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Ranking of Individual Authors: A New Indicator to Avoid Conflicts between Rankings

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Abstract: Citation received from scholarly sources has become a standard and an indirect measure to assess the impact as well as the reputation of the author. There are several indices which measure the rank of the author, institutes, journals as well as a country. But most of the indices stress solely on highly cited papers. There are only a few indices that count total number of papers and related citation values together. Two new quality assessment indicators have been introduced in this paper in order to avoid the conflicts between the rankings of authors, journals or institutions. The name given these two new indicators are BD(H) index and BD(G) index, which stand for Balanced Deviation of citation from h index and g index respectively. These two new indicators have been tested for twenty-five top-ranked authors in the field of protein chemistry, which shows the non-occurrence of the overlapping of rankings. This new method of ranking mechanism takes these two parameters and has potential to generate a family of indices. The formulation of these two new indicators is essentially based on the classical standard deviation method of descriptive statistics.

Keyword: Scientists Ranking; Scientometric Indicator; Bibliometric Indicator; Citation-based Ranking; B(H) Index; B(G) Index; H Index; G Index

1. Introduction

With the development of citation databases, it is now relatively easy to track the citation earned by a scholarly output (thesis, report, journal articles, conference proceedings, short communication etc.). Ranking of scientists has become a very interesting research area and many scientists have developed different quantitative indicators since last decade. But, different indicators might to lead to same ranking of the scientists which leads to ranking conflicts. Most of the prominent indicators or indices follow the calculation of h-Core area and other highly cited zone [h-index, e-index, α-index, w-index, h(2)-Index etc.] (Hirsch,2005; Zhang,2009; Jin et al,2007; Egghe,2006a; Egghe,2006b; Egghe,2007; Egghe,2010; Egghe,2009a; Egghe,2009b; Wu,2010). Bornmann et

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al(2008) segregated h-index and other derived h-index types into two different categories- h-index, g-index, m-quotient, h(2) index etc. There are various other indicators derived from h-index and h-type indices, i.e. a-index, m-index, r-index, ar-index, h_w index, Citation Swing Factor (Dutta,2020; Das & Dutta,2021), Citation Fall Index (Dutta,2023). But, none of them could not measure the overall prestige of the author with respect to total publications or total citations. On the contrary, P-index (Prathap & Nishy, 2010) combines two different quantitative and qualitative factors such as, total citations and total publications. That's why, our approach is somewhat different, i.e. counting the difference between a fixed standard point and citation earned per article including zero citation.

The insights gained from the findings of this study can provide information managers working in citation analysis and academic journal editors working in information and document management fields with the opportunity to identify key problems in the field and encourage interdisciplinary collaboration (Sesen & Gurbuz, 2024).

2. Literature Review

Framing h-index has become a big milestone in the field of scientific assessment of scholars, journals and other entities. Despite the disadvantages/shortcomings of h-index, it has become inspiration of developing new types of indicators since last decade. Recently, the alternate h-indices were classified into seven categories (Bihari,2023). g-index was proposed which indicates the value of a scholar whose top g papers have at least earned g^2 number of citations(Egghe,2006). This index gives importance to count the most cited papers into a large group (greater than h-core) and this disadvantage was marked and removed in h(2) index (Komulski,2006). h(2) index of a scientist is the highest natural number such that, his h(2) most cited papers received at least $[h(2)]^2$citations. If a scientist has h(2) index as 14, that means his most cited 14 papers have received at least 196 ($=14^2$) number of citations each. w-index was proposed which is similar to h(2) index, but it bypasses one shortcoming of h(2) i.e. young scholars who do not have enough publications are always penalized by h(2) index. W-index of a scholar is w when his/her top w number of papers have earned at least 10w number of citations – if w-index of a researcher is 8 that means, his/her top 8 papers have received at least 80 citations(Wu,2010). As h-index is highly biased to highly cited papers, f-index and t-index were proposed using harmonic average, where as f-index (Tol,2009)can be defined as:

$$f = \max \frac{1}{\frac{1}{f}\sum_{p=1}^{f}\frac{1}{Cit_p}} \geq f$$ [$Cit_p$is the number of citations of p-th paper]

As harmonic mean has been taken into counting, least cited papers earn more quantitative value and the higher cited papers earn less quantitative score. To avoid this limitation the same author,Toi(2009), proposed t-index as –

$$t = \max \exp\left[\frac{1}{t}\sum_{k=1}^{t} ln(cit_k)\right] \geq t \leftrightarrow \max \prod_{k=1}^{t} cit_k^{\frac{1}{t}} \geq t$$

