City University of Hong Kong
SDSC4116 Data Science Capstone (Academic Year 2023/24)

Principled Ranking for Academic Journals

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Abstract: Academic journals play an important role in disseminating scholarly research and advancing our collective knowledge. These publications serve as dynamic platforms for researchers to share their discoveries, theories, and insights with the academic community and beyond. This report will delve into the current ranking system of academic journals and focus on the crucial task of modifying it based on robust criteria for evaluating the value and influential power of these journals. Existing methodologies, such as PCA technique, will be explored to identify their strengths and limitations and propose alternative approaches that can enhance the accuracy and reliability of journal rankings. By considering factors such as citation impact, peer recognition, and disciplinary relevance, this report aims to provide valuable insights on how the ranking system can be refined to better reflect the significance and impact of academic journals in the scholarly landscape.

1. Introduction

Academic journals serve as essential conduits for scholarly communication. They facilitate the exchange of ideas, foster intellectual discourse, and contribute to the growth of scientific knowledge.

The ranking system for academic journals has become integral to the scholarly ecosystem. It provides a structured framework for evaluating and comparing journals based on their influence, impact, and prestige. Various methodologies have been developed to assess journals, including metrics such as citation counts, impact factors, h-index, and expert opinions. Traditional academic journal ranking systems, such as the SJR indicator developed by the Scimago Lab and CiteScore published by Scopus, will also be discussed later.

The value of a good journal ranking system cannot be ignored. It has several key purposes:

Guiding Researchers: A reliable ranking system assists researchers in identifying high-quality journals for publishing their work. By selecting reputable journals, researchers enhance the visibility and impact of their findings. The system acts as a compass, directing them toward journals that resonate with their field of study. A reliable ranking system helps them identify high-quality journals, ensuring maximum visibility and impact.

Institutional Evaluation: Institutions benefit from journal rankings by evaluating the research productivity and impact of their faculty members. By considering journal rankings, institutions make informed decisions regarding promotions, tenure, and academic recognition. Journal rankings provide a standard for evaluating scholarly output.

Resource Allocation: Funding agencies rely on journal rankings to allocate resources effectively. By supporting research published in influential journals, they ensure that their investments contribute to meaningful scientific advancements (Bosworth, 2022).

Enhancing the Ranking System

This report also aims to explore potential modifications to the existing ranking system. Criteria that evaluate both the value and influential power of academic journals will be outlined. By refining the ranking system, I aim to enhance its accuracy and relevance compared to traditional ones.

Current Journal Ranking System

Researchers, universities, funding agencies, and other organisations utilise various journal ranking systems. The most widely recognised methods for ranking journals include the following (Rajpurohit, 2023):

• **Clarivate Analytics' Journal Citation Reports (JCR)** utilises the Impact Factor (IF) as a ranking metric for journals. The IF computes the citation count a journal receives within a specific year, divided by the number of articles published by the journal in the preceding two years.

• **Elsevier's Scopus Journal Analyzer** employs the SNIP (Source Normalised Impact per Paper) and SJR (SCImago Journal Rank) metrics as ranking indicators for journals. SNIP computes the contextual citation impact of a journal by considering the citation count, the number of published articles, and the prestige of the citing journals. In contrast, SJR measures the prestige of a journal based on the citation count, the number of published articles, and the prestige of the citing journals.

• **Clarivate Analytics' Web of Science** utilises the Journal Impact Factor (JIF) as a ranking metric for journals. Similar to the Impact Factor, JIF calculates the average number of citations received by articles published in a journal within a specific year, divided by the number of articles published in the journal over the preceding two-year period.

• **The SCImago Journal and Country Rank (SJR)** employs the SJR metric, which is also used by Scopus, to assess the quality of journals. This metric considers factors such as the number of citations received by a journal, the number of articles published, and the prestige of the journals that cite the journal in question. By incorporating these elements, SJR provides a comprehensive evaluation of a journal's impact and reputation within the scholarly community.

The diverse methods used by these systems to rate journals often generate different outcomes. It is crucial to consider the specific standards and limitations of each approach when analysing journal quality rankings. Each system employs its own set of measures and algorithms, which may prioritise certain factors over others. Therefore, a comprehensive understanding of the unique characteristics and limiting factors of each traditional ranking system will help refine the ranking system and improve its accuracy and relevance.

Metrics Used in Ranking System of Academic Journal

Different metrics will be applied to academic journals as indicators in the ranking system, which will be used to evaluate the impact and importance of journals.

The metrics below are the most well-known in academia (Halim & Khan, 2019):

Journal Impact Factor:
= citations in a year to documents published in the previous 2 years /
number of citable items in previous 2 years

Citescore:
= citations in a year to documents published in previous 3 years /
number of documents in previous 3 years

Source Normalised Impact per Paper (SNIP):
= number of citations given in the present year to publications in the past three years /
the total number of publications in the past three years.

H-index:
Calculate the number of publications where an author has received citations from other authors that are at least equal to the number of times they have been cited.

Literature Review: Intrinsic Flaws of Current Academic Journal Ranking Systems

There have been numerous reviews and criticisms of traditional academic journal ranking systems, with some highlighting the issue of over-prioritizing certain aspects of a journal, such as the number of citations or the impact factor while neglecting other crucial indicators of quality. This narrow emphasis on quantitative metrics can result in distorted assessments of journal value, impeding the recognition of journals that excel in areas beyond mere citation counts. In this part, some inner problems and inherent limitations of these ranking systems will be discussed based on the literature reviews.

Imbalance between Quality and Quantity

Bryce, Dowling, and Lucey (2020) conducted a study on the perception gap regarding journal quality among UK researchers. The objective of their study was to explore the factors influencing researchers' perceptions of journal quality and examine the extent to which these perceptions align or differ from national journal ranking systems. This study was motivated by the recognition that journal rankings often reflect the average quality of articles within a journal rather than providing an accurate assessment of the precise quality of individual articles.

Their study has revealed that 39% (around 8000 individual journal rankings) of subjective evaluations, provided by approximately 500 respondents, regarding the ranking of journals in the AJG 2018 (a guide for assessing the quality and scope of journals in the field of Business and Management academic research), differed from the actual rankings published in the subsequent list. The findings suggested that researchers have diverse perspectives on the quality and relevance of journals, leading to differences in their perceptions compared to the established ranking system. This underscores the importance of considering researchers' subjective evaluations alongside objective ranking systems to obtain a comprehensive understanding of journal quality and impact.

The results of the study mentioned above are closely associated with the imbalance between quantity and quality. The fact that a significant number of opinions varied from the official rankings suggests that academics' evaluations of the quality of journals are influenced by factors more than just numbers, including the number of articles published or citations obtained. Alternatively, other qualitative aspects like the research's rigour, relevance to the field of study, or influence on the academic community may take priority. This disparity emphasises how important it is to weigh quantity and quality when assessing journals. A journal's quality may be ignored if only quantitative measurements are used, and objectivity or bias may be introduced if only subjective assessments are

used. Achieving a balance between quantity and quality in journal rating is important for guaranteeing an accurate and comprehensive evaluation of journals' impact and significance.

Disadvantages of Impact Factor Calculation

As mentioned, a comprehensive and precise ranking matrix is necessary for an effective evaluation of the influence and significance of journals. Among the metrics used in the ranking system of academic journals, many studies have reviewed the impact factor. The impact factor computation has the obvious drawback of not always reflecting the quality of each paper published in the journal; as a result, it can be easily influenced by one or a small number of highly cited studies (Charlesworth et al., 2021). In comparing the accuracy of the ranking metrics, H-index is often considered a more comprehensive and robust measure. Since the h-index is not only used for journal evaluation. It is frequently used to rank researchers, nations, etc. because it easily combines a productivity measure with a quality measure. However, although the impact factor is widely accepted, used, and recognised as at least a reasonable approximation, it is also commonly recognised that the impact factor is an imperfect approach for rating and evaluating journal quality. By contrast, according to Elsevier, the h-index is becoming more and more popular because, as previously mentioned, its calculation is a better indicator of the average paper published in a specific journal than it does of the most well-known (i.e., most frequently cited) paper or papers published in that journal. However, due to its recentness (it was first presented in 2005), fewer researchers are as familiar with this methodology and, as a result, are less likely to recognise what the h-index of a particular journal implies.

