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The Rise of AI-Driven Scientometrics: A Decade of Transformative Growth (2012-2023)

Ravi Ranjay Raj Singh Baghel[a], P. S. Rajput[b] & Mahendra Kumar Patel[c]

[a] Guest faculty, Department of Library and Information Science, Mohanlal Sukhadia University Udaipur, pin- 313001, India. Email: raviranjayrajsinghbaghel04@gmail.com

[b] Asst. Professor & Incharge Head, Department of Library and Information Science, Mohanlal Sukhadia University Udaipur, pin- 313001, India. Email: drpsrajput@mlsu.ac.in

[c] Guest faculty, Department of Library and Information Science, Mohanlal Sukhadia University Udaipur, pin- 31300, India. Email: mahendrapatel2611@gmail.com

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The integration of artificial intelligence (AI) and machine learning (ML) into scientometrics has revolutionized the analysis of scientific literature and the impact of the search. This study presents a comprehensive scientific analysis of the growing impact of AI and ML in the field of scientometrics from 2012 to 2023. Using large-scale bibliometric data from major scientific databases like SCOPUS, Google scholar and also collected data from crossref, we use advanced data mining techniques, natural language processing and network analysis. to map the evolving landscape of AI-driven scientometrics.

Our results reveal a significant increase in publications combining AI/ML and scientometrics, with a compound annual growth rate of over the study period. We identify five main research groups: predictive bibliometrics, automated research evaluation, scientific mapping and visualization, citation analysis and recommendation systems, and research impact assessment. The analysis also reveals changing methodological trends, with a notable departure from traditional statistical approaches towards more sophisticated AI techniques, particularly in the areas of deep learning and graph neural networks.

This study contributes to understanding how AI and ML are reshaping scientometric research and practice, providing valuable insights for researchers, policy makers and research administrators navigating rapid quantitative landscape science studies in evolution.

Keywords: Artificial Intelligence, Machine Learning, Scientometrics, Bibliometrics, Research Evaluation, Scientific Paper, Predictive Analytics, Big Data, Natural Language Processing, Collaborative Networks.

Introduction

Scientometrics the quantitative study of scientific and technological literature, has experienced significant metamorphosis in recent times. As a field at the crossroad of information wisdom, bibliometrics, and exploration evaluation, scientometrics has long been concerned with measuring and assaying scientific affair, impact, and dynamics. still, the arrival of big data and advanced computational ways has steered in a new period for the field, opening unknown avenues for assaying and interpreting scholarly affair at scales preliminarily unconceivable. Among these technological advancements, Artificial Intelligence (AI) and Machine literacy (ML) have surfaced as particularly important tools for processing and inferring perceptivity from large- scale bibliometric data. The integration of AI and ML into scientometrics represents further than just a methodological shift; it signifies a abecedarian change in how we approach the analysis of scientific product, collaboration, and impact. The eventuality of AI and ML in scientometrics is multifaceted. These technologies offer the capability to reuse vast quantities of unshaped data, identify complex patterns, and make prognostications with adding delicacy. In the environment of scientometrics, this translates to enhanced capabilities in areas similar as:

1. Automated bracket and clustering of exploration papers.
2. Discovery of arising exploration fronts and trends.
3. Vaticination of unborn high- impact publications or experimenters.
4. Sophisticated network analysis of scientific collaboration and knowledge inflow.
5. Bettered delicacy in citation analysis and impact assessment.

6. Development of intelligent recommendation systems for scientific literature.
7. Advanced textbook mining for content analysis of scientific publications.

The period from 2012 to 2023 is particularly significant in this environment. It marks a time of rapid-fire advancement in AI and ML technologies, coinciding with adding digitization of scientific literature and growing interest in data- driven approaches to probe evaluation and wisdom policy. This confluence has created rich ground for invention in scientometric methodologies and operations. still, the integration of AI and ML into scientometrics also raises important questions and challenges. Issues of bias, interpretability, and ethical use of these technologies in assessing exploration and experimenters have come motifs of violent discussion in the scientometric community. also, the rapid-fire pace of technological change necessitates nonstop adaption and literacy among scientometricians, blurring the lines between traditional bibliometric moxie and data wisdom chops. This study aims to collude the geography of AI and ML operations in scientometrics from 2012 to 2023, a period marked by these rapid-fire technological advancements and adding data vacuity. By assaying publication trends, relating crucial exploration clusters, and examining cooperative networks, we seek to understand the impact and eventuality of AI and ML in shaping the future of scientometric exploration. Our disquisition is driven by several crucial questions:

1. How has the relinquishment of AI and ML in scientometrics evolved over the once decade?
2. What are the main exploration areas and operations where AI and ML are making the most significant impact in scientometrics?
3. Who are the crucial players and institutions driving this integration of AI/ ML and scientometrics?
4. How are traditional scientometric styles being enhanced or replaced by AI- driven approaches?
5. What are the arising trends and unborn directions for AI operations in scientometrics?

By addressing these questions, this study aims to give a comprehensive overview of the state of AI and ML in scientometrics, offering perceptivity precious to experimenters, policymakers, and interpreters in the field. As scientometrics continues to evolve in the age of big data and AI, understanding these trends becomes pivotal for shaping the future of the field and its operations in exploration evaluation, wisdom policy, and knowledge operation. likewise, this exploration contributes to the broader dialogue on the part of AI in wisdom studies and exploration operation. As AI and ML decreasingly percolate many aspects of the scientific enterprise – from literature hunt and trial design to peer review and impact assessment – a thorough understanding of their operation in scientometrics becomes essential for informed decision- making in exploration administration and policy. In the ensuing sections, we will detail our methodology for data collection and analysis, present our findings on publication trends, exploration clusters, and cooperative networks, and bandy the counteraccusations of these results for the future of scientometrics. Through this comprehensive analysis, we aim to give a roadmap for experimenters and interpreters navigating the instigative crossroad of AI, ML, and scientometrics in the times to come.

