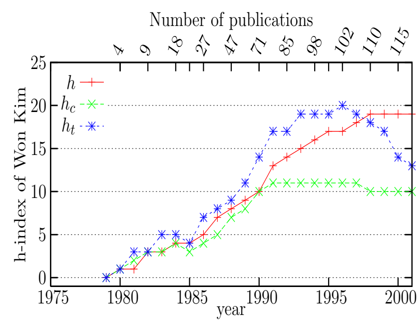

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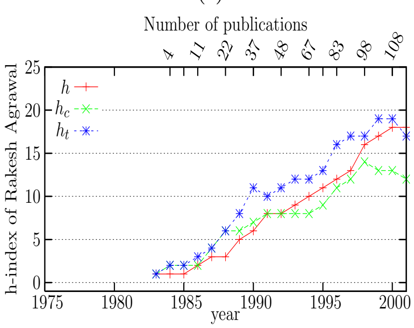
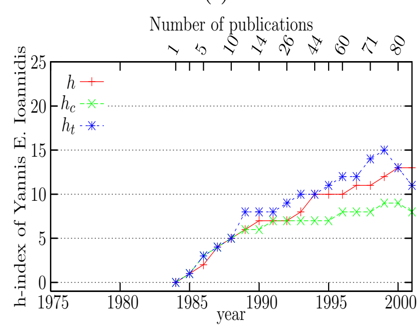


(g)



(h)

Figure 1: *h-index* of Authors belonging to Database domain

index is always lower than the *h-index* for the year of 2000, for all the researchers that we present, it stays high in her case.

In Figure 1(h) we see an increasing trend that is analogous with the Jim Gray one. The *trend h-index* remains constantly over *h-index*, which means that there is a remarkable potential. On the other hand, the *contemporary h-index* presents a small deflection from *h-index* since 1993, which is completely analogous to Jim's Gray since 1985. Based on the material we have, Yannis Ioannidis follows the same progress path as Jim Gray, with a timing deflection of almost 10 years.

In Figure 1(f), Won Kim presents an analogous path with Stonebraker. For instance, there is a high ascending curve for *trend h-index*, but *contemporary h-index* remains low after 1990, and it is finally obvious that *trend h-index* will also follow a decreasing path. Therefore, we expect that *h-index* will not present high increase.

4.1.1 Evaluation of Results

In papers [7] and [8] we have used the '*SIGMOD E.F.Codd Innovations Award*' to evaluate our ranking methods. The higher an awarded author is ranked, the better the rank method is. Here, we perform the same experiment to see whether the *h-index* and its variations are reflected in the awards for the Database scientific domain.

Name	h	h_c	h_t	h	h_c	h_t	*year*	h	h_c	h_t
Michael Stonebraker	1	3	2	3	2	1	1992	1	2	1
Jim Gray	12	7	9	12	11	10	1993	15	11	8
Philip A. Bernstein	4	16	17	2	6	4	1994	2	9	5
David J. DeWitt	3	1	1	3	1	1	1995	2	1	1
C. Mohan	28	37	31	44	36	35	1996	49	23	19
David Maier	20	10	18	11	9	15	1997	15	10	17
Serge Abiteboul	13	5	6	17	4	11	1998	16	6	11
Hector Garcia-Molina	9	11	7	10	8	4	1999	14	7	5
Rakesh Agrawal	7	4	4	9	4	4	2000	7	4	4
Rudolf Bayer	145	196	183	142	218	222	2001	145	196	183
Patricia G. Selinger	143	144	119	143	144	119	2002	143	144	119
Donald D. Chamberlin	44	87	69	44	87	69	2003	44	87	69
Ronald Fagin	11	39	32	11	39	32	2004	11	39	32
Lowest Ranking Point	145	196	183	143	218	222		145	196	183
Sum of Rank points	440	560	498	451	543	539		464	494	469

Table 5: Positions with *h-index* variations of Awarded Authors

In Table 5 we present the list of the awarded authors by the '*SIGMOD E.F.Codd Innovations Award*'. In the first three columns (h, h_c, h_t) the position of each author is presented by using the respective method. The next group of columns contains the position of each author by using the respective method close to the moment of the awarding. Column *year* shows the year of the awarding. The second group (h, h_c, h_t) shows the author positions at the end of the year before the awarding and the last group shows his position during (at the end of) the year of the awarding.