Taking into account the previous literature reviews, this study will consider and incorporate the H-index rather than the impact factor.

Comprehensiveness of SJR (SCImago Journal Rank)

Systematically, the SRJ indicator assigns citation values based on the scientific impact of the journals that generate them. It employs a three-year citation window, which is both brief enough to capture the dynamics of the scholarly communication process and long enough to cover the citation peak of a significant number of publications. To prevent excessive self-citation from artificially increasing a journal's value, it limits a journal's ability to self-cite to no more than 33% of its published references. This restriction does not affect the standard self-citation procedure (Gonzalez-Pereira et al., 2010).
Unlike traditional metrics, the SJR indicator is size-independent and ranks journals based on citation weighting schemes and eigenvector centrality within complex and heterogeneous citation networks,

such as Scopus. SJR considers the varying citation practices and publishing patterns in different fields, allowing for a fairer comparison of journals across disciplines. Researchers appreciate this inclusive approach to evaluating scholarly impact (González-Pereira et al., 2010).

To sum up, the SJR indicator combines citation weighting structures, eigenvector centrality, and a size-independent approach to address the limitations of traditional metrics. It is an effective tool for evaluating the influence and quality of journals because of its inclusiveness and capacity to accommodate disciplinary differences.

The value and influential power of academic journals are intricately tied to both quality and quantity. High-quality journals, known for their reliability and credibility, draw outstanding research papers. They have a significant effect on scholarly discourse and scientific development. Yet quantity is also important. A wide variety of publications provides a vibrant academic environment that encourages specialisation and unique points of view. Research that is widely shared reaches more people, and due to the sheer number of publications, there are also some hidden gems. The synergy lies in balancing quality and quantity or maintaining strict standards while promoting a vibrant research community. In the long run, the quantity increases impact, and quality sets the foundation, moving academic journals toward greater importance and value. Hence, a good balance between the quality and quantity of academic journals can reflect the value and influence of academic journals, which is also important in today's academic world.

Insights from Professionals on the Current Academic Journal Ranking System

A total of 3 professionals were interviewed, including 1 expert and 2 researchers. The expert’s name is Dr. Po-lung LI, a senior lecturer at the Hong Kong University of Science and Technology (HKUST), who has published numerous publications over 39 years. The other two interviewed researchers were Mr. Yan Shing Lee, Joshua (BA in English (Language and Literature), City University of Hong Kong), and Mr. Evan Quincy Lee (MSc in sports and exercise psychology, University of Greenwich, London).

Professionals' perspectives offer valuable knowledge and experience, enriching the analysis. They can point out problems, make suggestions for improvements, and inspire new ideas. Their participation guarantees an extensive and knowledgeable conversation that fosters creativity and attends to the

changing requirements of the academic community. Including expert viewpoints can lead to a deeper and more insightful analysis of principled journal ranking.

To get insights and inspiration from their professional perspectives, the interview questions included the following: What challenges or constraints exist within the current academic journal ranking system? And what would be the ideal ranking system for you?

Interview Content:

Expert - Dr. Po-lung LI:

When asked about the challenges or constraints within the current academic journal ranking system, Dr Po-lung Li expressed strong reservations about the practice of quantifying scientific output using a single, one-dimensional ranking metric. He described it as a terrible idea and highlighted the shift away from such approaches. He mentioned that impact factors, which were previously widely used, are no longer allowed in grant applications by the national funding agency. He further emphasised that universities are now rewriting their personnel policies to adopt a qualitative and individual approach, placing greater emphasis on scrutinising individuals' CVs.
Dr. Li's comments reflect a growing recognition that assessing scientific output only in terms of quantitative indicators would not accurately reflect the contributions of scholars. The move in evaluation methodology towards a more comprehensive approach that considers qualitative elements and individual accomplishments is reflective of a desire for a deeper understanding of researchers' abilities and achievements that go beyond a single metric.

Regarding the ideal ranking system, Dr. LI suggested a more comprehensive approach that considers not only quantitative metrics like citation counts but also qualitative factors such as editorial policies. He emphasised the need for a balanced evaluation that takes into account both the quantity and quality of research output.

First Researcher - Mr. Yan Shing Lee, Joshua:

According to Mr. Yan Shing Lee, journal ranking systems were originally designed with specific purposes in mind. However, he noted that most people tend to misuse these systems, focusing on their satisfaction rather than understanding what they are intended to reflect.
Mr. Lee further expressed concerns about the gamification of popular metrics. He observed that once a metric gains popularity, it quickly becomes a target for manipulation and exploitation. This, in turn, renders the ranking systems unstable and susceptible to manipulation.

His comments draw attention to the potential drawbacks and difficulties of relying journal rating systems solely on metrics. Mr. Lee believes that in order to prevent gaming and manipulation, a more comprehensive knowledge of these systems is required, taking into consideration their original purpose.
These findings highlight the necessity of regular evaluation and development of ranking systems for the purpose of maintaining their integrity and effectiveness in fairly representing the quality and importance of academic publications.

Regarding the ideal ranking system, Mr. Yan Shing Lee expressed the desire for a metric that is stable and ensures a consistent measure over time. He emphasised the importance of establishing a ranking system that offers a reliable and constant evaluation of journal quality and effect rather than being rapidly influenced by temporary fluctuations or unrelated factors.

Second Researcher - Mr. Evan Quincy Lee:

Mr. Evan Quincy Lee highlighted the significant concern of excessive self-citations within the academic community. He expressed that researchers, driven by various motivations, sometimes engage in the excessive use of self-citations. While self-citations were originally intended to bolster credibility, they now teeter on the edge of overuse.
Mr. Lee drew attention to the delicate balance between self-promotion and scholarly integrity, comparing it to a tightrope walker swaying precariously. This metaphor captures the potential ethical implications and challenges associated with self-citations, as researchers must navigate the fine line between self-promoting and maintaining the integrity of the scholarly discourse.
The concerns raised by Mr. Lee shed light on the ongoing discussions surrounding self-citations and the need for guidelines or best practices to address this issue.

Regarding the ideal ranking system, Mr. Evan Quincy Lee stated that he was looking for a metric that would cover two important factors: lowering the impact of self-citations and avoiding excessive, unnecessary references.

Prioritising Criteria for Scholarly Impact

Improving the accuracy and reliability of academic journal rankings is a major target of this project. Analysing the intrinsic flaws of the current academic journal ranking system and obtaining expert opinions are valuable in achieving this goal. Prioritising excellence in research output to foster meaningful contributions and lasting influence within the academic community.

To sum up, the following criteria of journals will be prioritised in coming academic journal rankings:

1. **Quality over Quantity**: emphasises quality over the sheer volume of publications in an effort to avoid dilution of scholarly impact.
2. **Avoiding Over-Referencing**: Too many references may dilute the originality of a paper.
3. **Stability:** Ensuring a consistent measure over time offers reliability in evaluating the influence of scholarly work.
4. **Citation Impact Regulation**: By reducing the impact of self-citations, a more balanced and unbiased evaluation of scholarly impact will be achieved.
5. **Avoiding Legacy Bias:** Concentrating on recent citations avoids undue influence from dated publications.

Taking these aspects together in the new ranking system offers a more comprehensive perspective of a journal's performance, considering various dimensions of influence, quality, and relevance. Both researchers and institutions will benefit from such a comprehensive evaluation during their publishing decision-making process.

