Scopus and google scholar publication profiles of Bharat Ratna C.N.R. Rao: A comparison for better assessment of individuals

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Abstract
Publications and citations are extensively used for assessing individuals for awards, promotions, accreditations, allocating funds etc. The demands for assessment may be based on single database viz. Scopus or Web of Science which are commonly used for eliciting citations. Google Scholar which also gives citation data can also be used for these purposes or at least for self-assessment. In certain cases, significant differences are observed from Scopus or Web of Science data when Google Scholar is used. The coverage of these databases may be the reason for such a difference. In some cases, documents covered in Scopus or Web of Science have noteworthy increase in citations in Google Scholar. The present work made an endeavor to explore this fact by taking a case study of publications and citation data of Dr C.N.R. Rao, a prominent Indian researcher in Materials Chemistry and Solid State Chemistry and perhaps the Indian with highest number of publications. The data from Scopus and Google Scholar are compared and presented how the assessment is affected by taking single database for the purpose.

Keywords: Citation analysis, Scopus, Google scholar, Author assessment, Bio-Bibliometrics, Publication productivity, h-index, G-index, i10-index.

Introduction
When faculty members are evaluated, they are judged in part by the impact and quality of their scholarly publications. While all academic institutions look to publication counts and venues as well as the subjective opinions of peers, many hiring, tenure, and promotion committees also rely on citation analysis to obtain a more objective assessment of an author's work (Kiduk & Meho, 2006).

Scopus from Elsevier Publishers offer powerful features for browsing, searching, sorting and saving functions along with citations. Many researchers focusing on citation studies rely on the database for the bibliometric and citation data. *Google Scholar* is a free service, also gives citation information, and for many who consider it to be a gift for the world. Bibliometric searches to explore the size, source base, breadth and composition of a data base, or the literary genealogy of a specific subject are exceptionally well facilitated in *Scopus* when it is compared with *Google Scholar*. When the coverage of the source items included in *Scopus* are concerned journal sources are the major one and *Scopus* also covers books and conference proceedings. *Google Scholar* does not offer publisher list, journal list, neither any clue about the time-span or the disciplinary distribution of records in *Google Scholar*. Its search software prevents the users from finding any reliable data about these traits of the database (Jacso, 2005).

Many of the assessment studies on individual researchers rely on *Scopus* data and many assessment agencies recommend to use *Scopus* for such evaluation. Even though *Google Scholar* has some drawbacks, its coverage is certainly wider than *Scopus*. When the studies are restricted to *Scopus* data, the individual may miss out their credibility. The number of citations to a publication in *Scopus* may vary in number from *Google Scholar* (generally it is more in *Google Scholar*). The differences are very much visible if the number of published documents possessed by an individual is very large.

Dr. Chintamani Nagesa Ramachandra Rao, FRS, also known as C.N.R. Rao (born 30 June 1934), is an Indian chemist and recipient of country's highest civilian award, the Bharat Ratna. He was appointed Chair of the Scientific Advisory Council to the Indian Prime Minister in January 2005, a position which he had occupied earlier during 1985–89.

Dr. Rao is currently the National Research Professor, Linus Pauling Research Professor and Honorary President of Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore which he founded in 1989. He is also the director of the International Centre for Materials Science (ICMS) and serves on the board of the Science Initiative Group. C.N.R. Rao has received many awards and recognitions and he is editorial board member of many national and international journals of scientific nature.

His research interests includes Solid State and Materials Chemistry, Structural Chemistry. Some of the major areas of research are transition metal oxides and other extended inorganic solids (new synthesis and novel structures, metal-insulator transitions, CMR materials, superconductivity, multiferroics etc.), inorganic-organic hybrid materials, nanomaterials including nanotubes and graphene, and artificial photosynthesis and hydrogen generation by photocatalysis and thermal means. Dr. Rao also made immense contributions to nano-materials over the past two decades, besides working on hybrid materials (IANS, Bengaluru, 2013). Other major professional interests are science education and direct contact programmes with school children.

Perhaps, he may be on top among Indians who published substantial number of documents and made very good impact. There may be difference when the publication profiles in *Scopus* and *Google Scholar* are compared. These differences must be an eye opener for those who conduct such analysis to bring justice to the actual productivity and impact made by an individual.

Objectives

The objective of the study is compare the publication profiles of an individual scientist and explore the differences observed in both the databases. The differences may be guiding forces for those who take up bio-bibliometric studies to determine the right impact made by individuals by restricting the data from one database like *Scopus* or *Web of Science*.

Materials and Methods

Scopus and *Google Scholar* are used to elicit the number of citations to C.N.R. Rao's publications. g-index is calculated after analyzing the publication records.