Here, we have to remind the reader that our database does not include enough data for the time period after 2000. Thus, all the ranking for the years after 2000 are equal. However, we can make interesting observations for the years before 2000:

- **C. Mohan**: Although at this moment he is ranked relatively low by using the *trend h-index* and *contemporary h-index*, during the year of 1996 he was ranked higher according to the *trend h-index*. This was later depicted on the *h-index* and from the 49^{th} position that he was ranked during 1996 he now climbed to the 28^{th} position.

- Other similar cases with obvious difference in the ranking are of **Hector Garcia-Molina** and **Philip A. Bernstein**.

- **Serge Abiteboul**: During the year of the awarding the *trend h-index* is relatively low (compared to the *contemporary h-index*). According to the *contemporary h-index*, Hector Garcia-Molina was ranked in a higher place. This shows that, he had presented interesting work during the age of the awarding. Thereofre, he received the award before this work get reflected to the *trend h-index* and *h-index*. This means, that in some cases, the *contemporary h-index* gives us information that it cannot be depicted to the other indicators.

- For the cases of **Michael Stonebraker** and **David J. DeWitt**, we see that they are stable at the top. For the cases after 2000 we cannot draw analogous conclusions due to the lack of data.

4.2 Experiments with Conferences Ranking

The set of data that we used is described in the previous section. ¿From this set we extract only the Database conferences according to [5], and rank only these ones. In the first part of this section we will make experiments by using only the indicators that we have fixed for authors (*h-index*, *normalized h-index*, *contemporary h-index* and *trend h-index*). In Table 6 we present the 15 first conferences using the *h-index* for the ordering. The ordering changes dramatically in Table 7, but this is due to the fact that we have not complete data for some of the conferences. Since the quality of the conferences is more constant than the quality of the authors, we observe that in Tables 8 and 9 there are no significant differences in the ranking.

In Figure 4 we present in the same way we used for authors, the progress of selected conferences. Note here that the *h-index* is shown per year in the graphs, which means that this is the computed *h-index* during the specific year. E.g. the *h-index* that is computed for the VLDB for 1995 is the *h-index* that is

Name	h	a	$N_{c,tot}$	N_p
1.sigmod	45	6.05	12261	2059
2.vldb	37	7.10	9729	2192
3.pods	26	5.74	3883	776
4.icde	22	6.83	3307	1970
5.er	16	5.80	1486	1338
6.edbt	13	3.89	658	434
7.eds	12	3.65	527	101
8.adbt	12	2.86	412	42
9.icdt	11	4.79	580	313
10.oodbs	11	3.96	480	122

Table 6: Conferences Ranking using *h-index*

Name	h_n	h	a	$N_{c,tot}$	N_p
1.adbt	0.28	12	2.86	412	42
2.dpds	0.17	7	2.97	146	39
3.eds	0.11	12	3.65	527	101
4.icod	0.11	6	3	108	52
5.jcdkb	0.11	8	3.32	213	70
6.ddb	0.09	4	6.87	110	44
7.oodbs	0.09	11	3.96	480	122
8.tdb	0.08	3	6.44	58	36
9.berkeley	0.07	10	3.52	352	142

Table 7: Conferences Ranking using *normalized h-index*

Name	h_c	a_c	h	$N_{c,tot}$	N_p
1.sigmod	21	9.49	45	12261	2059
2.vldb	17	11.34	37	9729	2192
3.pods	12	9.73	26	3883	776
4.icde	11	11.88	22	3307	1970
5.icdt	8	5.04	11	580	313
6.edbt	7	6.16	13	658	434
7.oodbs	6	3.63	11	480	122
8.er	5	16.21	16	1486	1338
9.kdd	5	6.89	6	243	1074
10.dood	5	6.57	8	440	171

