Global Research On Artificial Intelligence: A Scientometric Study

Keshava
Professor
Department of Studies and Research in Library and Information Science
Tumkur University, Tumkur
keshtut@gmail.com

Shankar B Chavan
Deputy Librarian
Central Library, Indian Institute of Technology Delhi
shankaraochavan@gmail.com

ABSTRACT: *The study's primary objective is to map the global research landscape in artificial intelligence (AI). For this study, the data were extracted from the Scopus Bibliographic database using "artificial intelligence" for the publications under various journals dated 2014 to 2023 publications in journals. The publication growth significantly increased approximately nine-fold in 2023 compared to 2014, and the doubling time (Dt) was 0.62. 77.49 per cent of publications were articles; the average citation is 22.57, whereas the citations per publication to the review is 40.14. The average citation per publication increases as the number of authors increases. Eight of the top ten source titles were open access, indicating that authors prefer to publish in open-source journals. Of the top ten institutions, four institutes were from China. In keyword analysis, artificial intelligence is strongly related to computations and applications in health and medical sciences.*

Keywords: Artificial intelligence, Scientometrics, Research analysis, Growth analysis, Technology trend analysis

Received: 14 August 2024, Revised 18 August 2024, Accepted 30 August 2024

DOI: https://doi.org/10.6025/stm/2024/5/117-130

1. Introduction

Artificial Intelligence (AI) has emerged as a transformative force across various sectors, revolutionising industries and driving innovation. The evolution of AI can be traced back to the 1940s, with the pioneering work of computer scientists like Alan Turing and John von Neumann. In 1956, McCarthy organized a conference on machine learning, and since then, it has been known as the field of artificial intelligence. The rapid advancements in AI technologies, from machine learning and deep learning to natural language processing and computer vision, have led to an exponential increase in research activities worldwide. AI has been integrated into many facets of everyday life, such as computer gaming, Alexa, Google Assistant, and many others. In the past few decades, it has experienced enormous growth. To explore the dynamics and impact of the field, a scientometric study offers a comprehensive analysis of global AI research. Scientometrics is the science of measuring and analysing scientific literature that provides valuable insights into the trends, productivity, and influence of research activities. This study aims to map the global landscape of AI research. A scientometric analysis provides a holistic view of global artificial intelligence research. This study helps researchers, academicians, policymakers, funding agencies and industry leaders to make informed decisions to foster innovation, collaboration and application across various fields.

2. Review of Literature

The scientometric study is vital to ascertain research progress and its impact on social life. Several scientometric studies have been conducted on various subject landscapes and artificial intelligence research. Pandey, Verma, and Shukla (2021)

conducted a survey of AI research in India from 2009 to 2018 and found that the relative growth rate was decreasing; however, the doubling time was shown to be an increasing trend. Gupta and Dhawan (2018) conducted a scientometric analysis of artificial intelligence research publications in India from 2007 to 2016. India ranked third in contribution, and the growth rate was 27.45 per cent compared to the global 9.82 per cent. Niu et al. (2016) evaluated the world research of artificial intelligence from 1990 to 2014 using bibliometric analysis, and the United States and China were ranked 1 and 2, respectively. Cheng and Wang (2012) analysed the data indexed in the Web of Science from 2010 to 2011 on artificial intelligence. They found that 97.83 per cent of papers were in English, and 70 per cent of documents were shared from the top 11 countries. Tjebane et al. (2022) examined AI in sustainable construction management research indexed in the Scopus database from 2011 to 2021. They revealed China, the United States of America, and the United Kingdom are the top contributing countries. Darko et al. (2020) studied the quantitative analysis of 41,827 related bibliographic records retrieved from Scopus. The results suggested that genetic algorithms, neural networks, fuzzy logic, fuzzy sets, and machine learning have been the most widely used AI methods in AEC. There are many scientometric studies conducted on artificial intelligence, but no study has been done on the global coverage of artificial intelligence research in the recent decade. The findings of this study will benefit stakeholders like researchers, funding bodies, and industries for collaboration and wider research and applications of artificial intelligence across the fields.