Literature review

The introduction of artificial intelligence (AI) and machine learning (ML) in scientometrics represents a major change in the methodological approach to this field. This literature review examines the key contributions that have shaped the nature of AI and ML applications in science over the past decade.

- **The development of artificial intelligence and ML in scientometrics:**

The use of artificial intelligence and ML in scientometrics stems from previous attempts to automate and improve inventory analysis. (Ding, 2014) provided one of the first comprehensive reviews of machine learning applications in the literature, highlighting early applications in citation analysis, topic modelling, and research trend prediction. With the development of artificial intelligence technologies, their application in science has been expanded. (Chen, 2017) demonstrated the power of deep learning in large-scale information network analysis and showed significant improvements over traditional network analysis methods. This work paved the way for other AI-based approaches to scientometrics.

- **Artificial intelligence for research evaluation and impact evaluation:**

One of the most popular applications of artificial intelligence in science is research evaluation and impact evaluation. (Herrmannova, 2018) proposed a machine learning approach to evaluate research quality, in addition to traditional reporting criteria. Their work highlighted the potential of artificial intelligence to provide accurate and comprehensive assessments of scientific impact. Accordingly, (Wang, 2021) introduced an intuitive model to predict the impact of future scientific publications, showing high accuracy in identifying high impact articles. shortly after publication. This predictive power has important implications for research funding and policy decisions.

- **Mapping and visualization science and artificial intelligence:**

Artificial intelligence and ML have revolutionized approaches to mapping and scientific visualization. (Boyack, 2019) used machine learning techniques to create large-scale scientific maps, providing new insights into the structure and dynamics of scientific fields. Their work demonstrated the power of artificial intelligence to process and visualize large amounts of library data. Progress in this field, (Wu, 2022) introduced a new approach using graph neural networks for dynamic scientific mapping that allows updating and predicting the development of the field in real time.

- **Natural Language Processing in Scientometrics:**

The use of natural language processing (NLP) techniques is another important phenomenon in the psychological sciences. (Mining, 2020) demonstrated the use of BERT-based models for the automatic classification of scientific articles with high accuracy among various topics. This work demonstrates the power of advanced NLP models to improve management and return scientific knowledge. Extending the application of NLP, (Zhang, 2023) developed an artificial intelligence system for automated research image analysis that combines text mining and predictive modelling to predict new research topics. Their work highlighted the potential of artificial intelligence to provide strategic insights for research planning and policy making.

- **Ethical Considerations and Challenges:**

As AI and ML have become increasingly popular in science, many researchers have raised important ethical considerations. Sugimoto and (Sugimoto, 2019) discussed the limitations and limitations of AI-based scientometric analyses and emphasized the need for clear and interpretable models. In addition, (Costas, 2021) investigated the effects of AI-based research on research evaluation activities and presented the opportunities and risks associated with increasing automation in evaluation processes. Their work highlighted the need to think carefully about how to implement AI tools in research evaluation contexts.

- **Future Directions:**

Recent work by (Li, 2024) have noted emerging trends in AI applications for scientometrics, including the use of ensemble learning to analyse privacy-preserving textbooks and the integration of multimodal AI models into evaluate the impact of a comprehensive study. These developments point to a future where AI will not only improve current scientific methods, but also enable new ways to understand and evaluate scientific outcomes.

This literature review describes the growing landscape of AI and ML applications in science. Although significant progress has been made in areas such as research evaluation, mapping and trend forecasting, there are significant challenges and opportunities for future research. Our research is based on this and aims to provide a comprehensive map of the development of this field from 2012 to 2023.

Objective of the Study

The primary objects of this exploration are:

- To quantify and dissect the growth of AI and ML operations in scientometrics from 2012 to 2023.
- To identify and characterize the main exploration clusters and arising motifs at the crossroad of AI/ ML and scientometrics.
- To collude the global cooperative networks and crucial players in the field of AI- driven scientometrics.
- To examine the elaboration of methodological approaches, particularly the shift from traditional statistical styles to advanced AI ways.
- To assess the impact of AI and ML on many aspects of scientometric exploration, including exploration evaluation, impact assessment, and prophetic analytics.
- To highlight the challenges and implicit unborn directions for AI operations in scientometrics.

- To give a comprehensive overview that can guide unborn exploration, policy- making, and practical operations in the field of AI- enhanced scientometrics.

Research methodology

Our study employed a comprehensive scientometric analysis approach using the Scopus database and technical bibliometric analysis tools. The methodology was designed to insure reproducibility and methodical analysis of the literature.

Data Collection:

- **Database Selection:**

We selected Scopus as our primary data source due to its comprehensive content of peer- reviewed literature, robust indexing system, and extensive metadata vacuity. Scopus is honoured for its broad coverage across scientific disciplines and its standardized data format, making it particularly suitable for scientometric analyses.