Dataset

According to Clarivate Analytics (2022), up to August 2022, there are over 25,000 journals available in comprehensive multidisciplinary citation databases, including Web of Science and Scopus. These databases are derived from the journal's annual citation data, and the journals are ranked using different metrics such as CiteScore, Journal Impact Factor, and H-index.

In order to enhance the comprehensiveness of the dataset, three indexing databases are collected. They are Scimago Journal Ranking, Web of Science Master Journal List, and Scopus. The Kaggle dataset by Xabir Hasan (2023) is also referenced in terms of dataset format.

Database Source

The data was collected through scraping and using the vlookup function in Excel, in which journal titles were used as primary keys to match the data of each journal's title. While the journal ranking, based on the sorted SJR Index, remains unchanged. Rows with some missing values will be removed due to their incompleteness in an effort to ensure data integrity and prevent potential issues, such as biased or inaccurate results during analysis or modelling. Furthermore, new rankings based on the CiteScore value and H-index value of each academic journal were also appended to the dataset.

Dataset Size

After the data cleaning process, the DataFrame shape is 18013 rows with 59 columns (df.shape: 18013, 59).

Definition of Database Key Attributes

According to the explanation from Scimago Journal Ranking, Web of Science Master Journal List and Scopus, as well as Xabir Hasan Kaggle Dataset,

Key attribute definitions are as follows:

Rank: Overall rank of the journal (derived from sorted SJR index).

Title: Name or title of journal.

OA: Open Access or not.

Country: Country of origin.

SJR-index: A citation index calculated by Scimago.

CiteScore: A citation index calculated by Scopus.

H-index: Hirsch index, the largest number h such that at least h articles in that journal were cited at least h times each.

Best Quartile: Top Q-index or quartile a journal has in any subject area.

Best Categories: Subject areas with top quartile.

Best Subject Area: Highest ranking subject area.

Best Subject Rank: Rank of the highest-ranking subject area.

Total Docs.: Total number of documents in the journal.

Total Docs. 3y: Total number of documents in the past 3 years.

Total Refs.: Total number of references of the journal.

Total Cites 3y: Total number of citations in the past 3 years.

Citable Docs. 3y: Total number of citable documents in the past 3 years.

Cites/Doc. 2y: Total number of citations divided by the total number of documents in the past 2 years.

Refs./Doc.: Total number of references divided by the total number of documents.

Publisher: Name of the publisher company of the journal.

Core Collection: Web of Science core collection name.

Coverage: Starting year of coverage.

Active: Active or inactive.

In-Press: Articles in press or not.

ASJC Codes: All Science Journal Classification codes for the journal.

Data Analysis

Based on the dataset, there are several data features that are worth mentioning, including open accessibility, journal distribution by country, journal count of quartiles, area of academic disciplines number and field of study, and correlation between SJR-index rank and metrics.

Open Accessibility

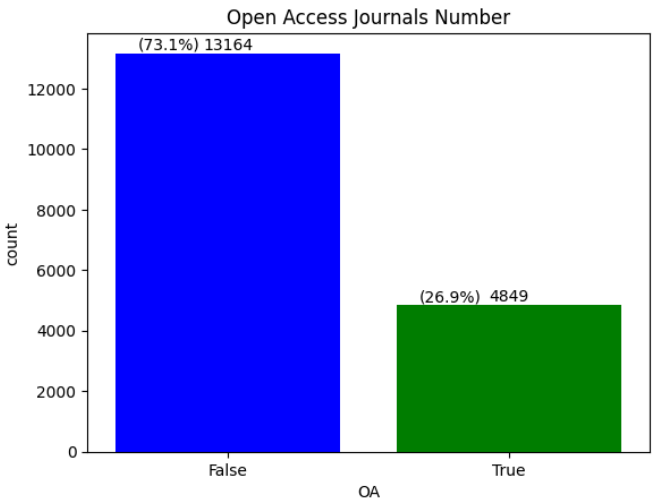
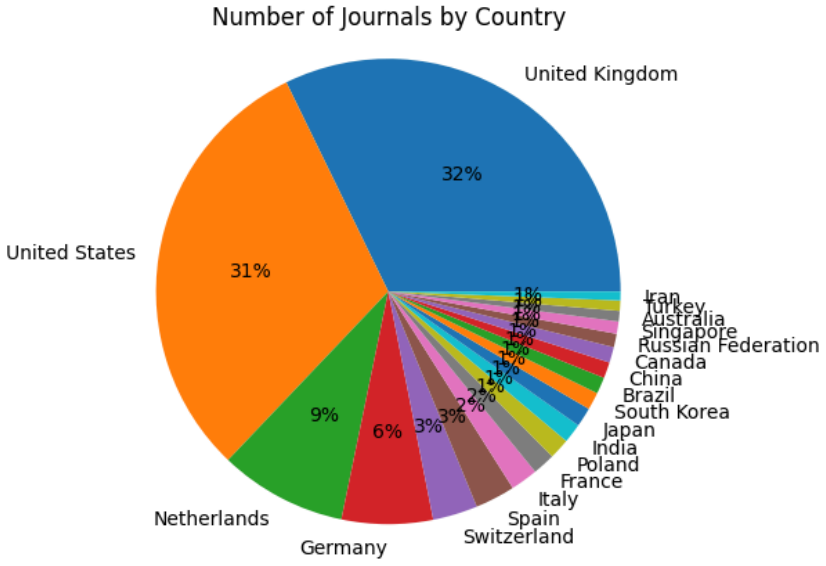


figure x

Regarding the accessibility of journals (in Figure x), out of the total number of journals examined, 13164 (73.1%) were identified as not openly accessible, while 4849 (26.9%) journals were found to be openly accessible.

Journal Distribution by Country



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Among the countries where the academic journals were published, the United States, the United Kingdom and a few European countries account for more than three-quarters of the total.

Journal Count of Quartiles

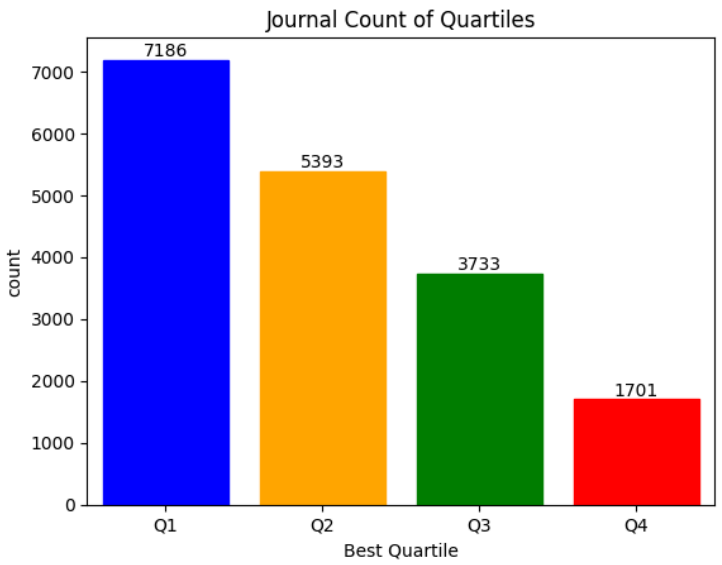


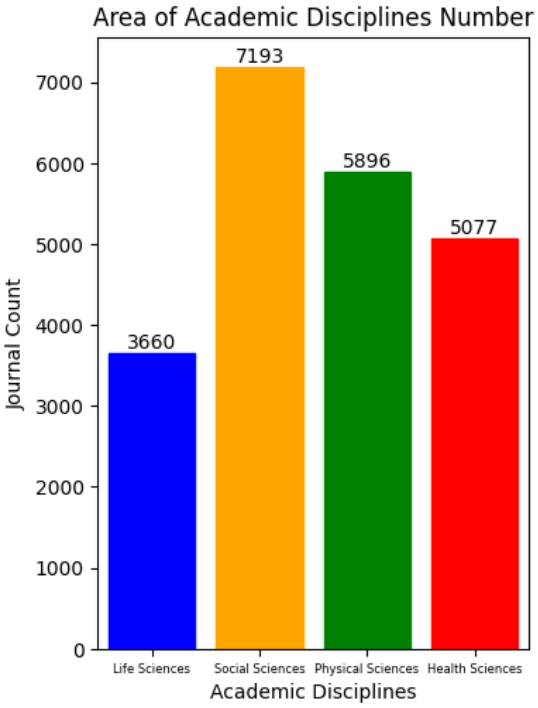
figure x

Relationship between Academic Disciplines and Fields of Study in Academic Journal Dataset