Results and Discussion

Scopus and Google Scholar are used by many scientometricians, researchers, academic administrators, policy makers for making many decisions on individuals. The following details are given in both the databases on a particular author:

Scopus	***Google Scholar***
Affiliation/s	Affiliations
ORCID	*Not available*
other name formats	*Not available*
subject area/s	subject area/s
document and citation trends	*Not available*
h-index	h-index
Not available	i10 index
number of documents by the author	number of documents by the author
number of citations	number of citations
co-authors	co-authors
author history	*Not available*
option to add ORCID	*Not available*
citation alerts	*Not available*
request for author details correction	*Not available*
graphs where ever possible	limited

Even though the details of the authors are less in *Google Scholar* than in *Scopus*, many depend on *Google Scholar* data for the above mentioned purposes. The Scopus database accessibility may be the reason for this. No. of publications, h-index, g-index, i10 index of Dr. C.N.R. Rao are noted and calculated from the data given in both the databases and compared in Table 1.

Table 1: No. of publications, h-index, g-index, i10 index of Dr. C.N.R. Rao as per *Scopus* and *Google Scholar* databases as on end of March 2018.

Profile element	***Scopus***	***Google Scholar***
No. of publications	1525	2199
h-index	119	142
g-index	203	225
i10 index	964	1203

The differences are very significant when all the four parameters are concerned especially h-index (a commonly used parameter now a days for comparing researchers for many purposes) of 119 and 142 in *Scopus* and *Google Scholar* respectively makes a huge difference when it comes to comparison. The study would like to point out that when a researcher is assessed based on the impact he makes should not be undermined by choosing only single database. The citations which do not included in *Scopus* can be object of another area of study whether they are omitted because the source document is not included in *Scopus*. It is observed in *Google Scholar* that the cited documents are considered as citations to many documents.

Table 2 presents the top cited ten documents of C.N.R. Rao with citations. There are significant differences in number of citations to individual documents.

Table 2: Top cited ten publications of C.N.R. Rao in *Scopus* and *Google Scholar* as on end of March 2018

Scopus	**Citations**	**Google Scholar**	**Citations**
Graphene: The new two-dimensional nanomaterial, Angewandte Chemie - International Edition, Vol. 48(42), 7752-7777 (2009)	2500	Graphene: The new two-dimensional nanomaterial, Angewandte Chemie - International Edition, Vol. 48(42), 7752-7777 (2009)	3003
Metal carboxylates with open architectures, Angewandte Chemie - International Edition, Vol. 43(12), 1466-1496 (2004)	1778	Chemical applications of infrared spectroscopy, Academic Press (1963) (book)	2077
Synthesis, structure, and properties of boron- and nitrogen-doped graphene, Advanced Materials, Vol. 21(46), 4726-4730 (2009)	963	Metal carboxylates with open architectures, Angewandte Chemie - International Edition, Vol. 43(12), 1466-1496 (2004)	1938
Ferromagnetism as a universal feature of nanoparticles of the otherwise nonmagnetic oxides, Physical Review B - Condensed Matter and Materials Physics, Vol. 74(16) (2006)	868	Inorganic nanowires, Progress in Solid State Chemistry, Vol. 31(43132), 5-147 (2003)	1269

Structural diversity and chemical trends in hybrid inorganic-organic framework materials, Chemical Communications, Vol. (46), 4780-4795 (2006)	782	Synthesis, structure, and properties of boron- and nitrogen-doped graphene, Advanced Materials, Vol. 21(46), 4726-4730 (2009)	1174
MoS2 and WS2 analogues of graphene, Angewandte Chemie - International Edition, Vol. 49(24), 4059-4062 (2010)	711	MoS2 and WS2 analogues of graphene, Angewandte Chemie - International Edition, Vol. 49(24), 4059-4062 (2010)	1150
Inorganic nanowires, Progress in Solid State Chemistry, Vol. 31(43132), 5-147 (2003)	696	Colossal magnetoresistance, charge ordering and other novel properties of manganates and related materials, Advances In Chemistry: A Selection of CNR Rao's Publications (1994–2003) (2003)	1080
Nanotubes, ChemPhysChem, Vol. 2(2), 78-105 (2001)	603	Ferromagnetism as a universal feature of nanoparticles of the otherwise nonmagnetic oxides, Physical Review B - Condensed Matter and Materials Physics, Vol. 74(16) (2006)	1023
Metal nanoparticles and their assemblies, Chemical Society Reviews, Vol. 29(1), 27-35 (2000)	578	Transition-metal oxides, Solid state chemistry (1974) (book)	861
Graphene-based electrochemical supercapacitors, Journal of Chemical Sciences, Vol. 120(1), 9-13 (2008)	550	Hybrid Open-Framework Iron Phosphate–Oxalates Demonstrating a Dual Role of the Oxalate Unit, Advances In Chemistry: A Selection of CNR Rao's Publications (1994–2003) (2003)	848

Some of the documents covered by *Google Scholar* have not included in *Scopus* and the assessments based on only *Scopus* database will certainly affected by these documents.

Conclusions

Scopus and *Google Scholar* have their own strengths and weaknesses and there is a large difference between the publication parameters available in these two databases. The choice of the database and the number of databases used affects the assessment of individual scientific impact. The researchers or professionals engaged in analyzing the scientific impact of individuals should make sure the actual impact made by individuals under study. The present study have shown the scenario where an individual is studied with one database and two databases. The evaluation of individual impacts may be misrepresented by these errors. It is recommended to use the tools for bio-bibliometric studies judiciously and try to minimize the difference in claimed data.

Conflict of Interest: None.

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