M-score: a context-specific score to assess scientific productivity with OEVGSI grading

Madhu S. Nair

Department of Computer Science, University of Kerala, Kariavattom, Thiruvananthapuram 695 581, India

In this communication, a new context-specific score, named *M*-score is being proposed. This score is able to complement the mock *h*-index (h_m-index) and at the same time overcome some limitations of other popular indices such as *h*-index, *g*-index, etc. The proposed *M*-score is computed not only on the basis of an individual's performance in scientific productivity, but also on the basis of the performance of other individuals in the field. This means that the *M*-score of an individual is an indicator towards his/her research performance relative to others in the field. Finally, based on the *M*-score of an individual, his/her research contributions are graded using the OEVGSI (Outstanding, Excellent, Very Good, Good, Sufficient and Insufficient) grading system. The significance of context-specific *M*-score has been proved with the help of a sample dataset taken from Google Scholar.

Keywords: Bibliometrics, mock *h*-index, *M*-score, scientometrics.

THE most widely used index in scientometrics, introduced in 2005, is the *h*-index which quantifies an individual's scientific output into a single number[1]. But it has been proved that the *h*-index fails in situations where there are tall cores or long tails[2]. A high *h*-index may not indicate scientific excellence and at the lowest levels, it can be used as a measure of basic competence[3]. To overcome these limitations, several other indices have been proposed. Among them, the *g*-index is being widely used[4]; it was introduced as an improvement of the *h*-index in 2006 to measure global citation performance. It has been shown that in contrast to the *h*-index, the *g*-index takes into account the citation scores of the top articles without losing the merits of the *h*-index.

In 2009, another metric named mock *h*-index (h_m-index) was proposed[2] for research output assessment, which complements the *h*-index and gives better resolving power. This metric takes into account the parameters such as citation (C), productivity (P) and quality (C/P) to rank the individuals. In contrast to the *h*-index, the h_m-index is sensitive to the citation numbers in tall core and long tail. Though the h_m-index is not a replacement for the *h*-index, it gives more realistic values for ranking the individuals, especially when they have the same *h*-index pattern.

e-mail: madhu_s_nair2001@yahoo.com

A common shortcoming of metrics available in the literature, including the *h*-index, *g*-index and h_m-index is that they are computed based only on the statistics of an individual's scientific productivity. They do not take into consideration the performance of an individual relative to that of other scientists in the field. For instance, assume that a scientist R has an h_m-index value of 16.90, calculated based on his/her own research output. The h_m-index value 16.90 is not capable of indicating the performance of R compared to his/her peers in the field. In such a scenario, a relative score is needed to assess his/her research output based on the computed h_m-index value of 16.90 as well as the computed h_m-index values of his/her peers. The proposed *M*-score is thus a relative score which takes into consideration the h_m-index value of an individual whose score is to be calculated as well as the h_m-index values of his/her peers. The proposed *M*-score thus gives us the flexibility to define different scenarios based on which the score of an individual's scientific productivity can be computed.

Some of the scenarios based on which the *M*-score can be calculated are listed below:

- All specializations together.
- A particular area of specialization (narrow/broad area).
- The performance of a scientist in his/her home country.
- The performance of a scientist in his/her home country in a specific area of specialization, etc.

The *M*-score of an individual based on each of the above scenarios might be different, since it is calculated relative to the performance of the other individuals in the peer group associated with each scenario.

In the proposed work, a grading system called OEVGSI is also introduced to grade the research contributions of a scientist based on the *M*-score value. Following are the grades used in the proposed OEVGSI grading system: Outstanding contributions; Excellent contributions; Very good contributions; Good contributions; Sufficient contributions; Insufficient contributions.

The mathematical model of the proposed *M*-score is detailed below. The significance of the *M*-score metric is then proved with the help of a sample dataset taken from Google Scholar.

At this stage, a mathematical model for the proposed *M*-score is derived. As mentioned earlier, the *M*-score is different from other scientometrics in that it is a context-specific assessment metric. Mathematical model for the *M*-score is designed in such a way that an individual's scientific productivity can be assessed in a specific context/group (mentioned about different scenarios/contexts earlier in the text) based on his/her performance as well as the performance of his/her peers who belong to that context/group. The *M*-score is introduced to complement the existing h_m-index[2] or, in other words, it is calculated based on the h_m-index value of the individuals.

The important parameters used in the mathematical model for the M-score are given below

$h_m \rightarrow h_m$-index value.
$h_{mb} \rightarrow$ Average h_m-index value calculated for the bottom 30% researchers belonging to a specific group/context with at least one citation.
$h_{mt} \rightarrow$ Average h_m-index value calculated for the top 20% researchers belonging to a specific group/context.
$s_b \rightarrow$ Score assigned to h_{mb}. Here, s_b is taken as 300.
$s_t \rightarrow$ Score assigned to h_{mt}. Here, s_t is taken as 800.