Table 8: Conferences Ranking using *contemporary h-index*

Name	h_t	a_t	h	$N_{c,tot}$	N_p
1.sigmod	34	6.67	45	12261	2059
2.vldb	27	8.00	37	9729	2192
3.pods	19	6.53	26	3883	776
4.icde	16	9.52	22	3307	1970
5.icdt	12	3.67	11	580	313
6.edbt	9	6.02	13	658	434
7.er	8	10.35	16	1486	1338
8.dood	8	4.43	8	440	171
9.kdd	7	6.42	6	243	1074
10.dbpl	7	5.11	8	410	228

Table 9: Conferences Ranking using *trend h-index*

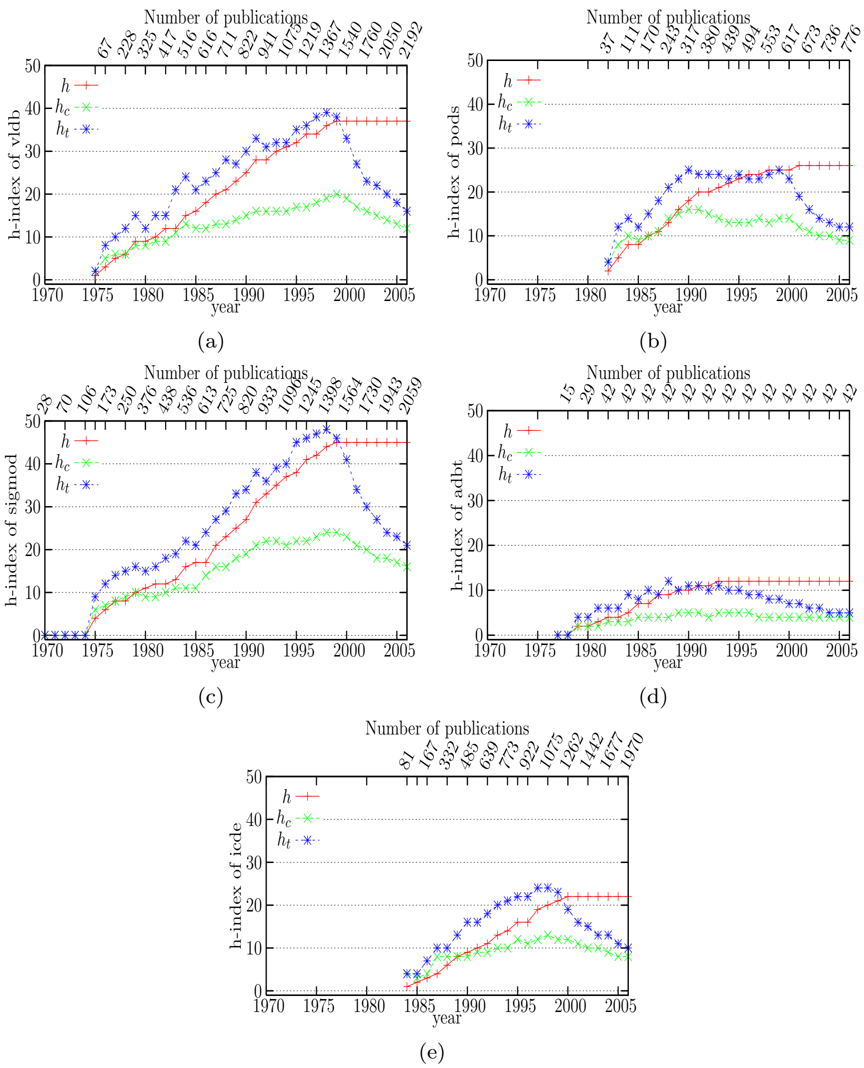


Figure 2: *h-index* of Database Conferences

computed if we exclude everything from our database after 1995. Apaprently, this is different from a score for the VLDB95 organization which is defined as h_{1995}. Finally, we have to remind that there is lack of citations in our dataset for the years after 1999. Therefore, in all graphs there is a stabilization of the *h-index* line and a downfall for the indicators *trend h-index* and *contemporary h-index*.