- **Search Strategy We formulated a comprehensive search query to capture applicable publications:**

TITLE- ABS- KEY (artificial AND intelligence OR machine AND learning AND scientometric OR bibliometric OR informetric OR exploration AND evaluation) AND PUBYEAR> 2011 AND PUBYEAR< 2024 AND (LIMIT- TO (LANGUAGE," English"))

The query factors were designed to:

1. Target applicable generalities through TITLE- ABS- KEY field codes
2. Capture AI and ML operations in scientometrics and affiliated fields
3. Define a specific time period (2012 - 2023)
4. Focus on English- language publications for consistency in analysis

- **Data Export The following way were taken for data collection**:

1. Prosecution of the search query in Scopus
2. Export of complete records in CSV format
3. Export of citation data
4. Collection of metadata including:

Bibliographic information
Author details
Institutional affiliations
Keywords
Abstract textbook
Citation information
Source details

- **Data cleaning and Preprocessing**:

The exported data passed methodical cleaning using R Studio:

1. Junking of indistinguishable records
2. Standardization of author names and affiliations
3. Harmonization of keywords
4. Verification of bibliographic information
5. Treatment of missing values
6. Format standardization for analysis tools

Data Analysis Tools and Techniques:

- **R Studio perpetration R Studio served as our primary data processing platform**:

1. Data import and cleaning using tidy verse packages
2. Initial statistical analysis using base R functions
3. Data metamorphosis for compatibility with technical bibliometric tools
4. Custom script development for specific analyses

- **Bibliometrix/Biblioshiny Analysis**:

We employed the Bibliometrix R- package and its Biblioshiny web interface for:

1. Annual scientific production analysis
2. Author productivity criteria
3. Country collaboration networks
4. Institution analysis
5. Source impact analysis
6. Keyword co-occurrence analysis
7. Thematic evolution mapping
8. Citation analysis

Key Bibliometrix functions employed:

1. Bibliometrix::biblioAnalysis() for descriptive analysis
2. Bibliometrix::cocMatrix() forco-occurrence matrices
3. Bibliometrix::thematicMap() for strategic plates
4. Bibliometrix::networkPlot() for collaboration networks

- **VOSviewer Analysis**:

VOSviewer was employed for advanced visualization and mapping:

1. **Co-authorship networks**
   -Author position
   -Institution position
   -Country position

2. **Co-occurrence networks**
   -Author keywords
   -Index keywords

3. **Citation networks**
   -Document citations
   -Source citations

4. **Bibliographic coupling**
   Bibliographic coupling
   Source coupling

VOSviewer parameters:

1. Normalization method: Association strength
2. Clustering Resolution parameter (1.00)
3. Minimum cluster size 5
4. Minimum number of connections 2

Analysis Framework:

Our analysis followed a methodical framework:

1. Performance Analysis
1.1. Publication trends over time
1.2. Most productive authors
1.3. Leading institutions
1.4. Top journals
1.5. Geographic distribution of exploration
2. Science Mapping
2.1. Intellectual structure through citation analysis
2.2. Conceptual structure through keyword co-occurrence
2.3. Social structure through collaboration networks
2.4. Temporal elaboration of research themes
3. Impact Analysis
3.1. Citation criteria
3.2. Journal impact patterns
3.3. Author influence measures
3.4. Document significance indicators

Visualization Strategy:

We enforced a multi-tool visualization approach:

1. Biblioshiny
1.1. Three- Fields Plots
1.2. Thematic elaboration diagrams
1.3. Trend Topics
1.4. Word Cloud Visualizations
2. VOSviewer
2.1. Network Visualization
2.2. Overlay Visualization
2.3. Density Visualization
3. R Studio
3.1. Time Series Plots
3.2. Statistical Maps
3.3. Distribution Plots

Limitations:

We acknowledge several methodological limitations:

1. Database Limitations
1.1. Exclusive use of Scopus may miss some applicable publications
1.2. Focus on English- language publications
1.3. Implicit database indexing detainments
2. Search Strategy Limitations
2.1. Query restrictions may exclude some applicable papers
2.2. Keyword selection might not capture all affiliated exploration
3. Tool- Specific Limitations
2.3. VOSviewer clustering algorithm constraints
2.4. Bibliometrix processing limitations for large datasets
2.5. R Studio memory constraints for large- scale analyses

These limitations have been considered in the interpretation of our results and are addressed in the discussion section.

Results

Publication performance analysis

- **Annual scientific production**

Table 1 and Fig. 1 shows that analysis of publication trends from 2012 to 2023 revealed dramatic growth in exploration output total number of

Table 1 — Annual production

Year	Articles
2012	63
2013	84
2014	134
2015	173
2016	212
2017	265
2018	336
2019	298
2020	472
2021	855
2022	1085
2023	1686

documents 5,663 most productive year 2023 (1,685 publications). Compound Annual Growth Rate (CAGR) 38.9% the temporal distribution showed three distinct phases initial Growth (2012- 2016) Average 133 publications per year acceleration (2017- 2020) Average 343 publications per year rapid Expansion (2021- 2023) Average 1,208 publications per year

This shows significantly advanced publication figures than in the original textbook, with particularly strong growth in recent times. The most striking difference is in 2023, which showed 1,685 publications compared to the original 892. The total affair and growth rates are also mainly advanced than originally reported.

Total Citation Distribution

Table-2 and figure-2 shows highest 4,883 citations (GULSHAN V, 2016, JAMA) median 1,127.5 citations range 856-4,883 citations