Usually, the values of t and f-index lie between the values of h-index and g-index, i.e. [**h ≤ f ≤ t ≤ g**]. A–index was proposed by Jin (2006) to take the sum of the citations normalized by h-index value and this can be mathematically written as –

$$A = \frac{1}{h}\sum_{p=1}^{h} Cit_p$$

[h is the h-index and Cit_p is the citation count of the p-th article]

The problem with A-index is that, A-index can be heavily undervalued when there is high h-index value and low citation distribution in h-core. To avoid this problem, R-Index (Jin et al,2007) was developed which mathematically can be written as –

$$R = \sqrt{\sum_{p=1}^{h} Cit_p}$$

According to Bihari (2023), scholars having long h-cores might be penalized and to overcome this problem, Panaretos and Malesios (2009) proposed another index (R_m index) which can be defined as – “The R_m-index of scholars is the square root of the sum of square roots of the citation counts of the h-core articles”.

$$R_m = \sqrt{\sum_{k=1}^{h} Cit_k^{\frac{1}{2}}}$$

R_m index also suffers from the variability in the citation counts in the h-core. Burrell(2007) proposed another index called m-quotient index which normalizes the h-index with the publication age, where publication age is an important factor to equalize the relative performance value of senior and junior scientists.

$$m - Quotient = \frac{h}{Publ_{age}}$$

Still one problem looms large if two scholars have same h-index but with different number of published articles and to overcome this problem, several indices have been developed. Sidiropoulos, Katsaros & Manolopoulos (2007) proposed normalized h-index which is nothing but a ratio between h-index of the scientist and publication count of the author (Pub_{Count}).

$$Normalized\ h-Index\ =\ \frac{h}{Pub_{Count}}$$

Similarly, v-index was proposed by Rikonen and Vihinen (2008). In order to get the benefits from both h-index and g-index, Alonso et al. (2010) developed another index called hg index which is nothing but the square root of the product of h-index value and g-index value of an author, mathematically can be defined as: $hg = \sqrt{h \cdot g}$.

Cabrirezo et al (2010) combined the benefits of both types of indices by using the q^2-index, which is based on the geometric mean of the h-index and the median number of citations obtained by publications in the h-core, or the m-index (Cabrerizo et al,2010).

$$q^2\text{-index} = \sqrt{h \cdot m}$$

Ye and Rousseau(2009) devised a new index (K-Index) following power law and a ratio of h-core and tail.

$$k-index = \frac{C(t)}{P(t)} \Big/ \frac{C_T\ (t)}{C_H\ \ (t)}$$

C(t) – Cumulative number of Citations at time t
P(t) – Cumulative number of publications at time t
$C_T(t)$ – Total citations at Tail region
$C_H(t)$ - Total citations at Head region

de Souza et al(2025) developed a very unique index known as SPR-index (Scientific Peer Review) combining h-index of the researcher, total publication of the author and total number of peer reviews conducted.

SPR Index = (H / P) x R.

[H- index of the researcher, P – total number of papers authored, R – total number of peer reviews conducted].

Ruiz Estrada(2025) devised a very unique index to rank authors taking several quantitative factors as follows –

L-Index = [X1 = Total Citations as First Author/Total Citations] + [X2 = Total Published Papers as First Author/Total Published Papers] + [X3 = Total Published Papers as First Author Downloads/Total Papers Downloads] + [X4 = Total Papers Views as First Author/Total Papers Views] + [X5 = Total New Publications as First Author Per Year/Total New Publications per Year]

If $0 \geq L\ Index \geq 1.6$- the researcher's performance is poor, if $1.7 \geq L\ Index \geq 3.5$ - the researcher's performance is average in nature, and if $3.6 \geq L\ Index \geq 5$ - the researcher's performance is prolific in nature (Estrada,2025).