Academic disciplines provide a structure for organising knowledge, while fields of study focus on specific areas within those disciplines. Disciplines provide a broad framework, while fields allow for specialised and focused study (The Content Authority, 2023). This interplay between disciplines and fields enables the exploration of specific topics within a broader academic context, facilitating both in-depth and comprehensive research and study.

For example, in the dataset, the title of the journal “Cell”, in which the area of academic disciplines belongs to ‘Life Sciences’ and the field of study is ‘1300 Biochemistry, Genetics and Molecular Biology’.
There may be some academic journals that belong to more than one area of academic disciplines and fields of study.

Area of Academic Disciplines Number



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Area of Fields of Study Number

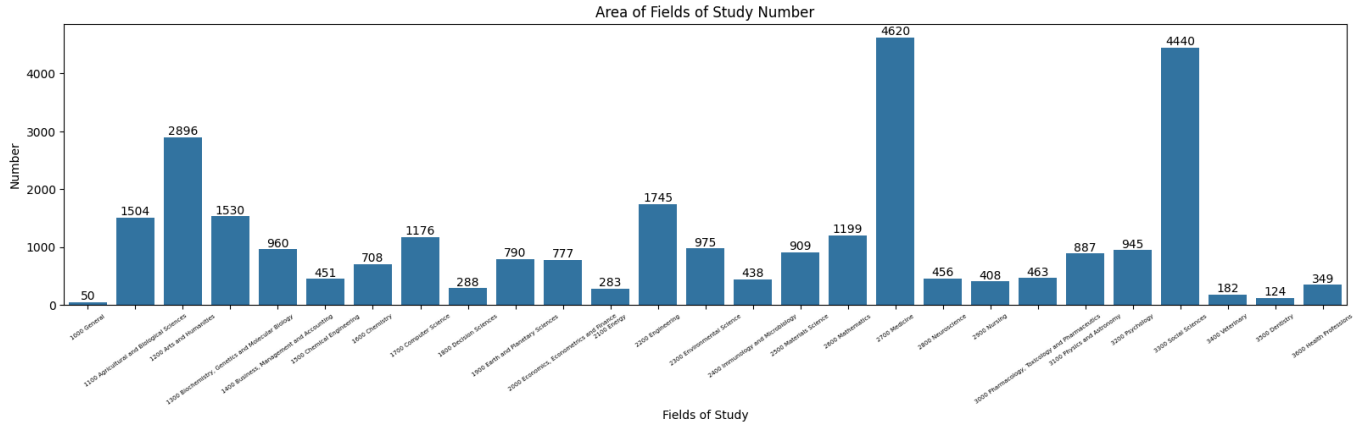

figure x

Selection of Metrics and Indices for Ranking Journals

As mentioned, the following aspects of journals will be prioritised in academic journal rankings: including quality over quantity, avoiding over-referencing and legacy bias, stability as well as citation impact regulation.

In this dataset, several metrics and indices will be selected in order to evaluate the scholarly impact of journals and create a new comprehensive academic journal ranking.

SJR-index (Scimago Journal Rank):
The SJR-index takes into account not only the volume of citations a journal receives but also the reputation of the citing journals, offering a more nuanced perspective on the journal's impact. One of the features of SJR-index, moreover, is normalised across disciplines, which adjusts for differences in citation practices among different fields, making it suitable for cross-disciplinary comparisons. Weight-wise, the approach emphasises citations from influential journals while reducing the influence of self-citations, ensuring a balanced assessment.

CiteScore (Scopus):
CiteScore considers all forms of documents, such as articles, reviews, and conference papers, thereby offering a broader view of a journal's impact. With annual updates, CiteScore provides a stable evaluation over time, ensuring stability.

H-index (Hirsch index):
Scholars frequently take into consideration journals with high H-indices for their academic contributions, which can evaluate a journal's influence based on its most frequently cited articles, thus representing both the volume and value of the research papers. The H-index demonstrates less sensitivity to outliers, such as papers that are either exceptionally highly cited or rarely cited.

Total Cites 3y:
The total number of citations in the past three years captures the recent impact of a journal, reflecting its present relevance. By concentrating on the latest citations, an undue emphasis on dated publications is prevented.

Cites/Doc. 2y:
This ratio is a measure of a journal's efficiency in attracting citations for its documents. Higher values suggest articles of significant impact.
This metric highlights the importance of the quality of publications over their sheer number.

Refs./Doc.:

A lower ratio indicates that the journal maintains high standards by limiting excessive citations. Avoid excessive citations, as excessive citations can weaken the originality of your paper.

Depending on the importance of the goal of this project, the above metrics and indices will be given different weights in the new academic journal ranking matrix.

Similarity of Metrics

Correlation between SJR-index Rank and Metrics

Well-known metrics like SJR-index, H-index and Cite Score are commonly used to evaluate the Journal's quality, especially in terms of citation impact and academic reputation. The academic journals in the dataset were ranked based on SJR-index values (from largest to smallest). Rankings based on H-index and Cite Score value, total number of citations in the past 3 years (Total Cites 3y Rank), citations divided by the total number of documents in the past 2 years (Cites/Doc. 2y) and references divided by the total number of documents were also created, for comparison purposes.

Numerical Results:

Metrics Rank	Correlation Coefficient (compared to Dataset Rank)
SJR-index	0.99996
CiteScore	0.8709
H-index	0.7904
Cites/Doc. 2y	0.9007
Total Cites 3y	0.8088
Refs./Doc.	0.4440

Data Visualisation

Reference is made to the data visualisation work of Abir Hassan (2023), which shows the correlation between rankings and metrics for each academic journal as a whole.