The thresholds (30% and 20%) selected for the parameters h_{mb} and h_{mt} are based on the Lorenz curve of cumulative distribution of population (scientists) versus cumulative distribution of h_m-index values. The Lorenz curve shown in Figure 1 is plotted based on the sample dataset taken from Google Scholar. From the figure it is evident that around 30% of the researchers in the bottom group contribute less than 20% of the total h_m-index values and around 20% of the researchers in the top group contribute more than 30% of the top h_m-index values. Based on this particular data distribution, the thresholds are set for the parameters h_{mb} and h_{mt}. The score values 300 and 800 set for the parameters s_b and s_t are based on the thresholds 30% and 20%, which represent the bottom and top groups of researchers respectively.

The score (S) can be calculated based on the above-mentioned parameters as follows

$$S = s_b + (s_t - s_b)\frac{(h_m - h_{mb})}{(h_{mt} - h_{mb})}.$$

After avoiding the situation of assigning a negative value to the score S, the final M-score of a scientist can be represented as follows

$$M\text{-score} = \begin{cases} S, & \text{if } S > 0. \\ 0, & \text{if } S \le 0. \end{cases}$$

The final grading for an individual's scientific research productivity can be done based on the proposed OEVGSI grading system as follows

$$\text{Grade}_{M\text{-score}} = \begin{cases} \text{O – Outstanding,} & \text{if } M\text{-score} \ge 1000, \\ \text{E – Excellent,} & \text{if } 800 \le M\text{-score} < 1000, \\ \text{V – Very Good,} & \text{if } 500 \le M\text{-score} < 800, \\ \text{G – Good,} & \text{if } 400 \le M\text{-score} < 500, \\ \text{S – Sufficient,} & \text{if } 300 \le M\text{-score} < 400, \\ \text{I – Insufficient,} & \text{if } M\text{-score} < 300. \end{cases}$$

The significance of the context-specific M-score is proved here with the help of a sample dataset taken from Google Scholar. The dataset consists of citation records of 100 scientists (labelled S1 to S100) in two different specializations (labelled 'A' and 'B'). Table A1 (see Appendix) shows the citation details and M-score values of scientists in two specializations ('A' and 'B') together. Tables A2 and A3 (see Appendix) show the citation details and M-score values of scientists calculated based on the context of the specific area of specialization such as 'A' and 'B' respectively. For Table A1, the values for the parameters h_{mb} and h_{mt} are calculated to be 10.35 and 20.36 respectively. Similarly, for Table A2, the values calculated for h_{mb} and h_{mt} are 12.91 and 22.45 respectively, and for Table A3 they are 9.61 and 14.82 respectively.

Table A1 shows that the M-score values of scientists S70 and S92 are 519 and 627 respectively, with a grading

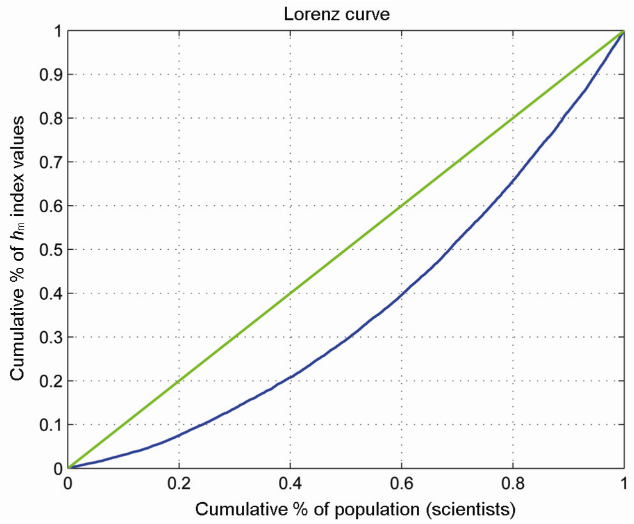

Figure 1. Lorenz curve of population (scientists) versus h_m-index values.