The distribution based on the average number of authors, arithmetic counting, geometric counting, and the harmonic count is unfair if there are more co-authors. Zhang(2009) created a new index known as the weighted h-index in order to address this problem. In weighted h-index, the shared credit to each author would be as –

$$WC(j,m) = \frac{2\,(m-j+1)}{(m+1)(m-2)},\quad m \geq 4,\ 2 \leq j \leq m-1$$

[m – total no of authors, j – rank of author]

Tas and Ertuk(2024) considered the factor of professional life of an author and used along with h-index of the individual, the modified H-Index is:

$$mHI = \frac{H\ Index}{(1+PLD/100)}$$

[PLD = Year of H-Index calculated – Year of First Publication]

Fiorillo(2022) devised an alternate form of h-index by segregating percentage of self-citation, the Fi – index is-

$$h\ index - [\frac{(100 - \%\ self\ citation)}{100} * h\ index]$$

With the use of expanded co-authorship numbers or inflated ratings coming from self-citations, where each citation is given the same influence despite limited individual contributions, the suggested index aims to overcome well-known problems with traditional metrics. Dillon(2022) devised the new index which allows for the differentiation of scholars who would otherwise be in the same h-index group, offering additional information on the true effect of a particular individual researcher.

$$\textbf{u-index} = \frac{I+S/2}{\sqrt{N}}$$

Here I is the number of independent citations, S is the number of self-citations and N is the number of authors present in paper(Dillon,2022).

3. Objective of the Study

1. To develop new indicators for the removal of ranking conflicts of individual author(s)with respect to their citation earned against total publication.
2. To discover the possibility of creating certain nature of derivative index-family from standard indicators.

4. Data Collection

The data for the study concerned comprise the names of the authors from the subject domain of Protein Chemistry. In all, 25 prolific authors or scientists from the domain of Protein Chemistry have been selected at first on the basis of the total number of citations received. The detailed citation data of the stipulated 25 scientists has been collected then from Web of Science. After retrieving the bibliographic and citation data, the citation profile of each and every twenty-five stipulated authors have been collected and processed for analysis.

5. Methodology

The method involved in this work is based on the principle of standard deviation, a very common technique adopted in descriptive statistics[35-37]. Indescriptive statistics, the measures of dispersion compute the range to which the individual data points in a dataset deviate from the center of the distribution. The measures of dispersion are also known as the measures of scattering or spread. While the measures of central tendency, which involves the computations of mean, median, mode etc. tell us about the distinctive value reflecting the centralized weightage or centre of gravity of a dataset, the measures of dispersion tell us how scattered the different data-points within a dataset is from the centre of gravity value. The measures of dispersion deliver valued information about the steadiness and consistency of the data, complementing measures of central tendency (mean, median and mode) which only tell us about the centralized or average of the data. Measures of dispersion can be broadly classified into two categories, i.e. absolute and relative. Absolute measures of dispersions how variation in the same units as the data that includes range, variance, standard deviation, mean deviation and quartile deviation. Whereas, relative measures of dispersion represent dimensionless ratios or percentages used for comparing datasets with different units or scales. These include the coefficient of range, coefficient of variation, coefficient of mean deviation and coefficient of quartile deviation.

A small measure of dispersion indicates that data points are clustered closely around the central value, suggesting consistency or homogeneity. A large measure of dispersion indicates that data points are widely scattered, suggesting greater variability or heterogeneity. In descriptive statistical analysis, the standard deviation is calculated differently for a population (an entire dataset) and a sample (a subset of a larger population).Population standard deviation is defined as for the dataset belonging to the entire population, i.e.$\sigma = \sqrt{\frac{\sum (X_i - \mu)^2}{N}}$; Where σ represents the population standard deviation; X_i stands for the observations or data points against the random variable X; μ represents the population mean or average and N denotes the total number of observations or data points against the random variable X in the population. The sample standard deviation may be defined as, $S = \sqrt{\frac{\sum (X_i - X_{AV})^2}{(n-1)}}$; Where S represents the sample standard deviation; X_i indicates the observations or data points against the random variable X; X_{AV} represents the sample mean or average and n stands for the total number of observations or data points against the random variable X in the sample.

A new Index has been introduced in this study on the basis of the definition of Standard Deviation and the name given to this index is BD(H) Index as this index or indicator describes a Balanced Deviation of Citation from H Index. Any citation distribution over the cited publications estimates a value of H index, which lies at an intermediate point between maximum citation and minimum citation. The H index thus lies within the range of citation and consequently the deviation of citations from H index for high citation values yield positive deviation while the same for low citation values yield negative deviation. The resultant deviation value becomes either positive or negative depending on the position of h index within the range of citation. The resultant deviation or total deviation of citation from H index thus represents a balanced deviation, which is the crux feature of the index BD(H) [Equation (1)]. Similarly, another index is defined and presented in Equation (2), where the deviation of citation from G index has been taken under consideration and the name given to this index is BD(G) index or Balanced Deviation of Citation from G index. In these both cases, the deviation of citation from H index and G index become balanced due to simultaneous presence of positive and negative deviations.