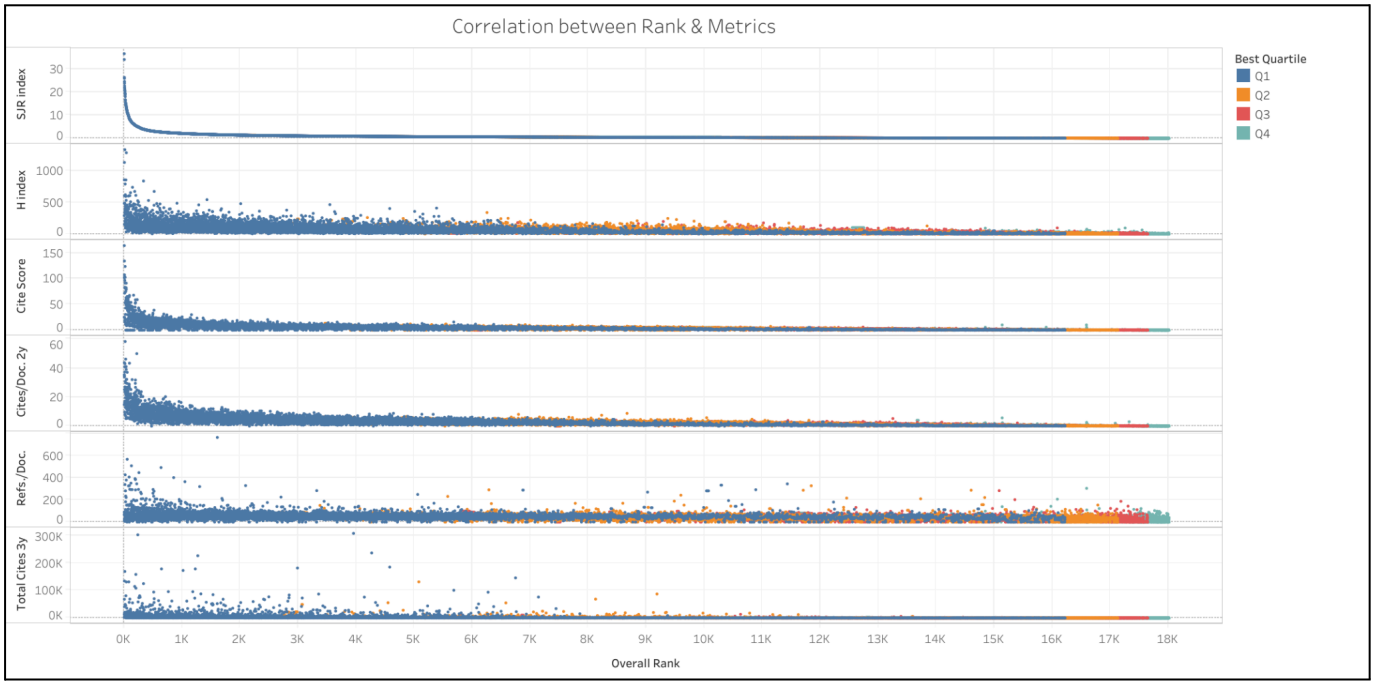

figure x

Methodology

In the development of the new academic journal ranking metrics, a collaborative approach that combines both subjective expertise and objective data science technique is considered. This approach will be applied to the same dataset of journals using both PCA-based index ranking and expert-weighted ranking.

Weight Allocation on Critical Aspects

In this approach, weight assignments are also driven by experts and researchers. Experts are engaged to provide insights on critical factors for journal ranking, and their collective judgement guides the allocation of weights to various ranking criteria. This subjective expertise is then combined with objective metrics, including SJR-index, H-index and Cite Score value, total number of citations in the past 3 years, citations divided by the total number of documents in the past 2 years and references divided by the total number of documents. These secondary measures ensure transparency and reduce bias.

Statistical Technique: Principal Component Analysis (PCA)

The Principal Component Analysis (PCA) technique is an effective statistical method used to minimise the complexity of large datasets while retaining the maximum amount of statistical data. It accomplishes this by generating new, uncorrelated variables (principal components) that successively optimise variance. The procedure identifies linear combinations of the original variables that capture the most significant variation. These components are ranked based on their eigenvalues and eigenvectors (Jolliffe & Cadima, 2016). In doing so, PCA converts the original data into lower-dimensional space, enhancing comprehensibility and minimising information loss.

In this study, we demonstrate the application of Principal Component Analysis (PCA) to analyse journal rankings based on multiple metrics.

The approach involves the following steps:

1. **Data Selection:**

Considering the calculation complexity, the first batch of 5,000 journals was selected as a demonstration. Metrics considered include SJR-index, H-index, CiteScore, Cites/Doc. in 2 years, Total Cites in 3 years, Refs./Doc., as well as the weighted sum of each journal.

2. **Covariance Matrix:**

We compute the covariance matrix to capture relationships between metrics.

3. **PCA and Feature Vectors:**

Eigenvalues and eigenvectors are calculated from the covariance matrix, and the feature vectors are obtained by projecting the data onto the selected eigenvectors.

4. **Normalised Weights:**

Loadings (normalised contributions) for each metric are derived. Weights for the principal components are also determined.

5. **Weighted Scores and Rankings:**

Weighted scores are computed by combining feature vectors and weights. Journals are ranked based on their weighted scores.

This approach provides insights into how different metrics contribute to journal rankings, which help us to identify dominant patterns, and provides a refined ranking based on weighted scores. It allows us to understand which dimensions contribute most significantly to journal performance. The resulting rank (PCA) reflects overall performance after considering the principal components.

The next step in this process is to evaluate the consistency of these approaches. The result rankings will be compared and assessed for their consistency and correlation with existing rankings using Kendall's Tau Rank Correlation. According to the explanation of Kendall's Tau rank correlation (Statisticshowto, n.d.), Kendall's Tau Rank Correlation is a statistical tool employed to evaluate the consistency and correlation between two rankings. It specifically measures the similarity between two different ranking methods and provides insights into how well different ranking methods agree with each other in order to evaluate the reliability and validity of rankings across different ranking metrics.

Comparing PCA and expert-driven weight allocations presents a comprehensive and adaptable approach for academic journal ranking. This strategy employs both statistical precision and specialised knowledge, resulting in more informed and robust rankings.

Results

Weights Definition

The final weight allocation on critical aspects is finalised based on the average weighting value that was allocated by two researchers and one expert.

The results are as follows:

Metric	**Weighting**
SJR-index	0.6
H-index	0.15
CiteScore	0.1
Cites/Doc. in 2 years	0.05
Total Cites in 3 years	0.05
Refs./Doc.	0.05

Weighted Sum Calculation:

For each academic journal, we computed the weighted sum by multiplying the weight of each metric by its corresponding value for that journal. The weighted sum represents the overall performance score.

Normalisation and Ranking:

To ensure a fair comparison, we normalised the weighted sums across all journals. Academic Journals were then ranked based on their normalised scores.

Each observation (academic journal) and its associated metrics were included in the data frame for analysis and comparison.

Apply Statistical Techniques - Principal Component Analysis (PCA) with Scikit-learn

Number of Components

The desired explained variance (95%) was specified when applying PCA with Scikit-learn in Python. The algorithm automatically determines the minimum number of components required to retain that specified level of variance.

Choosing 95% explained variance can strike a balance, which can simplify the model while preserving critical patterns (Chouinard, 2023).

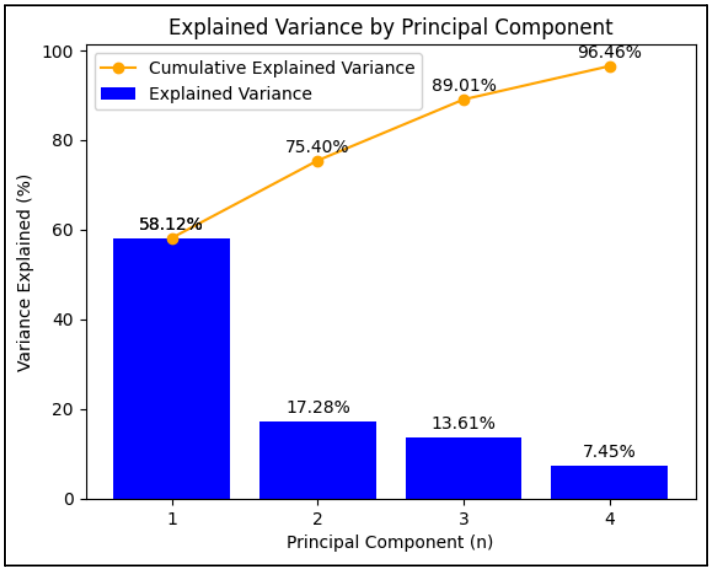

figure x

Figure X shows that the fourth principal component (PCA-4) cumulatively covers more than 95% of the explained variance.