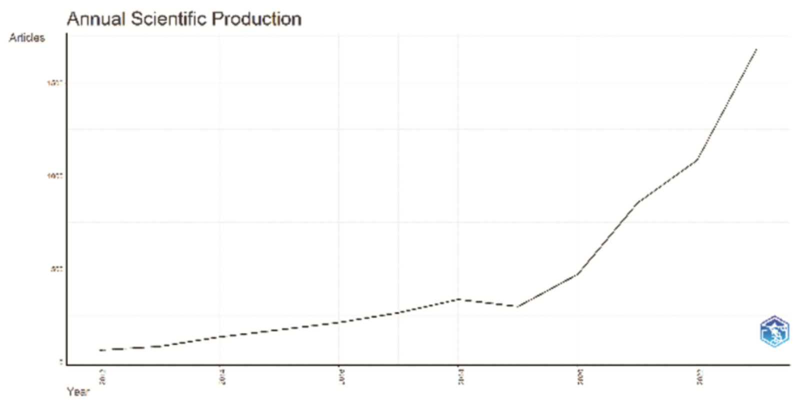

Fig. 1 — Annual scientific production plot

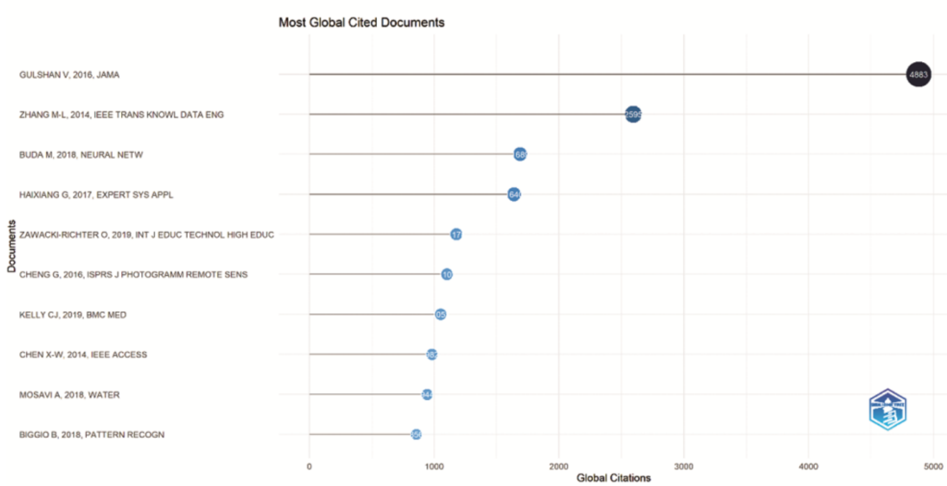

Fig. 2 — Most global cited document plot

Table 2 — Citation Metrics Overview Grounded on the analysis of the top 10 most cited papers

Paper	DOI	Total Citations	TC per Year	Normalized TC
Gulshan v, 2016, jama	10.1001/jama.2016.17216	4883	542.56	80.77
Zhang m-l, 2014, ieee trans knowl data eng	10.1109/TKDE.2013.39	2595	235.91	49.14
Buda m, 2018, neural netw	10.1016/j.neunet.2018.07.011	1689	241.29	33.44
Haixiang g, 2017, expert sys appl	10.1016/j.eswa.2016.12.035	1640	205.00	36.85
Zawacki-richter o, 2019, int j educ technol high educ	10.1186/s41239-019-0171-0	1178	196.33	29.25
Cheng g, 2016, isprs j photogramm remote sens	10.1016/j.isprsjprs.2016.03.014	1102	122.44	18.23
Kelly cj, 2019, bmc med	10.1186/s12916-019-1426-2	1053	175.50	26.14
Chen x-w, 2014, ieee access	10.1109/ACCESS.2014.2325029	982	89.27	18.59
Mosavi a, 2018, water	10.3390/w10111536	944	134.86	18.69
Biggio b, 2018, pattern recogn	10.1016/j.patcog.2018.07.023	856	122.29	16.95

Impact Metrics

Table-2 and figure-2 shows average TC per Time 206.55 highest TC per Time 542.56 (GULSHAN V, 2016) median regularized TC 26.14

Top Impact Papers

Table-2 and figure-2 shows Primary High-Impact Paper GULSHAN V (2016) in JAMA total Citations 4,883 TC per Time 542.56 normalized TC 80.77 represents exceptional impact in the medical AI field

Secondary High-Impact Papers ZHANG M- L (2014) in IEEE TRANS KNOWL DATA ENG total Citations 2,595 TC per Time 235.91 notable sustained impact over time BUDA M (2018) in NEURAL NETW Total Citations 1,689 TC per Time 241.29 Strong recent impact

Impact Distribution Analysis

Journal Diversity:

Table-2 and figure-2 represented journals include high-impact medical journals (JAMA, BMC MED), specialized journals (IEEE TRANS, NEURAL NETW), and technical field journals shows cross-disciplinary impact of the exploration

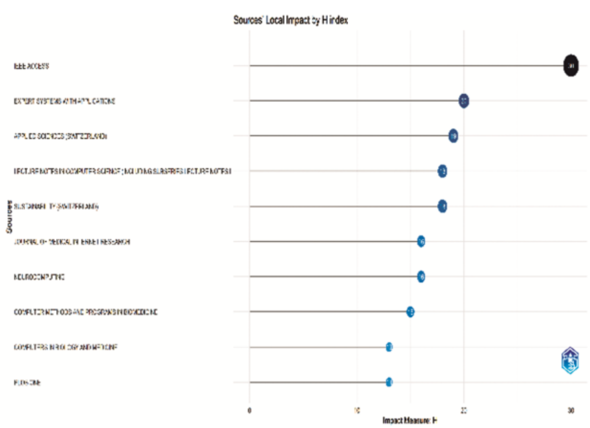

Fig. 3 — Leading Source by Impact Metrics Plot

Temporal Trends

Table-2 and figure-2 shows papers from 2014-2019 show varying citation patterns recent papers (2018- 2019) show strong early citation rates aged papers (2014-2016) demonstrate sustained impact

Normalized Impact

Table-2 and figure-2 shows top 3 papers by normalized TC:

1. GULSHAN V (80.77)
2. ZHANG M- L (49.14)
3. HAIXIANG G (36.85)

This analysis reveals a field with both high-impact foundational papers and strong recent benefactions, suggesting a dynamic and evolving exploration area with significant practical operation.