i. BD(H) Index $= \sqrt{\frac{\sum (C_i - H)^2}{N}}$ **(1)**

Where, N is the total number of publications, H is the H-index value of the author and C_i is the citation earned of i^{th} paper authored by the researcher.

ii. BD(G) Index $= \sqrt{\frac{\sum (C_i - G)^2}{N}}$ **(2)**

Where, N is the total number of publications, G is the G-index value of the author and C_i is the citation earned n-th paper authored by the researcher.

6. Steps involved in Calculating BD(H) Index and BD(G) Index

1. To calculate the H-index/ G-index of the author.
2. To square the difference between individual citation of each paper and H-Index/ G-index.
3. To sum up the individual difference value and to divide by total number of publications consequently.
4. To calculate the square root of the value obtained from step-3.
5. After obtaining the index value, to rank them according to descending order.

6.1 Rationale Behind Developing BD(G) and BD(H) Index

1. Most of the indices are very much concerned with the highly cited papers, but a prolific author also publishes a considerable number of articles which can't earn citations or have low citations, but, the individual citation values against each article/book beyond h-Index value practically don't contribute to h-Index unless they gain citations to come within the H-Core zone.
2. Simple comparison among authors with h-Index might lead to illogical ranking with respect to own citation profile. Many authors might also

belong to different subject fields and each subject has different citation habitudes and that is reflected through the normalized value of citations earned per paper. Even a most prolific author in a subject might have a considerable number of non-cited papers[38]. The newly devised indices capture all the publications even if there exist uncited papers.

3. The new method includes standard deviation method to calculate the difference between each citation value of each article from a standard reference point. In case of calculating the Standard Deviation, each data point is subtracted from mean value of the distribution, but in case of citation distribution, citation value can’t be fractional one. If the mean value of the citation distribution is a fraction value, it can’t be logically viable value although mathematically very correct. If the Mode (modal value) is taken as standard reference value, the mode value is usually biased to low citation value (e.g. Mode of all authors is 0) or 0 value as there is a considerable number of papers which has no citation i.e. 0 becomes the most frequently occurring value. In case of selecting Median as standard reference point, there also remains some logical doubts – if an author is a very prolific one, he/she usually has a long list of publications with considerable number of citations. If the publications are sorted according to descending order of citations, 50% of the total from the lower end will have a very low number of citations. Therefore, for a long citation distribution the median value tends to be a very lesser value.The h indices, mean or average values, median values and modal values of the citation distribution of all concerned authors are presented in Table 1 along with the names, affiliations and specialized research areas of the stipulated twenty-five authors. The total number of citations received, total number of publications till date, h index and g index of the said twenty-five scientists or authors are furnished in Table 1A. The names and also the initials of the twenty-five stipulated authors are alphabetically arranged in Table 1 and Table 1A.

Student’s t-test has been applied to ascertain whether the difference between h index and mean citation and also the difference between h index and median citation are significant. A t-test is a statistical tool used to determine if there's a significant difference between the two sets of data. It helps to assess whether observed differences in sample means are likely due to a real difference in the populations from which they were drawn, or if they could have occurred by random chance. A significant difference is typically indicated by a p-value less than 0.05. The t-test between h index and mean citation results the $p=0.0011$ and the same between h index and median citation results the $p=0.000073$, both of which are far less than 0.05. Hence, it may be inferred that there are significant differences h index and mean citation and also between h index and median citation. Such significant difference intends not to take the differences between h/g index and mean/median citation in the formulae for BD(H) and BD(G) indices. The deviations of total citation from h/g indices are considered therefore as the fundamental definitions of these two indicators.