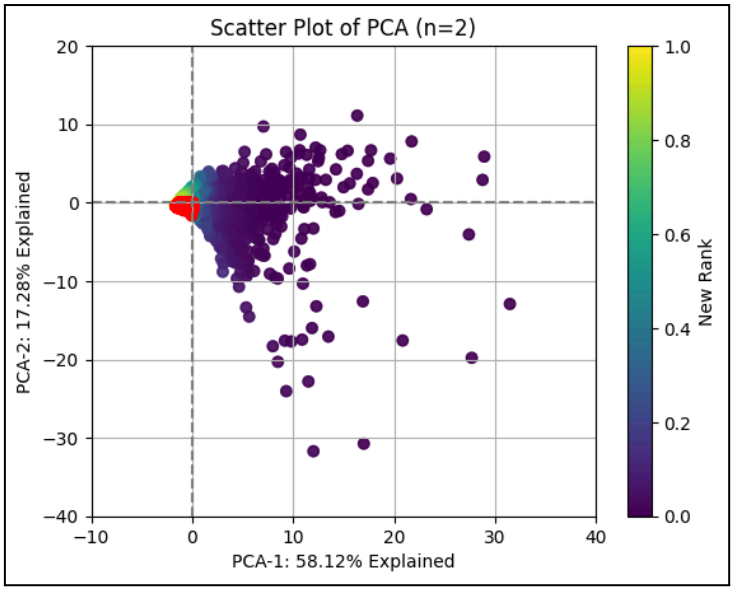

figure x

Figure x shows the visualisation of PCA-1 and PCA-2.

PCA Score Calculation:

As mentioned, only the first 5000 journals were selected, and their eigenvalues and eigenvectors of the covariance matrix were computed in order to perform Principal Component Analysis (PCA). Finally, the rank of journals can be generated after the calculation of their normalised weighted scores. The higher the weighted score, the higher the journal rank, meaning a journal performs relatively better under these specific dimensions.

The resulting rank (PCA) provides an overall assessment of each journal's performance after considering the principal components.

Comparison between the Original Rank, Experts Distributed Weights Rank and PCA Score Rank Results

In this comparison, we explore how three different ranking methods—Original Rank, Experts Distributed Weights Rank, and PCA Score Rank—yield distinct results. The Original Rank reflects the initial order of the dataset. The Experts Distributed Weights Rank considers domain-specific weights. Meanwhile, the PCA Score Rank emerges from dimensionality reduction techniques.

Scatter plot for comparing the PCA Score Rank and Experts Distributed Weights Rank:

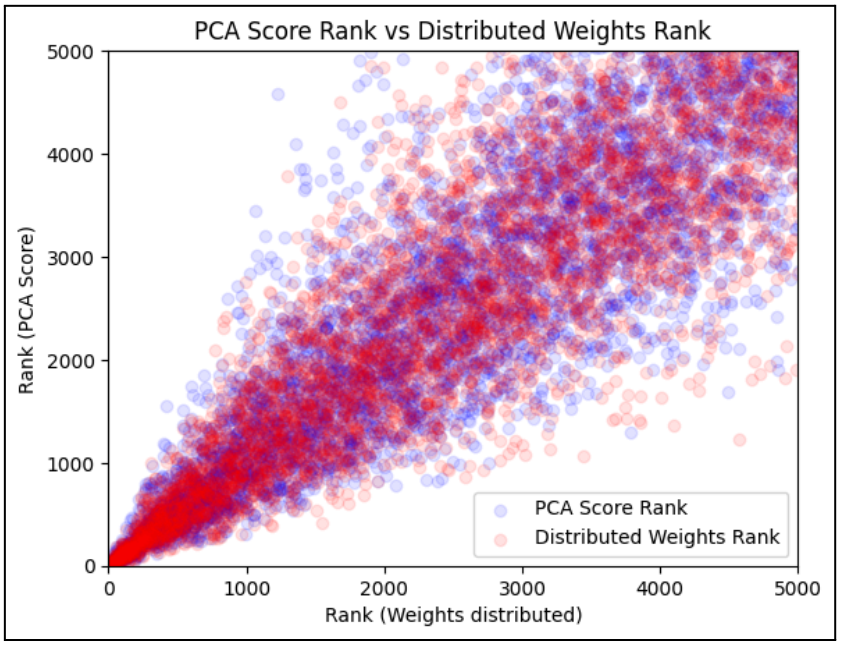

figure x

Scatter plot for comparing the Original Rank and Experts Distributed Weights Rank:

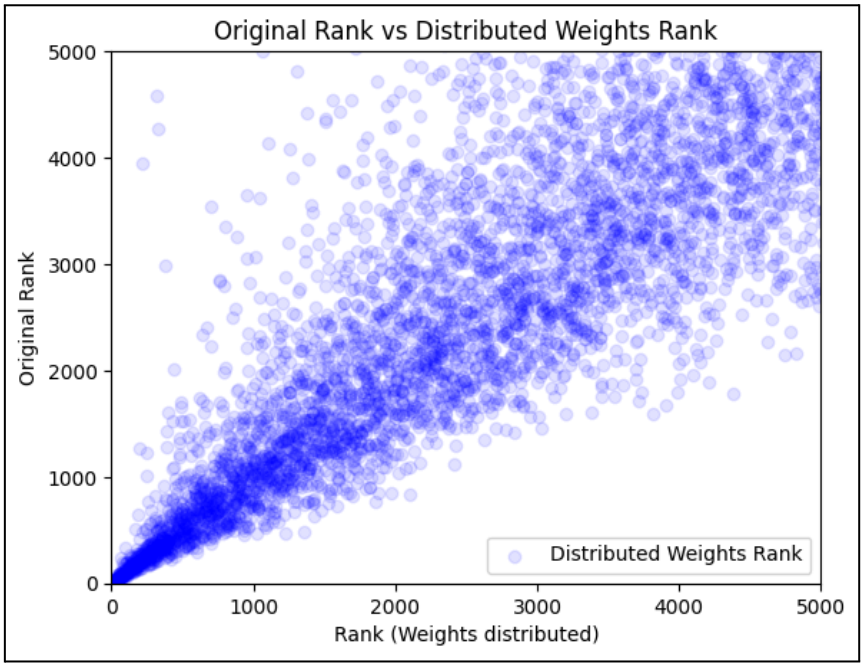

figure x

Scatter plot for comparing the PCA Score Rank and Original Rank:

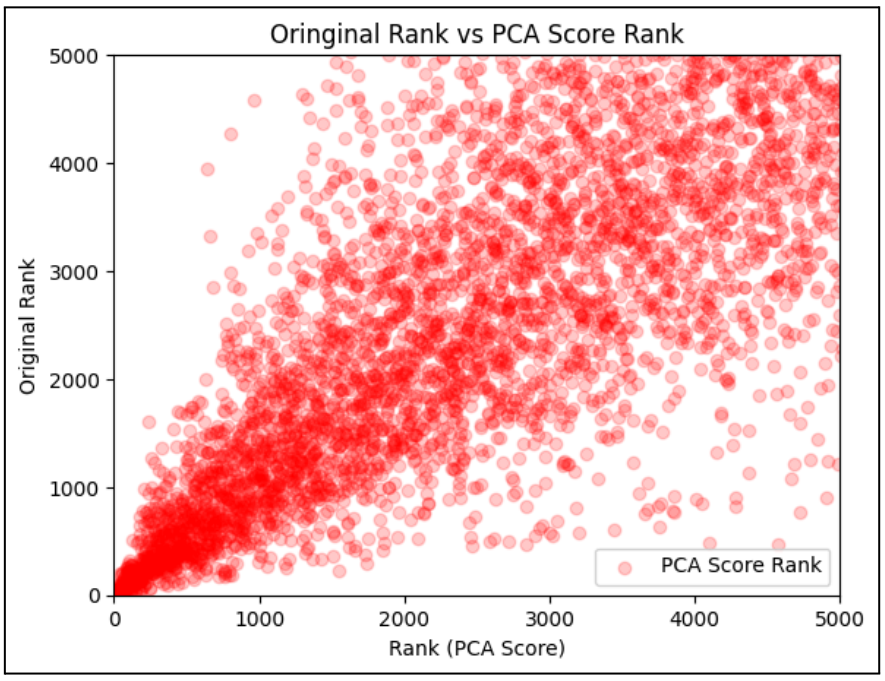

figure x

Scatter plot for comparing the PCA Score Rank, Experts Distributed Weights Rank and Original Rank (First 5000 Journals in Dataset):