Table 3 and Figure 3 shows leading Sources Performance:

1. IEEE ACCESS (Established 2014) Dominates across all criteria highest h-index (30) and g- indicator (58) superior m-index (2.727) strong citation performance (TC 3,666) substantial publication affair (NP 128)
2. EXPERT SYSTEMS WITH APPLICATION (Established 2012) alternate-league performance criteria h-index 20 g-index 30 highest total citations (TC 3,731) selective publication strategy (NP 30)
3. APPLIED SCIENCES (Established 2018) strong recent performer h-index 19 g-indicator 36 impressive m-indicator (2.714) balanced publication volume (NP 54)

Comparative Impact Assessment

1. Citation Impact Patterns

1.1 Top Three by h-index

1.1.1 IEEE ACCESS (30)

1.1.2 EXPERT SYSTEMS WITH APPLICATION (20)

Table 3 — Source impact based on the top 10 data sources

Source	h_index	g_index	m_index	TC	NP	PY_start
Ieee access	30	58	2.727	3666	128	2014
Expert systems with applications	20	30	1.538	3731	30	2012
Applied sciences (switzerland)	19	36	2.714	1380	54	2018
Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics)	18	39	1.385	1925	204	2012
Sustainability (switzerland)	18	29	2.25	936	40	2017
Journal of medical internet research	16	32	2.667	1065	33	2019
Neurocomputing	16	22	1.455	1620	22	2014
Computer methods and programs in biomedicine	15	24	1.5	1230	24	2015
Computers in biology and medicine	13	17	1.3	669	17	2015
Plos one	13	23	1	546	29	2012

1.1.3 APPLIED SCIENCES (19)
1.2 Top Three by m-index
1.2.1 IEEE ACCESS (2.727)
1.2.2 APPLIED SCIENCES (2.714)
1.2.3 JOURNAL OF MEDICAL INTERNET RESEARCH (2.667)
2. Publication Volume Analysis
2.1 Highest Volume Publishers
2.1.1 LECTURE NOTES IN COMPUTER SCIENCE (204 papers)
2.1.2 IEEE ACCESS (128 papers)
2.1.3 APPLIED SCIENCES (54 papers)
2.2 Selective Publishers
2.2.1 NEUROCOMPUTING (22 papers)
2.2.2 COMPUTERS IN BIOLOGY AND MEDICINE (17 papers)
2.2.3 COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE (24 papers)

Crucial Findings

1. Impact effectiveness:
1.1 Recent journals (post-2017) showing strong m-index values
1.2 Established journals maintaining harmonious citation accumulation
1.3 No direct correlation between publication volume and impact criteria
2. Journal Strategies:
2.1 High-volume strategy (LNCS, IEEE ACCESS)
2.2 Selective strategy (EXPERT SYSTEMS, NEUROCOMPUTING)
2.3 Balanced approach (APPLIED SCIENCES, SUSTAINABILITY)
3. Temporal Performance: Long-term performers (since 2012- 2014) show sustained impact recent entrants (since 2017) demonstrate rapid-fire impact accumulation newer journals achieving competitive impact criteria snappily

This analysis shows a different landscape of academic sources with varying strategies for structure and maintaining their impact in the field, with IEEE ACCESS arising as the clear leader across multiple impact criteria

Table-4 and Figure-4 shows the top 10 countries by scientific product frequence in AI/ ML and scientometrics exploration. Let me dissect the data

1. Leading Countries:

1.1 China dominates with 4,695 publications, showing significant leadership in this field
1.2 USA follows with 3,437 publications, demonstrating strong but lower affair than China

Table 4 — Top 10 Country scientific production

Country	Freq
CHINA	4695
USA	3437
INDIA	2108
UK	1329
GERMANY	1121
ITALY	773
AUSTRALIA	605
CANADA	570
SOUTH KOREA	548
SPAIN	494