In Figure 2(c) is presented the history of the SIGMOD Conference. According to the tables that we presented SIGMOD is in the first place. In the figure, we observe its intense ascendant course. Also the *trend h-index* remains higher than the *h-index* (until 1999). On the other hand, the PODS Conference (Figure 2(b)) follows a bending line after 1993. Thus, the *h-index* is lightly increased. ICDE is a younger conference compared to the rest conferences presented, but we can see in the plot (Figure 2(e)), that it follows an rapidly ascendant course.

Finally, for the conference ADBT (Figure 2(d)) there is lack of data. As we can see in $x2$ axes, the number of publications stops being increased after 1982. So, it cannot be compared to the rest of the conferences. The small number of publications of ADBT is the reason that ADBT is ranked first in Table 7.

4.3 Experiments on the Yearly Conferences Ranking

The next dimension of the Conferences ranking is mentioned in the definitions 2 and 3. This way we evaluate for example VLDB95 independently from VLDB94. It is obvious that in this case it is meaningless to add a second time dimension (with indicators *contemporary h-index* and *trend h-index*). *contemporary h-index* of VLDB95 will be stable during all the following years, since all papers are published during the same year. On the other hand, it is not important whether a conference organized in 1980 is still getting references.

Indicatively, we present the Tables 10 and 11 which present the conferences ranking for the years 1995 and 1990 respectively. In part (a) of these tables the ordering is performed by using the *yearly h-index* (h_y). Factor a is the second criterion for the ranking. We also present the columns h_y^n, which is the *h-index* divided by the number of publications $N_{p,y}$. Also, column $N_{c,1995}$ is the number of citations to papers published during 1995. In the second part (b) of the tables, the ordering is computed based to the *normalized h-index.* Notice here, that although it seems to have equivalences by using h_y^n, the real numbers make such a situation almost unprovable (i.e. $5/24 = 0.20833$, $6/29 = 0.206897$). What we observe here,is that there are no important differences in the ranking for the two indicative years, and not also by the *normalized h-index.* On the other hand, it is obvious that using the method *normalized h-index* gives a small advantage to the conferences that have a small number of publications. For example, the VLDB Conference is almost stable in the first place using the *yearly h-index*, but it is improbable to get the first place using the *normalized yearly h-index.*

Name	h_{1995}	a	h^n_{1995}	$N_{c,1995}$	$N_{p,1995}$
1.vldb	11	3.57	0.15	432	72
2.sigmod	9	4.62	0.10	375	85
3.icde	6	6.63	0.08	239	68
4.pods	6	4.16	0.20	150	29
5.ssd	5	2.08	0.20	52	24
6.kdd	4	3.81	0.07	61	56
7.cikm	3	6.22	0.05	56	55
8.dood	3	5.88	0.06	53	46
9.icdt	3	3.66	0.08	33	34
10.er	3	3.33	0.06	30	47

(a)

Name	h^n_{1995}	h_{1995}	$N_{p,1995}$
1.ssd	0.20	5	24
2.pods	0.20	6	29
3.cdb	0.2	2	10
4.vldb	0.15	11	72
5.coopis	0.14	3	21
6.artdb	0.11	2	17
7.sdb	0.11	1	9
8.sigmod	0.10	9	85
9.ride	0.10	2	19
10.tdb	0.1	2	20

(b)

Table 10: 1995 Conferences Ranking.