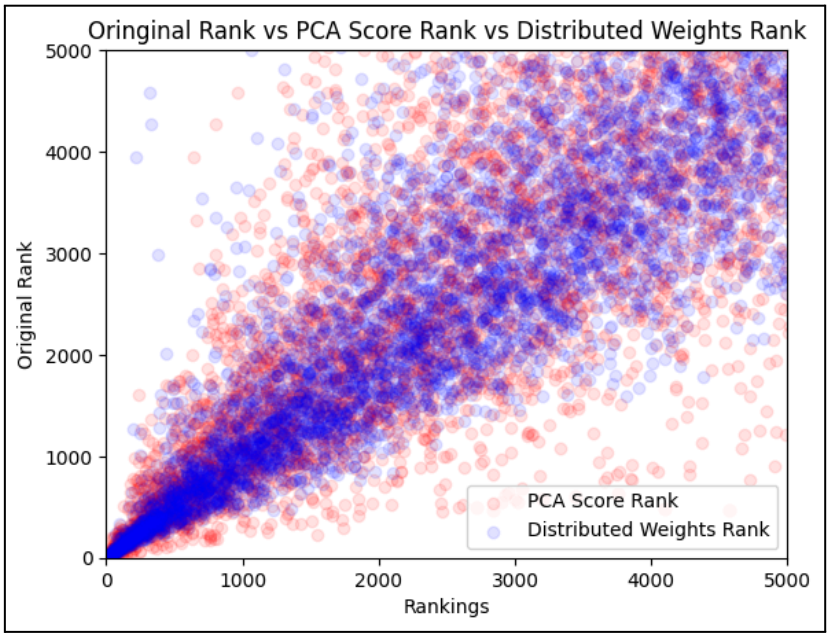

figure x

Scatter plot for comparing the PCA Score Rank, Experts Distributed Weights Rank and Original Rank (All Journals in Dataset):

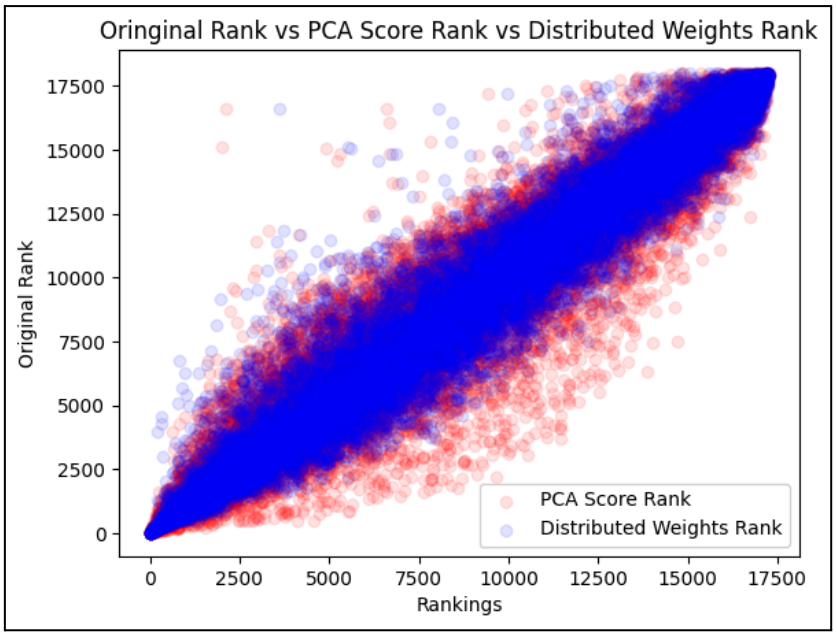

figure x

Comparing the Academic Journal Titles: "Cell", "Nature", and "Science" Across Different Ranking Metrics

Among a large number of academic journals in the dataset, the rankings of journal titles: "Cell", "Nature", and "Science" under different ranking metrics are focused on evaluating the outcome. The following results will show the original academic journal rank in the dataset **(Original Rank)**, Weights sum rank based on experts' distributed weights **(Distributed Weights Rank)** and PCA score rank of each academic Journal after performing Principal Component Analysis **(Rank (PCA))**.

Academic Journal Titles: "Cell"

“Cell” is a reputable journal known for publishing unusual discoveries across diverse fields of experimental biology, including cell biology, molecular biology, neuroscience, immunology, virology, microbiology, cancer, human genetics, systems biology, signalling, and disease mechanisms and therapeutics.

Results:
Journal Title: Cell
Original Rank: 4th
Distributed Weights Rank: 5th
Rank (PCA): 3rd

Academic Journal Titles: "Science"

“Science” is one of the most prestigious and influential scientific journals globally. It covers a wide range of scientific disciplines, including biology, chemistry, physics etc.

Results:
Journal Title: Science
Original Rank: 38th
Distributed Weights Rank: 15th
Rank (PCA): 4949th

Academic Journal Titles: "Nature"

“Nature” is a prestigious weekly international journal that publishes peer-reviewed research across all fields of science and technology. It emphasises originality, importance, interdisciplinary interest, timeliness, accessibility, elegance, and surprising conclusions.
In addition to research articles, Nature provides authoritative news and interpretation of trends affecting science and the wider public.

Results:
Journal Title: Nature
Original Rank: 12th
Distributed Weights Rank: 6th
Rank (PCA): 9th

Kendall's Tau Rank Correlation

Kendall's Tau Rank Correlation, a non-parametric measure similar to Spearman's ρ and Pearson's Product Moment Correlation Coefficient, is a statistical tool used to assess the consistency and correlation between two ranked variables or rankings (Stepanov, 2015).

The formula of Kendall's τ (tau) :

$$\tau = \frac{C-D}{C+D} = \frac{C-D}{\frac{n\cdot(n-1)}{2}} = \frac{C-D}{\binom{n}{2}} = \frac{C-D}{\frac{n!}{2!(n-2)!}}$$

Where C is a concordant pair, which means when the rank of the second variable is higher than the rank of the first variable, while D is a discordant pair, which means when the rank is the same as the first variable's rank or less.

Kendall's Tau correlation coefficient returns a value of -1 to 1, where:

- 0 indicates no relationship between the two rankings.
- 1 indicates a perfect positive relationship between the two rankings.
- -1 indicates a perfect negative relationship between the two rankings.

Results:

Ranking Metrics	Original Rank	Distributed Weights Rank	Rank (PCA)
Original Rank	/	**0.85**	**0.80**
Distributed Weights Rank	**0.85**	/	**0.88**
Rank (PCA)	**0.80**	**0.88**	/

Discussion

The Original Rank, Experts Distributed Weights Rank, and PCA Score Rank are positively related, with high Kendall's Tau Rank Correlation values as mentioned (0.85, 0.8, and 0.88), which may imply that there is a consistent pattern or agreement among these three ranking methods.

This positive correlation suggests that the rankings derived from these different approaches exhibit a significant level of alignment or agreement, in which the factors and criteria taken into account by each ranking method capture similar aspects of the dataset's characteristics while emphasising different aspects at the same time.

