

Original Paper

Applying an Author-Weighted Scheme to Identify the Most Influential Countries in Research Achievements on Skin Cancer: Observational Study

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Abstract

Background: Skin cancers are caused by the development of abnormal cells that can invade or spread to other parts of the body. The countries whose authors contribute the most amount of articles on skin cancer to academia is still unknown.

Objective: The objectives of this study are to apply an author-weighted scheme (AWS) to quantify the credits for coauthors on an article byline and allocate the author weights to the country-level credits in articles.

Methods: On July 20, 2019, we obtained 16,804 abstracts published since 1938, based on a keyword search of “skin cancer” in PubMed. The author names, countries/areas, and journals were recorded. International author collaborations on skin cancer were analyzed based on country-level credits in articles. We aimed to do the following: (1) present country distribution for the first authors and the most popular journals, (2) show choropleth maps to highlight the most influential countries, and (3) draw scatter plots based on the Kano model to characterize the features of country-level research achievements. We programmed Excel Visual Basic for Applications (Microsoft Corp) routines to extract data from PubMed. Google Maps was used to display graphical representations.

Results: Our results suggest that researchers in the United States have published most frequently, accounting for 30.37% (5103), while Germany accounts for 7.34% (1234), followed by Australia (997, 5.93%). The top three continents for the proportion of published articles are North America, Europe, and Asia, accounting for 32.29%, 31.71%, and 10.41%, respectively.

Conclusions: This study offers an objective picture of the representativeness and evolution of international research on the topic of skin cancer. The research approaches used here have the potential to be applied to other areas besides skin cancer.

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KEYWORDS

choropleth map; author-weighted scheme; Google Maps; x-index; skin cancer; journal impact factor

Introduction

Skin cancers are tumors that arise mostly from the skin due to the development of abnormal cells that invade or spread to other parts of the body [1]. There are three main types of skin cancers:

basal cell skin cancer, squamous cell skin cancer, and melanoma [2]. Skin cancers often appear as a painless raised area of skin with small blood vessels running over it but may present with an ulcer [2]; they may be caused by exposure to ultraviolet radiation from the sun [3].

Ultraviolet exposure has increased partly due to a thinner ozone layer [4,5]. Between 20% and 30% of melanomas develop from moles [6]. People with light skin are at higher risk as are people with reduced immune function [2,7] from taking immunosuppressant medications or through infection with HIV [8,9]. Skin cancer is the most common form of cancer, accounting for at least 40% of cases globally [8,10]. In 2012, melanoma occurred in 232,000 people worldwide and resulted in 55,000 deaths [6]. Australia and New Zealand have the highest rates of melanoma in the world [6]. Which countries have contributed the most to research on skin cancer based on author publications and quality of research is unknown.

We were motivated to investigate which countries contributed the most to research on skin cancer and how much authors from Australia and New Zealand have contributed to the current body of knowledge.

Given the multidisciplinary aspect of skin cancer research, it is necessary to gather specialists in medicine, pathology, and biomedical science to ensure collaboration through resource sharing, exchange of ideas, knowledge dissemination, and information acquisition. No researcher has investigated scientific collaborations on skin cancer, particularly using a fair author-weighted scheme (AWS) for quantifying coauthor contributions to their articles. As such, country-level research achievements are required to evaluate and compare whether AWS has been applied.

Some researchers have applied visualization approaches to interpreting their study results, notably in genetic research, which was identified as the primary collaborative field [11]. However, the pattern of data display was a static JPG format picture, unlike the dynamic dashboard on Google Maps. The

dashboard allows readers to see more detail on research topics by using the zoom-in/zoom-out functionality [12-14]. Furthermore, all coauthors in an article sharing equal credits is problematic and unfair. Quantifying coauthor contributions has been proposed in the literature [15,16], but few published articles were applicable in the past. Similarly, country-level research achievements cannot be fairly obtained if the AWS has not been adopted.