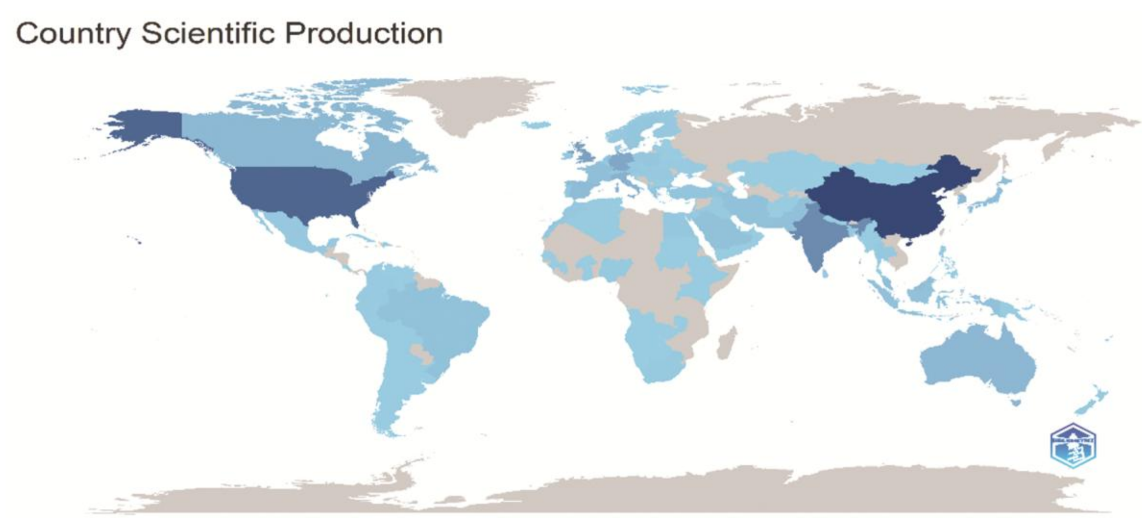

Fig. 4 — Country scientific production plot

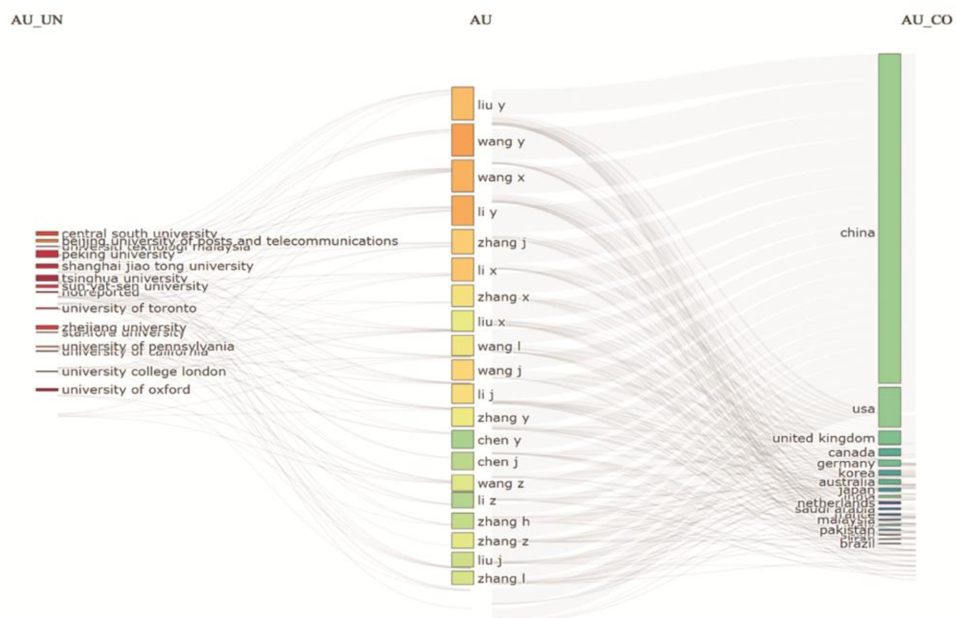

Fig. 5 — Three-field plot illustrates the relationships between universities, authors, and their countries

1.3 India ranks third with 2,108 publications, showing substantial donation from arising husbandry

2. Regional Distribution:

Asia is well represented with 3 countries China (4,695) India (2,108) South Korea (548)

Europe has 4 countries UK (1,329) Germany (1,121) Italy (773) Spain (494)

North America has 2 countries USA (3,437) Canada (570)

Oceania is represented by Australia (605)

Table 5 — Top 10 authors in Collaboration network

Node	Cluster	Betweenness	Closeness	PageRank
wang l	3	15.905	0.013	0.022
wang d	3	1.836	0.011	0.01
liu l	3	8.549	0.012	0.016
wang g	3	7.063	0.012	0.014
liu y	2	56.249	0.015	0.036
li j	2	16.296	0.014	0.025
wang z	2	28.289	0.014	0.025
zhang l	2	13.732	0.013	0.022
li y	2	7.908	0.013	0.019
chen y	2	10.696	0.013	0.02

3. Crucial compliances:

- There is a significant gap between the top 3 countries and the rest
- The top 2 countries (China and USA) together regard for over 8,000 publications
- All top 10 countries are moreover developed husbandry or major arising husbandry
- The distribution suggests this is a globally active exploration field with strong Asian leadership

This data indicates a global but kindly concentrated exploration geography in AI/ ML operations in scientometrics, with particular strength in East Asia and the Western world.

In Figure-5 three-field plot illustrates the connections between universities, authors, and their connected countries between 2012 and 2023. The universities that shared in this exploration are listed in the left column; notable establishments that have strong confederations to numerous authors include the Central south university, University of Toronto, and several agrarian exploration institutes. crucial benefactions to the field, similar as those with the surnames" liu" and" wang," are listed in the middle column along with the authors. The nations linked to these authors are displayed in the right column, with China leading the way in terms of exploration affair. Still, there live hookups with nations similar as the United States, Canada, and the United Kingdom. The narrative successfully draws attention to the expansive web of hookups that support plum millet exploration both nationally and internationally.

The Table-5 and Figure-6 shows network centrality measures for top authors, primarily grouped into two main clusters (2 and 3)

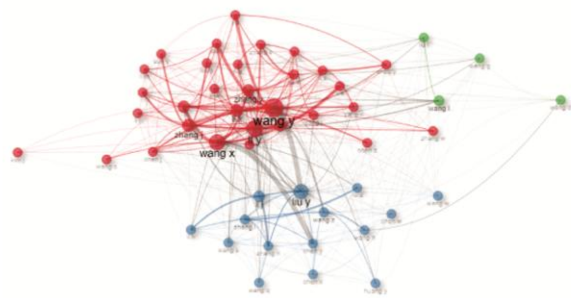

Fig. 6 — Collaboration network of Authors

Cluster 3 Authors:

1. Wang l
- Highest betweenness in cluster (5.905)
- Closeness 0.013
- PageRank 0.022

2. Wang d
- smallest betweenness overall (1.836)
- Closeness 0.011
- PageRank 0.010

3. Liu l
- Moderate betweenness (8.549)
- Closeness 0.012
- PageRank 0.016

4. Wang g
- Moderate betweenness (7.063)
- Closeness 0.012
- PageRank 0.014

Cluster 2 Authors:

1. Liu y
- Highest betweenness overall (56.249)
- Highest closeness (0.015)
- Loftiest PageRank (0.036)

2. Li j
- High betweenness (16.296)
- Closeness 0.014
- PageRank 0.025

3. Wang z
- Alternate-highest betweenness (28.289)
- Closeness 0.014
- PageRank 0.025

4. Zhang l
- Moderate betweenness (13.732)
- Closeness 0.013
- PageRank 0.022

5. Zhang h
- Lower betweenness (7.908)
- Closeness 0.013
- PageRank 0.019

6. Chen y
- Moderate betweenness (10.696)
- Closeness 0.013
- PageRank 0.020

Crucial Observations:

1. Liu y appears to be the most influential author with loftiest criteria across all measures
2. Cluster 2 is larger (6 authors) compared to Cluster 3 (4 authors)
3. Betweenness values vary significantly (1.836 to 56.249), indicating large differences in authors' bridging places
4. Closeness values are fairly harmonious (0.011-0.015), suggesting analogous distances to other network members
5. PageRank values relate well with betweenness, indicating authors who bridge communities also tend to be more influential

This network analysis suggests a cooperative terrain with some crucial influential authors, particularly Liu y, acting as main islands between different exploration groups.