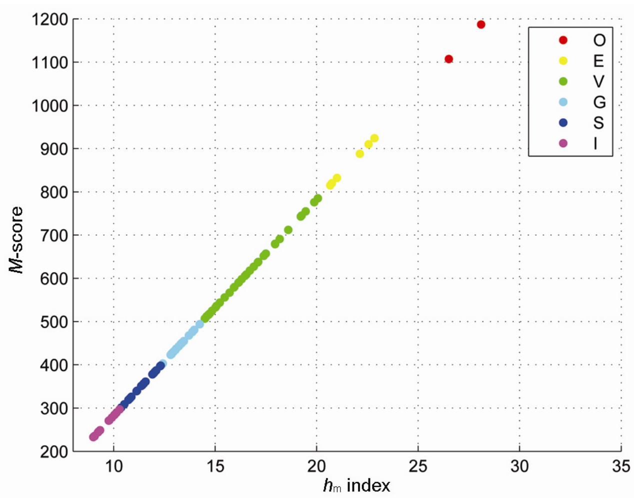

Figure 2. Scatter plot based on the h_m-index and M-score values from Table 1. Each colour indicates a specific grade assigned to the scientists based on their M-score value.

of ‘V’ based on the OEVGSI grading system. On the other hand, in Table A3, the *M*-score values of S70 and S92 are 792 and 1000 respectively. The change in the *M*-score value in Table A3 is due to the change in the context (specialization ‘B’) in which it has been calculated. Also, the grades assigned to S70 and S92 in Table A3 have been changed to ‘E’ and ‘O’ respectively.

Similarly, in Table A1, the *M*-score values of scientists S5 and S13 are 820 and 468 respectively. The grades assigned to them are ‘E’ and ‘G’ respectively. But from Table A2 it is evident that the above mentioned score

Appendix

Table A1. *M*-score values for 100 scientists calculated based on the citation record from Google Scholar in two specializations together

Scientist	Specialization	h_m-index	*M*-score	Grade	Scientist	Specialization	h_m-index	*M*-score	Grade
S1	A	26.51	1107	O	S51	B	14.49	507	V
S2	A	19.22	743	V	S52	B	13.21	443	G
S3	A	11.91	378	S	S53	B	10.15	290	I
S4	A	12.03	384	S	S54	B	15.02	533	V
S5	A	20.75	820	E	S55	B	10.37	301	S
S6	A	22.13	888	E	S56	B	9.76	271	I
S7	A	20.06	785	V	S57	B	11.13	339	S
S8	A	12.94	430	G	S58	B	13.03	434	G
S9	A	19.88	776	V	S59	B	9.79	272	I
S10	A	18.60	712	V	S60	B	10.53	309	S
S11	A	11.93	379	S	S61	B	12.42	403	G
S12	A	12.86	426	G	S62	B	11.48	357	S
S13	A	13.71	468	G	S63	B	14.85	525	V
S14	A	22.85	924	E	S64	B	13.97	481	G
S15	A	15.47	556	V	S65	B	10.03	284	I
S16	A	13.88	476	G	S66	B	15.95	580	V
S17	A	17.50	657	V	S67	B	13.37	451	G
S18	A	15.93	579	V	S68	B	14.58	512	V
S19	A	21.00	832	E	S69	B	11.36	351	S
S20	A	15.23	544	V	S70	B	14.74	519	V
S21	A	12.81	423	G	S71	B	11.49	357	S
S22	A	16.47	606	V	S72	B	10.81	323	S
S23	A	16.54	609	V	S73	B	13.08	437	G
S24	A	19.26	745	V	S74	B	10.73	319	S
S25	A	16.54	609	V	S75	B	10.05	285	I
S26	A	18.18	691	V	S76	B	12.29	397	S
S27	A	15.71	567	V	S77	B	13.05	435	G
S28	A	28.10	1187	O	S78	B	14.24	494	G
S29	A	17.95	680	V	S79	B	10.87	326	S
S30	A	14.50	507	V	S80	B	10.81	323	S
S31	A	22.56	910	E	S81	B	11.15	340	S
S32	A	16.17	591	V	S82	B	11.96	380	S
S33	A	11.41	353	S	S83	B	9.06	235	I
S34	A	16.71	618	V	S84	B	13.46	455	G
S35	A	17.10	637	V	S85	B	10.29	297	I
S36	A	17.95	679	V	S86	B	9.00	233	I
S37	A	19.46	755	V	S87	B	11.57	361	S
S38	A	16.15	590	V	S88	B	9.23	244	I
S39	A	20.67	815	E	S89	B	9.26	246	I
S40	A	16.31	598	V	S90	B	10.77	321	S
S41	A	12.86	425	G	S91	B	9.33	249	I
S42	A	15.06	536	V	S92	B	16.90	627	V
S43	A	14.68	516	V	S93	B	11.98	381	S
S44	A	14.85	525	V	S94	B	9.91	278	I
S45	A	17.12	638	V	S95	B	10.13	289	I
S46	A	14.67	516	V	S96	B	12.10	387	S
S47	A	12.92	429	G	S97	B	9.04	235	I
S48	A	13.31	448	G	S98	B	13.05	435	G
S49	A	11.98	381	S	S99	B	9.07	236	I
S50	A	17.39	652	V	S100	B	12.32	398	S