It is also unknown whether the United States and Europe still dominate publication output in science [17,18] using the x-index [19] to measure, even though Australia and New Zealand have the highest rates of melanoma in the world [6]. The bibliometric x-index [19] (Figure 1), newly proposed in 2018, has a twofold implication. One is citation-oriented and another productivity-oriented. A graphical representation is required to complement the x-index and disclose the deeper insights and knowledge of the attribute toward the influential, the productive, or the neutral (or, say, one-dimensional performance in the Kano model) [19,20], which can be displayed by using the Kano model [21]. The five elements (ie, scatter plots based on the Kano model, x-index as the bubble, citations on the y-axis, publications on the x-axis, and the AWS) are worthy to carry out and demonstrate in this study.

The objectives of this study are to apply an AWS to quantify the credits for coauthors on an article byline and allocate the author weights to the country-level credits in articles. Three tasks will be achieved: (1) presenting country distribution for the first authors and the most popular journals, (2) showing choropleth maps to highlight the most influential countries, and (3) drawing scatter plots based on the Kano model to characterize the features of country-level research achievements.

Figure 1. Equation for the x-index.

$$\sqrt{\max(i \times c_i)}, \text{ where all } c_i \text{ are sorted by article citations in descending order and } i \text{ denotes} \\ \text{the number of the individual author's publications}$$

Methods

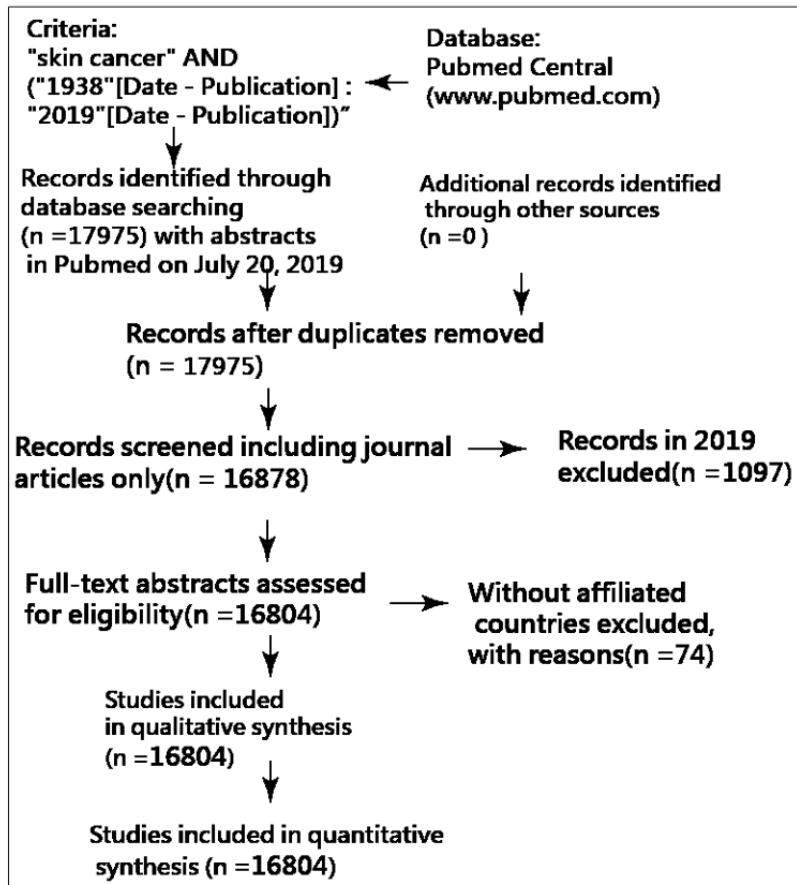
Data Source

We searched the PubMed database using the title keywords "skin cancer" on July 20, 2019. The search terms were the string "skin cancer" [Title/Abstract] AND ("1900" [Date-Publication]: "2018" [Date-Publication]); the process can be seen in a YouTube video [22]. A total of 17,975 articles published

between 1945 and 2018 were extracted. Among these, 16,878 identified the nation/area of the first author (Figure 2).

We made an Excel Visual Basic for Applications (Microsoft Corp) module to handle the data. All downloaded abstracts met the requirement for the type of journal article. Others, like those marked with "Published Erratum," "Editorial," "conference abstracts," "commentary," or those that did not name the author's nation, were excluded from this study. Ethical approval was not necessary for this study as no human subjects or personal data were involved.

Figure 2. Flow diagram of study selection.