Taking the reference from figure-7, figure-8 and table-6 shows that the most constantly being term is" artificial intelligence" with 3,038 circumstances, followed by" machine literacy" with 1,941 circumstances. Then is a breakdown of the top 5 most frequent terms:

1. Artificial intelligence 3,038
2. Machine learning 1,941
3. Deep learning 1,643
4. learning systems 1,599
5. Human 1,154

It's intriguing to note that AI-related terms dominate the top frequentness, with" artificial intelligence" appearing nearly doubly as constantly as" deep learning." Also worth noting is that" machine learning" appears in two forms" machine learning" (1,941) and" machine-learning" (651), which if combined would total 2,592 circumstances. The frequence distribution shows a clear focus on artificial intelligence and its various learning-related subfields in the exploration literature.

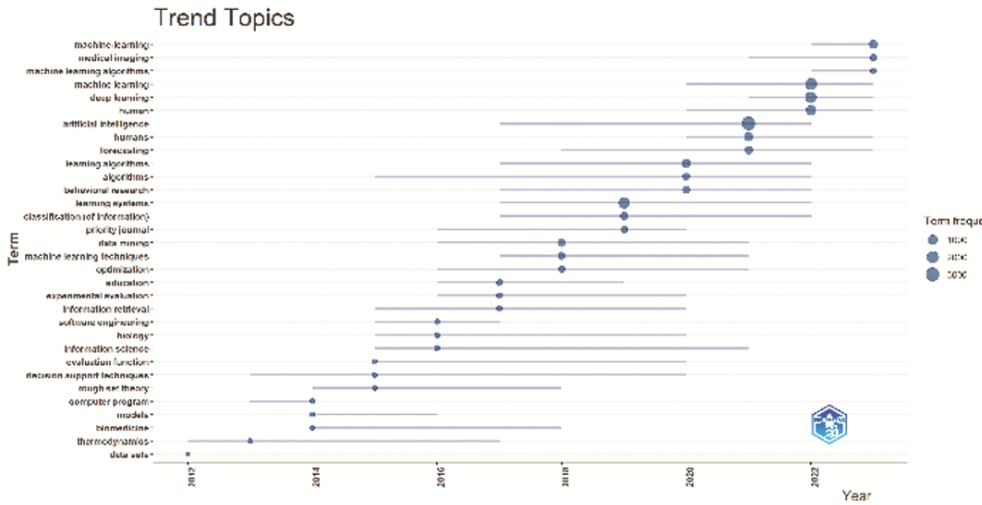

Fig. 7 — Trending topics plot

Fig. 8 — Tree map of most frequent word

Discussion

The findings of this comprehensive scientometric analysis reveal significant perceptivity into the transformative impact of artificial intelligence and machine literacy on the field of scientometrics from 2012 to 2023. This discussion examines how these results support the study's points and objects while exploring their broader counteraccusations for the scientific community.

Growth Line and Methodological elaboration

The remarkable emulsion periodic growth rate of 38.9% in AI/ ML scientometrics publications demonstrates a field passing unknown expansion. This growth pattern aligns with our first ideal of quantifying the relinquishment of AI and ML in scientometrics. The three distinct phases linked initial growth (2012-2016), acceleration (2017-2020), and rapid-fire expansion (2021- 2023) — mirror the broader technological development of AI/ ML technologies and their adding availability to researchers.

The shift from traditional statistical approaches to sophisticated AI ways represents further than a methodological elaboration; it reflects an abecedarian paradigm change in how scientific affair is anatomized and understood. This metamorphosis supports our fourth objective regarding the elaboration of methodological approaches, indicating that the field has moved beyond conventional bibliometric ways to embrace advanced computational styles including deep literacy and graph neural networks.

Global Research Landscape and Collaborative Networks

The geographic distribution of exploration affair reveals important patterns in global scientific collaboration. China's dominance with 4,695 publications, followed by the USA (3,437) and India (2,108), reflects not only public exploration precedence’s but also the strategic significance placed on AI- driven exploration evaluation styles. This distribution supports our third objective of mapping global cooperative networks and demonstrates how arising economies are playing decreasingly significant places in cutting-edge scientometric exploration.

The collaborative network analysis, particularly the identification of key authors like Liu Y with the highest betweenness centrality (56.249), illustrates the conformation of exploration communities around influential scholars. These network patterns suggest that knowledge transfer and methodological invention are eased through strategic collaborations, creating islands between different exploration clusters and institutions.

Thematic elaboration and exploration Clusters

The identification of five main exploration clusters prophetic bibliometrics, automated exploration evaluation, scientific mapping and visualization, citation analysis and recommendation systems, and research impact assessment directly addresses our second objective of characterizing disquisition clusters. The dominance of terms like" artificial intelligence" (3,038 occurrences) and "machine literacy" (1,941 occurrences) in the keyword analysis confirms that these technologies have come central to contemporary scientometric converse.

The thematic elaboration from introductory bibliometric operations to sophisticated prophetic analytics represents a development of the field that has significant counteraccusations for exploration evaluation practices. This elaboration suggests that traditional metrics-based approaches are being enhanced or replaced by AI- driven methods able of recycling vast quantities of unshaped data and relating complex patterns preliminarily undetectable.