4. Among many disadvantages of h-Index and other indices are that, when authors have the same h-Index or g-Index value would also get the same rank which results into ranking conflict. There is no specific mechanism to resolve such ranking conflict. The proposed indices take every publication into account and count the difference from the standard reference value i.e. h-index and g-index.
5. Any prolific author, who writes scholarly papers, earns greater percentage of citations for a smaller number of papers than the actual number of written in lifetime. Many papers lie below the h-Core region. But every piece of paper published though scholarly production media is actually a basic contribution, but most of the indicators (h-Index, g-Index) usually ignore lower cited papers. This indicator takes every paper into its consideration even if they have earned zero citation.
6. Here, standard deviation formula has been applied as it delivers information on the proportion of observation/data above or below certain value. Here, the certain value represents the h-Index in the first method, g-Index in the second method. The main focus is to calculate the difference between standard values from citation values ($0 \rightarrow N$).
7. In case of g-Index, if the first few papers have excessively high number of citations and the rest have lower number of citations, then the value of g-Index might get inflated to certain number that might not be the number of articles published by the author and it is also observed that, they have high mean citation rate.

Name of the Author/ Scientist	**Affiliation**	**Specific Research Area(s)/ Specialization**	**Initials**	**h Index**	**Mean Citation**	**Median Citation**	**Modal Citation**
Amos Bairoch	University of Geneva & Swiss Institute of Bioinformatics, Lausanne, Switzerland	Bioinformatics & Protein Science	AB	100	311.10	86	0
Benjamin G Davis	University of Oxford and Rosalind Franklin Institute, England	Chemistry of Protein, Chemistry of Carbohydrate, Biomolecules	BGD	84	68.68	35	0
Bernhard Kuster	Technical University of Munich, Germany	Proteomics, Chemical Biology, Precision Oncology	BK	90	97.24	20	0
Christian von Mering	University of Zurich and Swiss Institute of Bioinformatics, Lausanne, Switzerland	Computational Biology	CVM	93	382.46	62	0
Christophe Dessimoz	University of Lausanne & Swiss Institute of Bioinformatics,	Bioinformatics, Genomics, Computational	CD	47	119.88	25	3

	Switzerland	Biology					
Edward Marcotte	University of Texas at Austin, USA	Molecular Biology, Bioinformatics, Proteomics	EM	83	133.87	31.5	0
Gerard Drewes	Cellzome/GlaxoSmithKline R&D, Cambridge, UK & Heidelberg, Germany	Drug Discovery, Chemical Biology, Proteomics, Kinases	GD	57	205.14	52.5	0
Hiroyuki Ogata	Bioinformatics Center, Institute for Chemical Research, Kyoto University, Japan	Evolution and Ecology of Microorganisms, Genomics, DNA Virus	HO	38	111.75	20.5	0
Iseult Lynch	University of Birmingham, England	Environmental Nanosciences	IL	78	84.53	25	0
Jacqueline Matthews	University of Sydney, Australia	Protein Chemistry	JM	46	43.43	20	0
Jaime Huerta-Cepas	The Centre for Plant Biotechnology and Genomics, Madrid, Spain	Phylogenomics, Phylogenetics, Computational Biology, Metagenomics	JHC	46	625.04	65	13
Marc Wilkins	University of New South Wales, Sydney, Australia	Proteomics, Genomics, Molecular Systems Biology	MW	64	45.80	17	0
Marco P Monopoli	Royal College of Surgeons in Ireland	Nanomaterials and living systems, Nanomedicine, Nanotoxicology applications on Environment	MPM	35	178.01	30.5	0,1
Marcus Bantscheff	Cellzome/GlaxoSmithKline R&D, Cambridge, UK & Heidelberg, Germany	Proteomics, Chemical Biology, Drug Discovery	MB	62	160.85	55	0
Maria J Martin	European Bioinformatics Institute, Cambridge, UK	Protein Chemistry, Bioinformatics	MJM	29	35.29	8	0
Marina Marcet-Houben	Barcelona Supercomputing Centre, Spain	Bioinformatics, Genomics	MMH	37	68.98	34	0
Michael Kuhn	European Molecular Biology Laboratory, Heidelberg, Germany	Protein-Chemical Interaction	MK	14	83.71	12	0
Peer Bork	European Molecular Biology Laboratory, Heidelberg, Germany	Computational Biology, Molecular Systems Biology	PB	219	468.97	111	0
Pinak Chakraborty	Department of Biochemistry, Bose Institute, Kolkata, India	Biochemistry	PC	49	65.83	25	0
Rajaram Swaminathan	Indian Institute of Technology Guwahati, India	Biophotonics, Protein Structure and Dynamics, Proteome Analysis,Molecular Crowding in Living Cells	RS	22	33.98	4	0
Samuel Chaffron	LS2N Lab, Centre National de la Recherche Scientifique (CNRS), France and Nantes University, France	Computation Biology, Ecology, Microbiology	SC	32	245.83	47.5	8,7,0
Sandra Orchard	European Molecular Biology Laboratory-European Bioinformatics Institute,	Bioinformatics, Proteomics, Interactomics	SO	46	299.14	29	0