Seven Elements Used for Displaying Study Results

The seven elements are as follows:

1. Scatter plots were based on the Kano model.
2. Bubbles were sized by the x-index and colored by the types of research achievements.
3. Citations used for computing the x-index for countries were replaced with the journal impact factors (JIFs) published by inCites Journal Citation Reports (Clarivate Analytics) 2018. The JIFs were shown on the y-axis on the scatter plot mentioned above.
4. The number of publications for countries/areas was located on the x-axis.
5. We applied the AWS [23,24] as below.
6. See Figure 3, where the powers (m) as the ordered author name (m) on the article from $m-1$ to 0, the author number is $m-1$, more importance is given to the first ($=\exp[m-1]$, primary) and the last ($=\exp[m-1]$ as the corresponding or supervisory authors. We assume that the others (the middle authors) have made smaller contributions to their articles. The sum of all authors in an article byline equals 1.0.
7. The trend of publications for countries/areas was computed by the correlation coefficients using the $\text{correl}(A,B)$ function in Excel (Microsoft Corp), where A denotes the series from 2009 to 2018 and B represents the outputs across the 10 years.

Figure 3. Author-weighted scheme equation.

$$W_m = \frac{\exp(\gamma_m)}{\sum_{m=0}^{m-1} \exp(\gamma_m)} = \frac{(2.27)^{\gamma_m}}{\sum_{m=0}^{m-1} \exp(\gamma_m)}$$

Tasks to Reach the Study Goal

Country-Level and Journal-Based Publications on Skin Cancer in the Past

We applied two contingency tables to represent the country distribution for the first authors and the most popular journals.

Choropleth Maps to Highlight the Most Influential Countries

A choropleth map was used to highlight the most influential countries/areas where authors were affiliated. The country-level citations were replaced by the JIF as seen in Figure 4, where the author weight came from Figure 1 and the total weights on an article for a country (h) are determined by the country-level weights on the article (i). The x-index (Figure 1) [19] was used to denote the research achievements for a country by the steps:

(1) sorting the country-based C_{hi} in Figure 4 and (2) determining the number of publications at i and the responding c_i . The

countries were dispersed with bubbles sized by x-index and colored by the types of research achievements using the Kano model to display.

Figure 4. The equation used for computing the country-level citations.

$$C_{hi} = \sum_{m=0}^{m-1} (W_{h \in m} \times c_i)$$

Scatter Plots to Characterize Types of Country Research Achievements

The scatter plot was based on the Kano model, which classified members on the plot into three types: the attribute toward the influential, the productive, or the neutral (or, say, one dimension along at the 45-degree line in the Kano model) [19,20].

Creating Dashboards on Google Maps

The x-index was yielded by author-made modules in Excel (Microsoft Corp). We created pages of HTML used for Google Maps. All relevant information on the entities (ie, countries or states in the United States) can be linked to dashboards on Google Maps.

Results

Distribution of Publications by Author-Affiliated Countries and Areas

Multimedia Appendix 1 presents 16,804 papers that included author-affiliated countries/areas. It is evident that researchers in the United States have published most frequently, accounting

for 30.37% (5103), while German scholars account for 7.34% (1234), followed by Australia (997, 5.93%). The trend in the number of publications is presented at the bottom right (=1.0) of Multimedia Appendix 1, indicating a continuously increasing trend observed in this study. The three countries with the highest trends are Italy (0.98), China (0.97), and Germany (0.93).

The top three continents for the proportion of published articles are North America, Europe, and Asia, accounting for 32.29%, 31.71%, and 10.41%, respectively. Australia and New Zealand in the Oceania continent account for a mere 6.46% (see Multimedia Appendix 1), far behind the three continents of North America, Europe, and Asia.

Figure 5 displays a choropleth map based on the publications and first authors. Overall, the most influential countries/areas are the United States and Germany in Europe. Further information is available on the Google map [25] by clicking on each bubble. Another choropleth map (Figure 6) is also based on the publications and first authors in the United States as shown on the Google map [26]. We see that the three states with the highest x-indexes are California, Massachusetts, and New York.

Figure 5. Choropleth map presenting the most productive countries and areas of articles on skin cancer since 1938 (n=16,804).