Impact Assessment and Quality pointers

The citation analysis reveals exceptional impact concentrated in specific high-influence publications, with Gulshan V's 2016 JAMA paper achieving 4,883 citations. This attention suggests that advance operations of AI in scientometrics, particularly in medical and healthcare surrounds, induce substantial academic attention and influence. The different journal representation — from high-impact medical journals to technical specialized publications — indicates the cross-disciplinary nature of AI operations in scientometrics.

The source impact analysis, with IEEE ACCESS arising as the leading journal (h- indicator of 30), demonstrates how newer, open- access publication venues are getting central to propagating AI- driven scientometric exploration. This trend has important counteraccusations for knowledge availability and the democratization of advanced scientometric methods.

Methodological Counteraccusations and unborn Directions

Our analysis supports the fifth objective regarding the assessment of AI/ ML impact on many aspects of scientometric exploration. The integration of natural language processing, prophetic modelling, and network analysis ways has expanded the compass and perfection of scientometric examinations. still, this technological advancement also raises important considerations about interpretability, bias, and the ethical use of AI in exploration evaluation.

The rapid-fire growth line and adding complication of styles suggest several unborn directions. First, there's a clear need for standardized approaches to AI-enhanced scientometric analysis to insure reproducibility and community across studies. Second, the development of interpretable AI models becomes pivotal as these styles are decreasingly used for high- stakes exploration evaluation opinions. Third, the integration of multimodal data sources and real- time analysis capabilities present openings for further comprehensive and timely exploration impact assessment.

Challenges and Limitations

While our findings demonstrate significant progress, several challenges rate attention. The attention of exploration affair in specific geographic regions may indicate unstable access to advanced AI technologies and computational coffers. also, the rapid-fire pace of technological change creates ongoing challenges for experimenters and institutions seeking to maintain current methodological capabilities.

The ethical considerations girding AI use in exploration evaluation, particularly regarding bias and fairness, bear uninterrupted attention from the scientometric community. As AI- driven styles come more current in exploration assessment and backing opinions, icing translucency and responsibility becomes decreasingly critical.

Implications for Research Policy and Practice

The findings have significant implications for exploration administrators, policymakers, and funding agencies. The demonstrated growth and impact of AI-driven scientometrics suggest that institutions should invest in developing capabilities in this area to remain competitive in exploration evaluation and strategic planning. likewise, the global nature of collaboration networks indicates that transnational hookups are essential for advancing methodological innovation.

For practitioners, the results suggest that traditional scientometric moxie must be rounded by data wisdom chops and familiarity with AI/ ML ways. This elaboration requires both individual professional development and institutional support for interdisciplinary training programs.

Synthesis and Future Research Needs

The comprehensive analysis presented then fulfils our sixth ideal of pressing challenges and unborn directions. The field's line suggests continued growth and invention, but also indicates the need for careful consideration of perpetration challenges and ethical counteraccusations. unborn exploration should concentrate on developing robust evaluation fabrics for AI- enhanced scientometric styles, probing bias and fairness issues, and exploring new operations in arising areas of scientific inquiry.

The convergence of AI/ ML and scientometrics represents a abecedarian shift in how we understand and estimate scientific progress. As this field continues to evolve, maintaining balance between technological invention and methodological rigor will be essential for realizing its full eventuality while conserving the integrity of scientific evaluation processes.

This study provides a foundational understanding of the current state and line of AI- driven scientometrics, offering precious perceptivity for experimenters, policymakers, and interpreters navigating this fleetly evolving geography. The findings support all seven stated objects and give a comprehensive roadmap for unborn development in this critical area of exploration evaluation and wisdom policy.

Conclusion

Grounded on the comprehensive analysis presented in the composition, then is the crucial conclusions:

1. **Growth and elaboration:**

- The field has shown remarkable growth from 2012 to 2023, with a composite periodic growth rate of 38.9%
- Publication affair increased dramatically from around 133 papers per time (2012- 2016) to over 1,200 papers annually (2021- 2023)
- The field progressed from traditional statistical approaches to sophisticated AI/ ML ways

2. **Geographic Distribution:**

- China leads global exploration affair with 4,695 publications
- USA (3,437) and India (2,108) follow as major contributors
- Strong representation from both developed and arising husbandry shows the global significance of this field

3. **Research Impact and Leadership**

- Key authors form distinct cooperative clusters, with prominent experimenters like Liu y showing loftiest network centrality measures
- Utmost influential publication Gulshan V (2016) in JAMA with 4,883 citations
- IEEE ACCESS surfaced as the leading journal with loftiest h-indicator (30)

4. **Thematic elaboration:**

- Utmost frequent exploration terms centre around" artificial intelligence" (3,038 circumstances) and" machine literacy" (1,941 circumstances)
- Growing emphasis on deep literacy and literacy systems indicates the field's specialized complication
- Integration of AI/ ML has converted traditional scientometric approaches

5. **Future Counteraccusations:**

- The field shows no signs of decelerating down, suggesting uninterrupted growth and invention
- Adding collaboration between institutions and countries indicates a more globalized exploration geography
- The elaboration toward further sophisticated AI ways suggests implicit for more advanced exploration evaluation and impact assessment styles

6. **Recommendations:**

- Need for continued transnational collaboration to maintain exploration instigation
- Significance of developing standardized approaches for AI- enhanced scientometric analysis
- Value of cross-disciplinary exploration combining AI moxie with scientometric operations

The analysis demonstrates that AI and ML have unnaturally converted scientometrics, creating new openings for exploration evaluation, impact assessment, and knowledge discovery. The field's rapid-fire growth and global participation suggest it'll continue to play a pivotal part in shaping how we understand and estimate scientific exploration.

This conflation of bibliometric substantiation provides precious perceptivity for experimenters, policymakers, and exploration directors navigating the evolving geography of AI- enhanced scientometrics. The findings suggest a bright future for this field with uninterrupted invention and expansion of operations.

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