This means that certain domains or criteria hold more significance or weight in the ranking process. On the other hand, the PCA Score Rank involves techniques that reduce the dataset's dimensionality, aiming to capture the most important components or dimensions. Despite the introduction of these additional considerations through domain-specific weights and dimensionality reduction techniques, the positive correlation between these rankings and the Original Rank indicates that they do not significantly alter the initial order of the dataset. In other words, the rankings tend to converge or align with the original ranking.

Robustness and Convergence in the Ranking Approaches

This convergence of different perspectives implies that the various methodologies or approaches used to derive the rankings are capturing similar underlying factors or characteristics of the dataset. It

suggests that the experts' domain-specific weights and the dimensionality reduction techniques do not significantly deviate from the initial order of the data. This convergence brings a certain level of confidence to the overall ranking results by indicating that different perspectives and methodologies are in agreement regarding the relative positions of the academic journals being ranked. The result suggests that the rankings are not heavily influenced by a single approach or biased towards specific criteria. Instead, they provide a comprehensive and balanced assessment by considering multiple factors and perspectives.

The positive correlation observed between the Original Rank and the other ranking methods further strengthens the robustness of the rankings. This correlation indicates that the rankings are not heavily dependent on a single approach, as multiple ranking methods consistently produce similar results. Such consistency among different approaches enhances confidence in the validity of the rankings. When multiple methods converge and align with the original ranking, it assures that the results are not driven by a single approach or biased towards specific criteria. Therefore, the positive correlation reinforces the robustness of the rankings, enabling researchers and evaluators to have greater trust in the rankings' reliability, as they reflect a consensus among different methodologies and capture the essential characteristics of the dataset under consideration.

Evaluating Academic Journal Rankings

A Comparative Analysis of "Cell," "Nature," and "Science" Across Different Academic Journal Ranking Metrics

Academic Journal Title: "Nature"

The Original rank of "Nature" in the dataset was ranked at 12th.

The Distributed Weights rank of "Nature" is ranked at 6th

The PCA score rank of "Nature" is 9th

Analysis of Rankings

The result suggests that "Nature" performs exceptionally well based on both the distributed weights rank and the PCA score. Additionally, it is ranked ninth based on its contribution to the identified dimensions or components captured by the PCA analysis, which may be caused by the feature's interdisciplinary nature. "Nature" covers a broad range of scientific disciplines and often publishes

interdisciplinary research. This interdisciplinary nature could contribute to the strong patterns or variations observed in the PCA analysis. By publishing research that bridges multiple fields, "Nature" may capture unique and distinct patterns that differentiate it from other journals in the dataset. The significant patterns or variations captured by the PCA analysis could be a reflection of the influential and diverse research published in "Nature."

Academic Journal Title: "Cell"

The Original rank of "Cell" in the dataset was ranked 4th.
The Distributed Weights rank of "Cell" is ranked at 5th.
The PCA score rank of "Cell" is 3rd.

Analysis of Rankings

"Cell" consistently maintains a high ranking across different journal ranking metrics. The fact that "Cell" also ranks 5th based on the Distributed Weights Rank suggests that it performed well across various metrics, as determined by the given weights.
The 3rd rank in terms of the PCA score indicates that "Cell" exhibited significant importance and influence within the dataset after dimensionality reduction. The journal's articles, research, and impact have likely made substantial contributions in terms of the key dimensions identified through PCA. These dimensions may represent important themes, topics, or research areas that hold a strong presence and influence within the dataset.

Academic Journal Title: "Science"

The Original rank of "Science" in the dataset was ranked 38th.
The Distributed Weights rank of "Science" is ranked at 15th
The PCA score rank of "Science" is 4949th.

Analysis of Rankings

Compared to "Science", it holds a relatively high position in terms of the Distributed Weights Rank. However, the significantly lower rank of 4949th based on the PCA score indicates that, after dimensionality reduction through PCA, "Science" does not exhibit as strong a presence or influence within the dataset. There are some possible reasons behind that, such as the influence of outliers in the dataset. Since PCA is sensitive to outliers in the data, if there are outlier journals in the dataset that significantly impact the identified dimensions, they could influence the rankings of other journals, including "Science" The presence of influential outliers can affect the relative positioning of "Science" in the PCA analysis.

In this comparative analysis of academic journal rankings, "Nature" consistently performs well across different metrics. Its substantial impact and wide range of research contributions are indicated by its high ranks in the distributed weights rank and PCA score. One possible explanation for the significant patterns and variances shown in the PCA analysis is that "Nature" is an interdisciplinary work. "Cell" also maintains a high ranking, indicating its strong performance across various metrics and its importance in the dataset. However, "Science" exhibits a lower presence and influence after dimensionality reduction through PCA, possibly due to the result of outliers in the dataset. The presence of influential outliers can impact the relative positioning of journals in the PCA analysis, including "Science."

Real-life Example of Applying the Technique: Assessing Investment Portfolios

There is a real-life example where the convergence of different expert perspectives and PCA score rank can be observed in the evaluation of investment portfolios.

Different financial metrics and criteria are taken into consideration while assessing investment portfolios in order to evaluate the risk and performance of the portfolio. These measurements include different risk measures, alpha, beta, Sharpe ratio, volatility, and returns.

Financial institutions, investment firms, and analysts often provide their own rankings or ratings of investment portfolios based on their methodologies and criteria. Every organisation may use a different set of measures or employ another approach in evaluating the performance of their portfolio.

Despite the variations in rankings, there is often convergence and alignment among highly ranked portfolios. Portfolios with good performance across rankings tend to be marked by effective risk management techniques, strong investment performance, and alignment with investors' interests. Furthermore, by using dimensionality reduction methods such as PCA, it is possible to find underlying trends and variables that influence portfolio performance when evaluating investment portfolios. PCA helps identify important dimensions or variables that primarily influence the return and risk characteristics of a portfolio (Beliavsky, Danilova, & Yao, 2023).

Hence, the convergence of different perspectives and alignment in portfolio rankings, alongside the insights gained from PCA analysis, can also assist investors in making informed decisions about their investment choices. This approach provides a comprehensive evaluation of portfolios, considering multiple metrics and identifying the core factors driving their success.

Conclusion

"Principled Ranking for Academic Journals" encompasses the key findings and implications of the study. The report has critically examined the current ranking system of academic journals and proposed modifications based on different criteria for evaluating the value and influential power of these journals. By exploring existing methodologies and their limitations, the report has provided valuable insights into alternative approaches that can enhance the accuracy and reliability of journal rankings. A reliable ranking system is very important for guiding researchers in identifying high-quality journals, enabling institutions to evaluate research productivity. It has brought attention to the need for an improved method of rankings that more accurately captures the importance and influence of academic works.

This study has also outlined modifications to the existing ranking system, including prioritising criteria for scholarly impact, avoiding over-referencing, ensuring stability in measures over time, regulating citation impact, and avoiding legacy bias. With these suggested modifications, the weaknesses of the existing ranking methodology can be addressed, and academic journals can be evaluated more comprehensively and accurately. The selection of metrics and indices for ranking

journals, such as the SJR-index and H-index, is crucial in determining their relative positions and impact within the academic community. Additionally, the study has presented the final weight allocation on critical aspects based on the average weight value allocated by researchers and an expert. This allocation clearly explains the metrics and their relative importance in the ranking system. And emphasised applying statistical techniques like Principal Component Analysis (PCA) to analyse journal rankings based on multiple metrics. The convergence and alignment of rankings generated by multiple methodologies have been demonstrated by the comparative examination of several ranking criteria for certain academic journal titles.

In conclusion, this study, "Principled Ranking for Academic Journals", has provided a comprehensive analysis of the current ranking system for academic journals, proposed potential modifications, and demonstrated the application of statistical techniques to enhance the accuracy and reliability of journal rankings. The proposed modifications aim to address the intrinsic flaws of the current ranking system and provide a more comprehensive and accurate evaluation of academic journals, ultimately contributing to the advancement of scholarly research and knowledge dissemination.

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