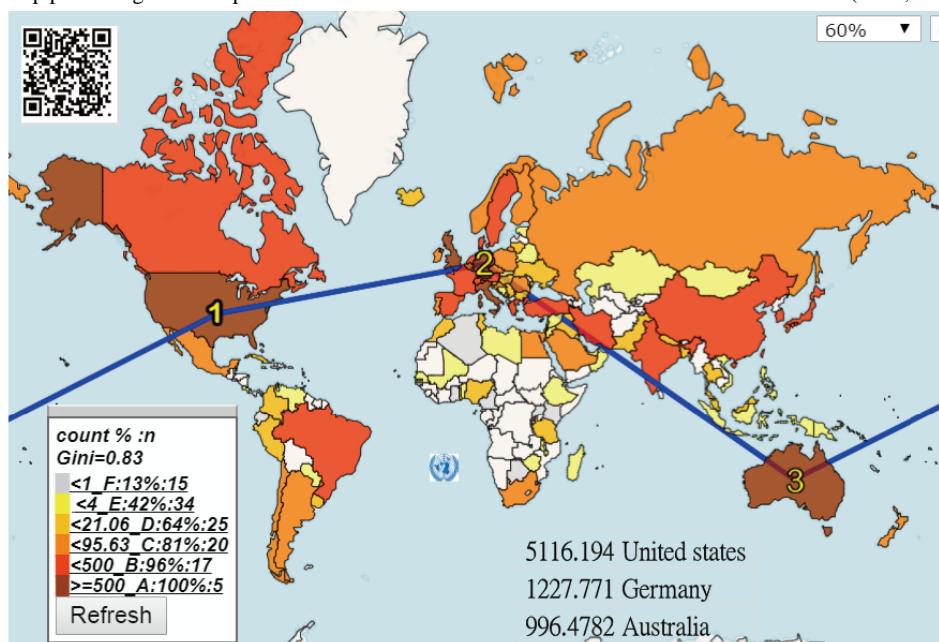
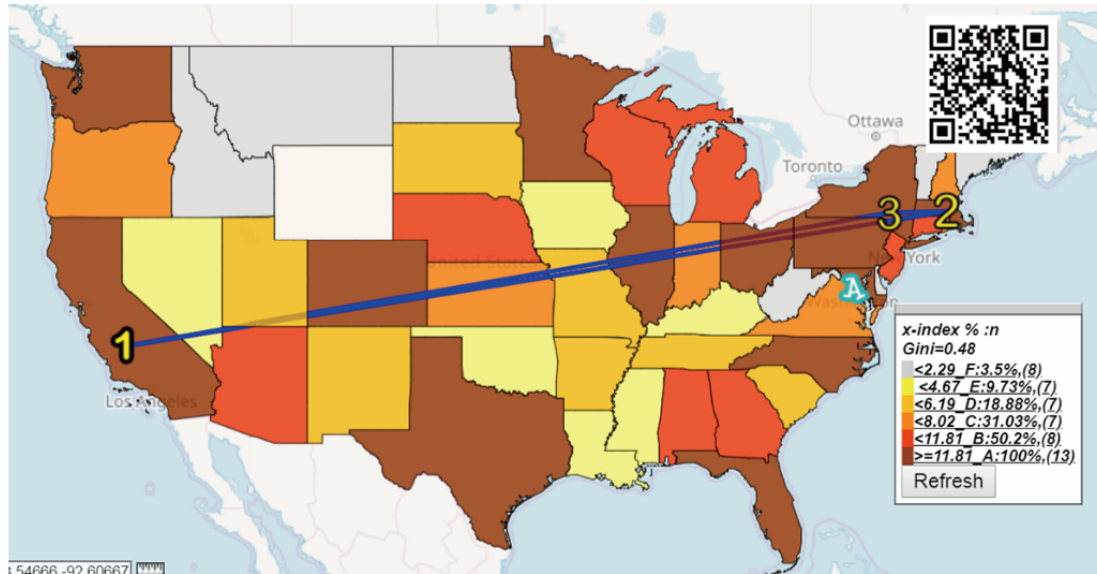


Figure 6. Choropleth map presenting the most productive states in the United States for articles on skin cancer since 1938 (n=5103).