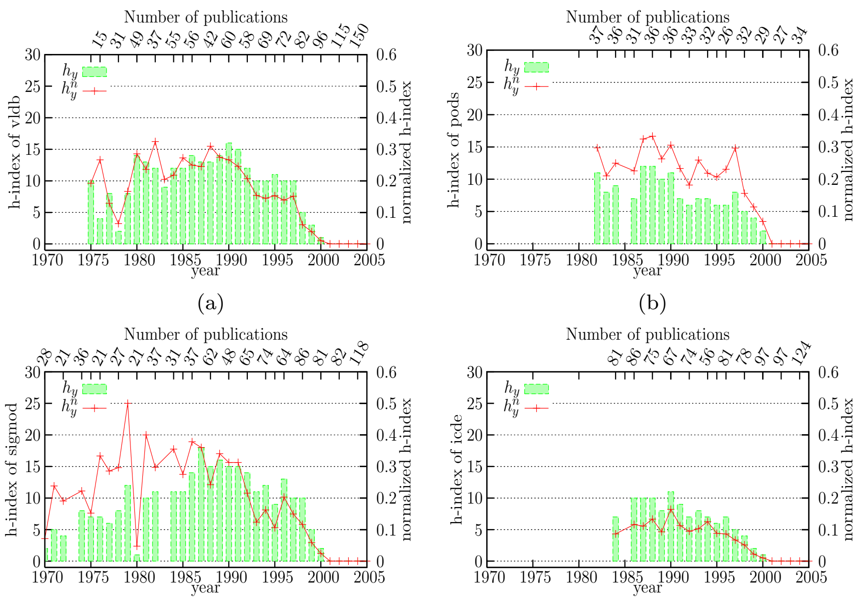
Name	h_{1990}	a	h^n_{1990}	$N_{c,1990}$	$N_{p,1990}$
1.vldb	16	2.57	0.26	659	60
2.sigmod	15	3.44	0.31	776	48
3.icde	11	2.76	0.16	335	67
4.pods	11	2.40	0.30	291	36
5.edbt	7	2.83	0.21	139	32
6.icdt	5	4.32	0.14	108	34
7.dpds	4	3.75	0.22	60	18
8.er	3	4.66	0.08	42	35
9.ds	3	4.11	0.12	37	24
10.ssdbm	3	3	0.16	27	18

(a)

Name	h^n_{1995}	h_{1995}	$N_{p,1995}$
1.sigmod	0.31	15	48
2.pods	0.30	11	36
3.vldb	0.26	16	60
4.dpds	0.22	4	18
5.edbt	0.21	7	32
6.ssdbm	0.16	3	18
7.icde	0.16	11	67
8.icdt	0.14	5	34
9.ds	0.12	3	24
10.ewdw	0.10	3	29

(b)

Table 11: 1990 Conferences Ranking.



(c) (d)

Figure 3: *yearly h-index* and *normalized yearly h-index* of Database Conferences

In Figure 4 we present the plots for the values of *yearly h-index* (h_y) and *normalized yearly h-index* (h^n_y) for the first four conferences VLDB, PODS, SIGMOD and ICDE. The values for h_y are drawn using bars, because each value is independent from the rest ones. The value for h_y of a conference has different upper bound for each year. The upper bound for each year is defined by the number of papers published during this year. This is depicted on axes $x2$. On the other hand, the h^n_y values are normalized. So, it is a comparable value for the two years of a conference and it is drawn with the (red) cross points line. The values for the h^n_y index are presented in axes $y2$. There is no association of axes $y1$ to $y2$, so we cannot compare (obviously) the values of h^n_y to h_y. The only remark that we can make is that the one curve follows approximately the other. This comes in agreement with the conclusions derived from Tables 10 and 11.

5 Experiments with Journal Ranking

In the case of Journals, we can use the basic form of *h-index* as well as the *normalized h-index*, *contemporary h-index* and *trend h-index* variations that we defined for authors and for conferences. Here, as of the case of the conferences, the *normalized h-index* is a valuable indicator contrary to the case of the authors-researchers.

In the following pages of this section, we present the results of computing the defined indicators for the Journals that belong to the Database scientific domain. Finally, we believe that each annual publication of a journal is not independent from previous/next publications. In other words, there is a cohesion between annual journal publications. For this reason, we consider that the evaluation of the annual journal publications does not add an important value, and consequently we do not present the *yearly h-index* and the *normalized yearly h-index* that we defined for the case of the conferences.