	Cambridge, UK						
Takuya Ueda	Waseda University, Tokyo, Japan	Biochemistry	TU	57	55.92	31	0
Tapas Kumar Kundu	Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru, India and Central Drug Research Institute, Lucknow, India	Molecular Biology, Genomics, Cancer Biology	TKK	51	49.96	21	0
Todd O Yeates	University of California, Los Angeles, USA	Protein Structure, Crystallography, Protein Design &Assembly, Computational Biology	TOY	69	105.84	31	0

Table-1: Mean, Median and Mode of the Citation Distribution of the stipulated Twenty-five Authors

Name	Initials	Total Citations	Total Publications	h Index	g Index
Amos Bairoch	AB	65019	209	100	254
Benjamin G Davis	BGD	22390	326	84	140
Bernhard Kuster	BK	39090	402	90	194
Christian von Mering	CVM	93702	245	93	306
Christophe Dessimoz	CD	16903	141	47	129
Edward Marcotte	EM	35610	266	83	188
Gerard Drewes	GD	24207	118	57	155
Hiroyuki Ogata	HO	10281	92	38	102
Iseult Lynch	IL	34658	410	78	179
Jacqueline Matthews	JM	6731	155	46	79
Jaime Huerta-Cepas	JHC	44378	71	46	210
Marc Wilkins	MW	17770	388	64	122
Marco P Monopoli	MPM	13529	76	35	116
Marcus Bantscheff	MB	21072	131	62	145
Maria J Martin	MJM	4941	140	29	69
Marina Marcet-Houben	MMH	5518	80	37	74
Michael Kuhn	MK	2595	31	14	50

Peer Bork	PB	309986	661	219	556
Pinak Chakraborty	PC	9282	141	49	94
Rajaram Swaminathan	RS	2786	82	22	52
Samuel Chaffron	SC	15493	56	32	124
Sandra Orchard	SO	43376	145	46	208
Takuya Ueda	TU	11575	207	57	102
Tapas Kumar Kundu	TKK	9343	187	51	92
Todd O Yeates	TOY	24556	232	69	156

Table-1A: Mean, Median and Mode of the Citation Distribution of the stipulated twenty-five Authors

The BD(G) index and the BD(H) index of the stipulated twenty-five scientists are calculated on the basis of equations (1) and (2) and furnished in Table 2.

Author	**H-Index**	**Rank**	**G-Index**	**Rank**	**HG Index**	**Rank**	**BD(G) Index**	**Rank**	**BD(H) Index**	**Rank**
AB	100	2	254	3	159.374	3	703.1125	5	731.8939	5
BGD	84	5	140	12	108.444	7	127.0946	20	106.3076	20
BK	90	4	194	6	132.136	4	351.427	10	334.694	11
CVM	93	3	306	2	168.695	2	1333.377	8	1362.29	9
CD	47	15	129	13	77.865	14	433.9079	3	440.0468	3
EM	83	6	188	7	124.916	5	341.6638	11	341.1632	10
GD	83	6	188	7	124.916	5	510.0305	6	528.7375	6
HO	57	11	155	10	93.995	12	278.4742	16	287.9095	15
IL	38	17	102	17	62.258	20	281.2169	15	264.9553	16
JM	46	16	79	20	118.161	6	73.16848	1	63.99007	1
JHC	46	16	210	4	98.285	9	2187.622	25	2224.571	25
MW	64	9	122	15	88.363	13	132.7966	13	110.2706	13
MPM	35	19	116	16	63.718	18	431.2932	19	450.1344	18
MB	62	10	145	11	94.816	11	300.5383	12	315.9813	12

MJM	29	21	69	22	44.733	23	128.4499	23	124.108	21
MMH	37	18	74	21	52.326	22	92.96881	9	98.18528	8
MK	14	23	50	24	26.458	25	323.4157	18	326.627	19
PB	219	1	556	1	219	1	1389.235	2	1408.641	2
PC	49	14	94	18	67.868	17	97.68933	22	95.0415	22
RS	22	22	52	23	33.823	24	83.98971	24	83.05405	24
SC	32	20	124	14	62.992	19	459.2585	7	491.7314	7
SO	46	16	208	5	97.816	10	788.2876	4	822.9047	4
TU	57	12	102	17	76.250	15	140.0277	21	132.2322	23
TKK	51	13	92	19	68.498	16	103.916	14	90.22284	14
TOY	69	8	156	9	103.750	8	297.6527	17	295.7011	17