Published Papers in Journals

The top 20 journals with the highest numbers of publications on skin cancer are shown in [Multimedia Appendix 2](#). The journals publishing the most articles on skin cancer are Journal of the American Academy of Dermatology, British Journal of Dermatology, and Journal of Investigative Dermatology. Journal of the European Academy of Dermatology and Venereology and JAMA Dermatology presented highly positive increases (>0.90 in trend) in the publication of papers on skin cancer (last column in [Multimedia Appendix 2](#)).

Scatter Plots to Characterize the Type of Country Research Achievements

Using the x-index [19] ([Figure 1](#)) makes it hard to discriminate the characteristics toward the influential, the productive, or the neutral. We applied the scatter plots based on the Kano model that can be easily used to identify the type for the country of interest.

We can see the United States is productivity-oriented and others are influence-oriented ([Figure 7](#)). As for states in the United States ([Figure 8](#)), both California and New York are productive. Massachusetts is neutral, and Minnesota is the influential type. Interested readers can scan the QR code in the figures for details about the name of the country (or state) on the dashboards.

Figure 7. Using the x-index to evaluate the achievements on skin cancer for different countries.

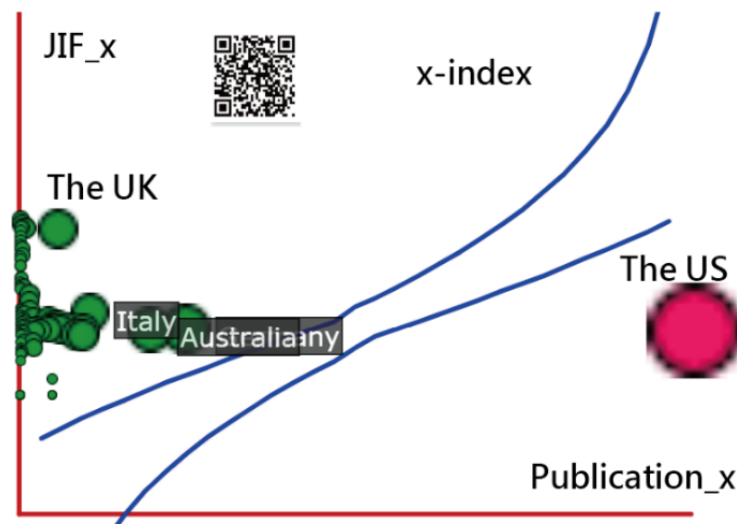
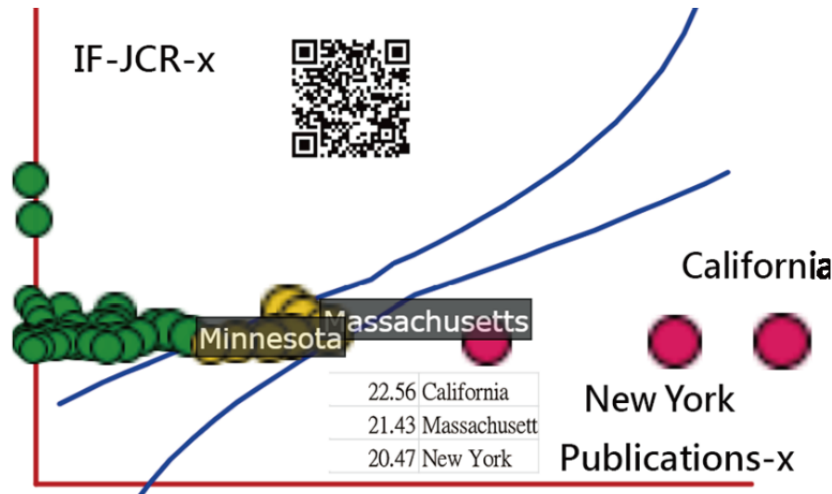


Figure 8. Using the x-index to evaluate the achievements on skin cancer for the United States.



Discussion

Principal Findings

The research question in this study was to disclose the country-level research achievements on the topic of skin cancer. The AWS was particularly applied to quantify the credits for coauthors on articles and allocate the weights to the countries/areas using the equations in [Figure 1](#) and [Figure 3](#). Three tasks were achieved and illustrated: (1) the top three most productive countries are the United States, Germany, and Australia based on the countries to which the first authors are affiliated, (2) the journal with the most frequent publications is *Journal of the American Academy of Dermatology*, and (3) the top three influential countries are similar to the productive results. The correlation coefficient is 0.86 between the two indices (ie, the x-indexes and the number of publications [[Multimedia Appendix 1](#)]) around the 116 countries/areas, and the three types of entities in [Figure 7](#) and [8](#) are toward the productive, the influential, and the neutral, respectively, using the Kano model to classify.