Name	h	a	$N_{c,tot}$	N_p
1.tods	49	3.88	9329	598
2.tkde	18	4.69	1520	1388
3.is	16	4.71	1208	934
4.sigmod	15	5.07	1142	1349
5.tois	13	4.37	740	378
6.debu	11	7.13	863	877
7.vldb	9	5.03	408	281
8.ipl	8	6.06	388	4939
9.dke	6	8.77	316	773
10.dpd	6	5.25	189	238

Table 12: Journal Ranking using *h-index*

Name	h_n	h	a	$N_{c,tot}$	N_p
1.tods	0.08	49	3.88	9329	598
2.tois	0.03	13	4.37	740	378
3.vldb	0.03	9	5.03	408	281
4.dpd	0.02	6	5.25	189	238
5.jiis	0.01	6	4.33	156	318
6.datamine	0.01	3	5.11	46	162
7.is	0.01	16	4.71	1208	934
8.ijcis	0.01	4	3.12	50	255
9.tkde	0.01	18	4.69	1520	1388
10.debu	0.01	11	7.13	863	877

Table 13: Journal Ranking using *normalized h-index*

Name	h_c	a_c	h	$N_{c,tot}$	N_p
1.tods	18	6.25	49	9329	598
2.tkde	10	6.40	18	1520	1388
3.sigmod	9	6.17	15	1142	1349
4.debu	6	9.21	11	863	877
5.vldb	6	6.47	9	408	281
6.tois	6	6.09	13	740	378
7.is	5	12.77	16	1208	934
8.dpd	5	4.19	6	189	238
9.jiis	5	3.79	6	156	318
10.dke	4	7.70	6	316	773

Table 14: Journal Ranking using *contemporary h-index*

Name	h_t	a_t	h	$N_{c,tot}$	N_p
1.tods	28	4.93	49	9329	598
2.tkde	13	6.64	18	1520	1388
3.sigmod	12	5.85	15	1142	1349
4.vldb	10	3.75	9	408	281
5.is	9	7.11	16	1208	934
6.debu	9	6.98	11	863	877
7.tois	9	4.83	13	740	378
8.dpd	6	4.88	6	189	238
9.jiis	6	4.75	6	156	318
10.dke	5	8.18	6	316	773

Table 15: Journal Ranking using *trend h-index*

6 Conclusions

Estimating the significance of a scientist's work is a very important issue for prize awarding, faculty recruiting, etc. This issue has received a lot of attention during the past decades and a number of metrics have been proposed which are based on arithmetics upon the number of articles published by a scientist and the total number of citations to these articles. The interest on these topics has been renewed and in a path-breaking paper, J. E. Hirsch proposed the h-index to perform fair ranking of scientists, avoiding many of the drawbacks of the earlier bibliographic ranking methods.

The initial proposal and meaning of the h-index has various shortcomings, mainly of its inability to differentiate between active and inactive (or retired) scientists and its weekness to differentiate between significant works in the past (but not any more) and the works which are diachronic.

Based on the identification of these *h-index* shortcoming, in this article we proposed a number of effective *h-index* variants. Some of these variants aim at the ranking of publication forums, i.e., conferences and journals or magazines. Other variants aim at a fair ranking of scientists, by taking into account the age of the published material, as well as the age of the citations to it.

To evaluate the proposed ranking metrics, we conducted extensive experiments on the online bibliographic database of DBLP. From the results we obtained, we conclude that *h-index* itself is not indicative of the authors progress.