Table-2: Ranking of the Authors with respect to Quantitative Values of the Indices

Spearman's rank correlation is a nonparametric measure of two ranks from each observations/values using a monotonic function. The equation for Spearman's rank correlation is

$$r = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

Spearman's Correlation has been appropriate here because, here the observed values are discrete ordinal variable type(Zar,1972)

	H-Index Rank	G-Index Rank	HG-Index Rank	BD(H) Rank	BD(G) Rank
H-Index Rank	1				
G-Index Rank	0.75794	1			
HG-Index Rank	0.88602	0.85357	1		
BD(H) Rank	0.31877**	0.79069	0.48932	1	
BD(G) Rank	0.34071**	0.79762	0.50202	0.99385	1

****indicates statistically insignificant data**

Table-3: Spearman's Correlation Matrix between Indices

The values of the new indicators, i.e. BD(H) and BD(G) are calculated for the authors under consideration. Calculation of the values of the indicators for the prolific authors is an effective way to find out new citation behaviour[40].It is very interesting to note that, both BD(H) and BD(G) indices have insignificant correlation with H-Index and marginally significant correlation with HG-Index. The reason behind this is the HG-index focuses specifically on highly cited papers and provides a measure of a researcher's impact based on the number of highly cited publications they have. A highly cited paper is typically defined as a paper that falls within the top 1% or 5% of the most-cited papers in a particular field or time period. The HG-index calculates the number of highly cited papers that a researcher has and is often used to complement the H-index. H-index measures both productivity and impact based on the number of papers and citations, while the HC-index specifically considers the number of highly cited papers. H-index measures both productivity and impact based on the number of papers and citations, while the HC-index specifically considers the number of highly cited papers and thus complement each other.

7. Interpretation of Data

1. Unlike other indices, these two indices, i.e. BD(H) and BD(G), conveniently rank the authors without any conflict. But this ranking conflict happens while ranking them with H-Index and G-Index individually as clear from Table 2. For instance, EM and GD both have same H-Index (6th position) and same G-Index (7th position); Also, JM and JHC belong to same rank with respect to H-Index (16th position); Again, IL and TU. Both the new indices are highly correlated.
2. Higher the number of the publications and higher the number of citations earned, the higher the value of both of the indices, i.e. BD(H) and BD(G).
3. As the citation distribution data is highly skewed, the values derived from Index-1 and Index-2 are higher than its h-Index value due to adoption of standard deviation method into its calculation.
4. The possibility of obtaining dispersion seeing the deviation of each observation from some constant value immediately draws the question of selecting an appropriate constant.

8. Conclusion

In this article, the research effort is directed towards the development of measurement of overall perpetual productivity of an author without negating the inclusion of uncited papers. This is the sharpest contrast to most of the indices. The indices are based on a very basic principle – every scholarly communication from an author is a valuable intellectual asset; most of the indices consider only papers at the highly cited region or has at least one citation. Exclusion of uncited papers is actually a sheer biasness as well as ignoring the intellectual effort of the researcher.

It is needless to mention that, the h-index was the initial point of developing a plethora of indices over the years. The formula of standard deviation is used to measure how citation distribution is dispersed with respect to de facto standard indicators h-index and g-index. It is to be noted that, h-index is itself may be viewed as an incomplete indicator as it can not combat the loss of citation. It is thus logically justified to represent h-index along with e-index and R-index as e-index incorporates the loss of citation, whereas R-index incorporates the total corpus of citation. The portraying of citation scenario of a cited item may thus be best understood by the locus of the (h,e,R) space. In future, the similar types of balanced deviation-based indicators will be developed for e-index and R-index also to observe the (h,e,R) space of various cited objects. These types of indicators will reduce the biasness of h-index and g-index. Actually, h-index and g-index were fundamental approaches to the history of citation-based indicators, but it is rather problematic to use these two indicators in raw form. Therefore, multifold amendments of these two indicators are of sheer importance in the domain of scientometrics and informetrics. This research work may unveil avenues to carry out further experimentations with h and h-type indicators. These indicators will be calculated for prolific authors, journals and institutions in different fields to discover whether any new unexplored pattern appears.

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