Table A2. Revised *M*-score values for 50 scientists (S1 to S50 as shown in Table A1) calculated based on the citation record in specialization 'A'

Scientist	h_m-index	*M*-score	Grade
S1	26.51	1033	O
S2	19.22	640	V
S3	11.91	246	I
S4	12.03	253	I
S5	20.75	722	V
S6	22.13	797	V
S7	20.06	685	V
S8	12.94	302	S
S9	19.88	675	V
S10	18.60	606	V
S11	11.93	247	I
S12	12.86	297	I
S13	13.71	343	S
S14	22.85	835	E
S15	15.47	438	G
S16	13.88	352	S
S17	17.50	547	V
S18	15.93	463	G
S19	21.00	736	V
S20	15.23	425	G
S21	12.81	295	I
S22	16.47	492	G
S23	16.54	496	G
S24	19.26	642	V
S25	16.54	496	G
S26	18.18	584	V
S27	15.71	451	G
S28	28.10	1118	O
S29	17.95	572	V
S30	14.50	386	S
S31	22.56	820	E
S32	16.17	476	G
S33	11.41	219	I
S34	16.71	505	V
S35	17.10	526	V
S36	17.95	571	V
S37	19.46	653	V
S38	16.15	475	G
S39	20.67	718	V
S40	16.31	483	G
S41	12.86	297	I
S42	15.06	416	G
S43	14.68	395	S
S44	14.85	404	G
S45	17.12	527	V
S46	14.67	395	S
S47	12.92	301	S
S48	13.31	321	S
S49	11.98	250	I
S50	17.39	542	V

Table A3. Revised *M*-score values for 50 scientists (S51 to S100 as shown in Table A1) calculated based on the citation record in specialization 'B'

Scientist	h_m-index	*M*-score	Grade
S51	14.49	769	V
S52	13.21	645	V
S53	10.15	352	S
S54	15.02	819	E
S55	10.37	373	S
S56	9.76	315	S
S57	11.13	446	G
S58	13.03	628	V
S59	9.79	317	S
S60	10.53	388	S
S61	12.42	570	V
S62	11.48	480	G
S63	14.85	802	E
S64	13.97	718	V
S65	10.03	341	S
S66	15.95	909	E
S67	13.37	661	V
S68	14.58	777	V
S69	11.36	468	G
S70	14.74	792	V
S71	11.49	481	G
S72	10.81	416	G
S73	13.08	633	V
S74	10.73	408	G
S75	10.05	342	S
S76	12.29	558	V
S77	13.05	630	V
S78	14.24	744	V
S79	10.87	421	G
S80	10.81	415	G
S81	11.15	448	G
S82	11.96	525	V
S83	9.06	247	I
S84	13.46	670	V
S85	10.29	365	S
S86	9.00	242	I
S87	11.57	488	G
S88	9.23	263	I
S89	9.26	267	I
S90	10.77	411	G
S91	9.33	273	I
S92	16.90	1000	O
S93	11.98	528	V
S94	9.91	328	S
S95	10.13	350	S
S96	12.10	539	V
S97	9.04	245	I
S98	13.05	631	V
S99	9.07	249	I
S100	12.32	560	V

values for S5 and S13 have been changed to lower ones such as 722 and 343 respectively, due to the change in the context (specialization 'A') where all scientists have performed well in scientific productivity. Also, their grades have been changed to 'V' and 'S' respectively. From the above illustrations it is discernible that the proposed *M*-score is context-specific and can accurately quantify the relative performance of scientists based on the context/group to which they belong.

Figure 2 shows the scatter plot of the h_m-index versus *M*-score values. It shows the distribution of the *M*-score values and the corresponding grade with the h_m-index

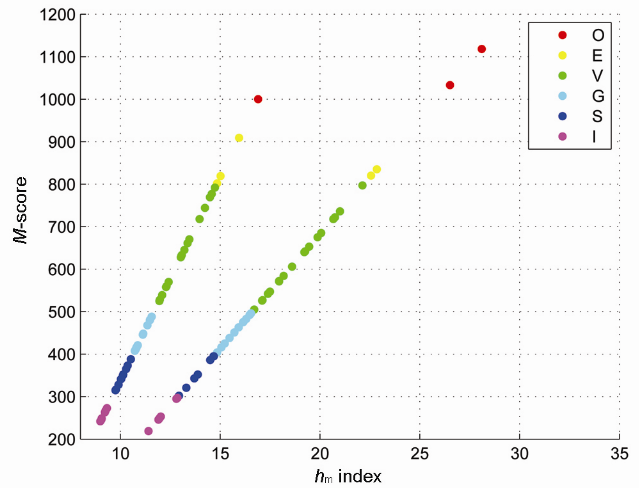

Figure 3. Scatter plot based on the h_m-index and *M*-score values from Tables 2 (specialization 'A') and 3 (specialization 'B') together. Each colour indicates a specific grade assigned to the scientists based on their new *M*-score value calculated in the context of their specialization.