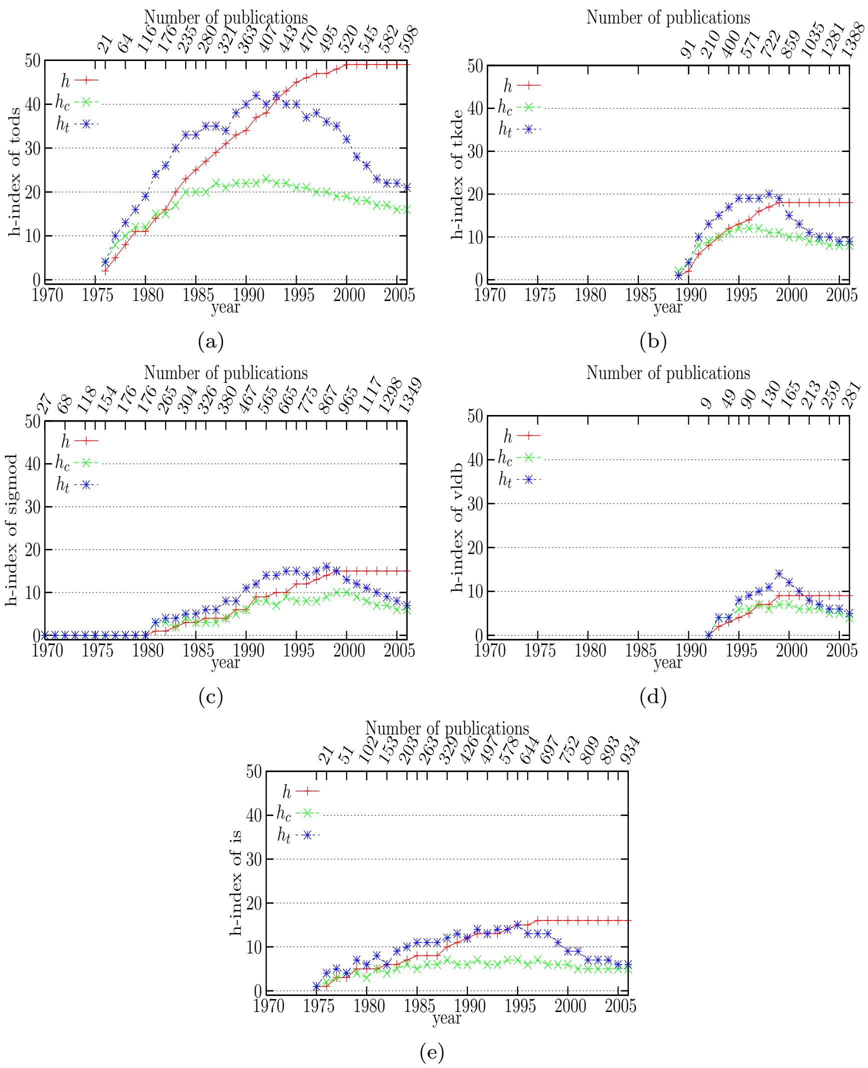


Figure 4: *h-index* Database Journals

Adding a time dimention to the *h-index* such as the *contemporary h-index* and the *trend h-index* variations, gives more information. Also, these two indicators may be used in order to predict the *h-index* path. For the conferences and journals, the variations of *normalized h-index*, *contemporary h-index* and *trend h-index* give a more fair view for the ranking. Finally, the *yearly h-index* and the *normalized yearly h-index* can be used in order to evaluate separatelly the conference organizations.

References

[1] P. Ball. Index aims for fair ranking of scientists – H-index sums up publication record. *Nature*, 436(7053):900, 2005.

[2] J. Bar-Ilan. H-index for price medalists revisited. *ISSI Newsletter*, 5, Jan.

[3] L. Bornmann and H.-D. Daniel. Does the h-index for ranking of scientists really work? *Scientometrics*, 65(3):391–392, 2005.

[4] L. Egghe. An improvement of the H-index: the G-index. *ISSI Newsletter*, 5, Jan.

[5] Ergin Elmacioglu and Dongwon Lee. On six degrees of separation in dblp-db and more. *SIGMOD Record*, 34(2):33–40, Jun 2005.

[6] J. E. Hirsch. An index to quantify an individual's scientific research output. *PNAS*, 102(46):16569–16572, Nov 2005.

[7] Antonis Sidiropoulos and Yannis Manolopoulos. A Citation-based System to Assist Prize Awarding. *ACM SIGMOD Record*, 34(4):54–60, Dec 2005.

[8] Antonis Sidiropoulos and Yannis Manolopoulos. Generalized comparison of graph-based ranking algorithms for publications and authors. *Journal for Systems and Software, accepted for publication*, 2006.

[9] Antonis Sidiropoulos and Yiannis Manolopoulos. A New Perspective to Automatically Rank Scientific Conferences Using Digital Libraries. *Information Processing and Management*, 41(2):289–312, 2005.