Previous research has investigated coauthor collaboration using social network analysis [[27-29](#)]. Our research using AWS weights is similar to the computation of degree centralities based on the weights between two entities in social network analysis but markedly different as we employ unique visual representations displayed on Google Maps. The application of this visual allows us to compare countries through bubbles in color and size. If the entity bubble is clicked on, the country information will appear on the map. This animated dashboard has been used in applications in other scientific fields to demonstrate entity characteristics [[12,23,24](#)].

A total of 16,804 abstracts were identified when searching PubMed on the keywords “skin cancer” on July 20, 2019. No previous literature uses the seven elements mentioned in [Methods](#) to present relevant knowledge to readers or dynamically applies Google Maps as we did in this study. Scientific publication is one of the objective measurements to evaluate the achievements of a medical specialty or discipline as we did in [Multimedia Appendix 1](#). Numerous scientometrics have been proposed to measure author-level research

achievements, such as h , g , e [[30-32](#)], h' [[20](#)], and R - and AR indexes [[32](#)]. The drawback is those indices ignoring the AWS for quantifying coauthors' contributions in articles, not to mention the country-weighted scheme we applied in [Figure 3](#). It is worth combining the seven elements and Google Maps to provide knowledge and information to the readership of journals in the future.

Strengths and Limitations

One strength of this study is the sophisticated use of Google Maps and in-text links for each topic [[33-35](#)]. Readers can manipulate the links independently to better understand author collaboration. The depiction of distribution by nation in figures is a useful feature to understand the research achievements on skin cancer. As it is said, a picture is worth a thousand words, so we hope future studies can report other types of information to readers using the Google application programming interface.

There are several limitations to this study. First, caution should be taken when interpreting and generalizing findings beyond this type of research, as data were extracted exclusively from PubMed.

Second, although the data were extracted from PubMed and carefully handled, the original download may have included errors, which may affect the resulting reports in this study.

Third, the formula ([Figure 1](#)) used in this study is also a special case of the general AWS model [[23,24](#)]. Any change in the parameters (eg, m in [Figure 3](#)) might present different weights for authors. Similarly, the assumption of corresponding (or supervisory) authors being the last authors might be challenged. Any parameters changed in our proposed formula would affect the computations of the metric.

Fourth, the data extracted from PubMed is different from other major citation databases such as the Scientific Citation Index (Clarivate Analytics) and Scopus (Elsevier). The results of the most influential countries/areas might be different if other databases were applied.

Fifth, the x-index [[19](#)] ([Figure 1](#)) is computed by both citations and publications. Replacing citations with the JIF to represent the quality of articles is another limitation. Although paper

impact (ie, citations) and journal impact (ie, JIF) on researchers' performance are frequently related [36-39], applying citations to the x-index is recommended in future studies if citations for each article can be obtained.

Conclusion

In conclusion, this study offers an objective picture of the representativeness and evolution of international research on the topic of skin cancer by employing Google Maps to present

results. We chose visualization technology to analyze country-level research achievements on skin cancer. As a result, researchers will be able to produce effective research diagrams on Google Maps, improve the efficiency of research work, and provide in-depth insight into the relationships among countries/areas and the types of their research achievements based on the Kano model. The results can provide readers with insight into the evolution of the skin cancer in publications across time and countries/areas.

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Authors' Contributions

TWC conceived and designed the study, HYW interpreted the data, and FJL monitored the process and the manuscript. TWC drafted the manuscript. All authors read the manuscript and approved the final manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Number of papers distributed across nation/area and the published years.

[\[DOCX File , 18 KB-Multimedia Appendix 1\]](#)

Multimedia Appendix 2

Journals on the topic of skin cancer distributed over the years.

[\[DOCX File , 17 KB-Multimedia Appendix 2\]](#)

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Abbreviations

AWS: author-weighted scheme

JIF: journal impact factor

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