values. Each colour value indicates a particular grade (OEVGSI) assigned to the scientists based on their respective *M*-score values. Effectively, this scatter plot splits the vertical axis (grades) into six zones, making the distribution of the *M*-score values easier to understand. Figure 3 shows the scatter plot based on the h_m-index and *M*-score values from Tables 2 (specialization 'A') and 3 (specialization 'B') together. As in Figure 2, here also each colour value indicates a specific grade assigned to the scientists based on their *M*-score value calculated in the context of specialization. The shift in the *M*-score values and the corresponding grades, when calculated in the context of specialization, is evident from Figures 2 and 3.

In conclusion a new context-specific scientometric named M-score has been proposed in this paper. The scientific productivity of an individual relative to others in the field (specific context/group) can be easily assessed using the *M*-score. The significance of the proposed *M*-score and how its value changes according to a specific context have been well established with the help of a sample dataset from Google Scholar.

1. Hirsch, J. E., An index to quantify an individual's scientific research output. *Proc. Natl. Acad. Sci. USA*, 2005, **102**(46), 16569–16572.
2. Prathap, G., Is there a place for a mock *h*-index? *Scientometrics*, 2010, **84**(1), 153–165.
3. Ramasesha, S. and Sen, D., Misuse of scientometry for individual assessment. *Curr. Sci.*, 2011, **100**(4), 446.
4. Egghe, L., Theory and practise of the g-index. *Scientometrics*, 2006, **69**(1), 131–152.

ACKNOWLEDGEMENTS. I thank Dr Gangan Prathap (CSIR National Institute of Interdisciplinary Science and Technology, Thiruvananthapuram) for guidance, advice and support throughout the course of this work.

Received 26 March 2015; revised accepted 7 May 2015

Measurement of environmental external gamma radiation dose rate outside the dwellings of southern coastal Odisha, eastern India

N. Sulekha Rao[1], Kajori Parial[1], Hiroaki Koide[2] and D. Sengupta[1,*]

[1]Department of Geology and Geophysics, Indian Institute of Technology, Kharagpur 721 302, India
[2]Research Reactor Institute, Kyoto University, Kumatori-cho, Sennan-gun, Osaka 590-04, Japan

External gamma dose rate measurement using thermoluminescent dosimeter has been performed along the southern coast of Odisha, eastern India. A total of nine villages from the three sectors, viz. Gopalpur, Chhatrapur and Rushikulya have been selected for the study. The average external gamma dose to people residing in the three sectors is 3.77, 4.47 and 3.57 mSv year^{-1} respectively, which is ~3–4 times the international limit of 1 mSv year^{-1}. These values are high compared to other high background radiation areas like Tamil Nadu along the east coast of India, but are comparable to the high radiation areas in Kerala, along the west coast of India.

Keywords: Coastal dwellings, eastern Indian beach placer, external gamma dose, natural radioactive hazard, thermoluminescent dosimeter.

RADIATION is present everywhere on the Earth's surface since its origin. According to UNSCEAR[1], about 87% of the radiation dose received by mankind is from natural sources and the remaining is due to anthropogenic sources. The dose received by the population in a region comprises of (i) external gamma radiation dose due to cosmic rays and primordial radionuclides; (ii) inhalation dose due to radon, thoron and their progeny, and (iii) ingestion dose due to the intake of radionuclides through the consumption of food, milk, etc. Environmental gamma-ray background generally refers to the gamma radiation from radioactivity in the environment, i.e. from terrestrial sources and building materials. The assessment of external exposure due to terrestrial radiation is possible, and in a given place its distribution is found to be dependent on the geographical characteristics of that place. There are several international studies reported for measurement of terrestrial gamma radiation background levels using the technique of thermoluminescence to assess the dose to the population[2–14]. In India, the west coast is a high-background radiation area (HBRA) due to monazite content in the sand. Preliminary studies on external gamma radiation dose level measurement with thermoluminescence

*For correspondence. (e-mail: dsgg@gg.iitkgp.ernet.in)