3. Objectives and Purpose of the study

The study aims to comprehensively map the global landscape of artificial intelligence (AI) research by scientometrics. The trend analysis and growth pattern in the artificial intelligence field provide insights into its development over time and the impact of artificial intelligence in the other fields of science, technology, biomedical science, social science, and management. Examines the geographical distribution of contributions, highlighting the role of different countries in advancing AI research, key academic and research institutions, prolific authors and institutions, and the most preferred source titles in AI publications. Explores authorship patterns and their impact on citation metrics, providing a deeper understanding of the influence and collaboration dynamics within the AI research community. It helps researchers, academics, and industries understand the impact of artificial intelligence, make informed decisions, and adopt AI-based technologies.

4. Methodology

For this study, the data were accessed from the Scopus database on 31st January 2024 using the search query TITLE-ABS-KEY (“artificial intelligence”) AND PUBYEAR > 2013 AND PUBYEAR < 2024 AND (LIMIT-TO (SRCTYPE, “*j*”)) this study is confined to scientometric analyses of the publications in journals for the period of one decade from 2014 to 2023. 150105 publications were extracted in .csv format and analysed using Excel and scientometric techniques. The word cloud for the frequency of the keywords is created on the site word art. Statistical methods, including descriptive and inferential statistics, are applied to interpret the findings and identify significant patterns. The results are presented through tables and graphs, and the findings are discussed and compared with existing literature. Areas for future research are suggested.

5. Results and Discussion

5.1. Growth trends in artificial intelligence publications

Table 1 and Figure 1 present the growth trends in artificial intelligence (AI) publications from 2014 to 2023, highlighting the number of publications, annual growth percentage, citations, and citations per paper for each year. The publication growth significantly increased from 4,642 in 2014 to 40,974 by 2023, approximately nine-fold in 2023 compared to 2014, indicating a positive growth trend, with the highest growth rate of 45.22% in 2020. The number of citations yearly is increasing; the highest is 535388 in 2020. The average number of citations was 64.08 in 2015 and decreased to 5.97 in 2023. This surge reflects the rapidly expanding interest and investment in AI research. However, the annual growth rate shows variability, including a notable decline in 2017. Despite the increasing number of publications, the average citations per paper have significantly declined from a high of 64.08 in 2015 to 5.97 in 2023. This is due to older publications having had more time to accumulate citations. Newer papers haven’t been around long enough to acquire the same number of citations, as citations accumulate over time. It can also be why more publications mean the citations are spread thinly across more publications, and the average citations per publication is less. The other reasons could be the publication of more insignificant research papers, the removal of journals from the Scopus due to retraction, and the reduction of self-citations. With more applications and innovations, it becomes crucial to consider the broader impact of AI technologies on society, privacy, employment, and more.

5.2. Relative Growth Rate (RGR) and Doubling time (Dt)

Table 2 presents the Relative Growth Rate (RGR) and Doubling time (Dt) for publications from 2014 to 2023. The publications’ growth was analysed using Relative Growth Rate (Mahapatra, 1985) and doubling time was calculated using the Napier logarithm. The average RGR over the period is 1.90, indicating a steady publication growth rate. The average

Table 1. Growth trends in artificial intelligence publications

Year	Number of Publications	Annual growth (%)	Number of Citations	Citations Per Paper
2014	4642		191592	41.27
2015	4790	3.19	306948	64.08
2016	5792	20.92	266995	46.10
2017	5644	-2.56	279215	49.47
2018	8031	42.29	396031	49.31
2019	10811	34.62	418716	38.73
2020	15700	45.22	535388	34.10
2021	22618	44.06	509700	22.54
2022	31103	37.51	379024	12.19
2023	40974	31.74	244608	5.97
Total	**150105**		**3528217**	**23.50**

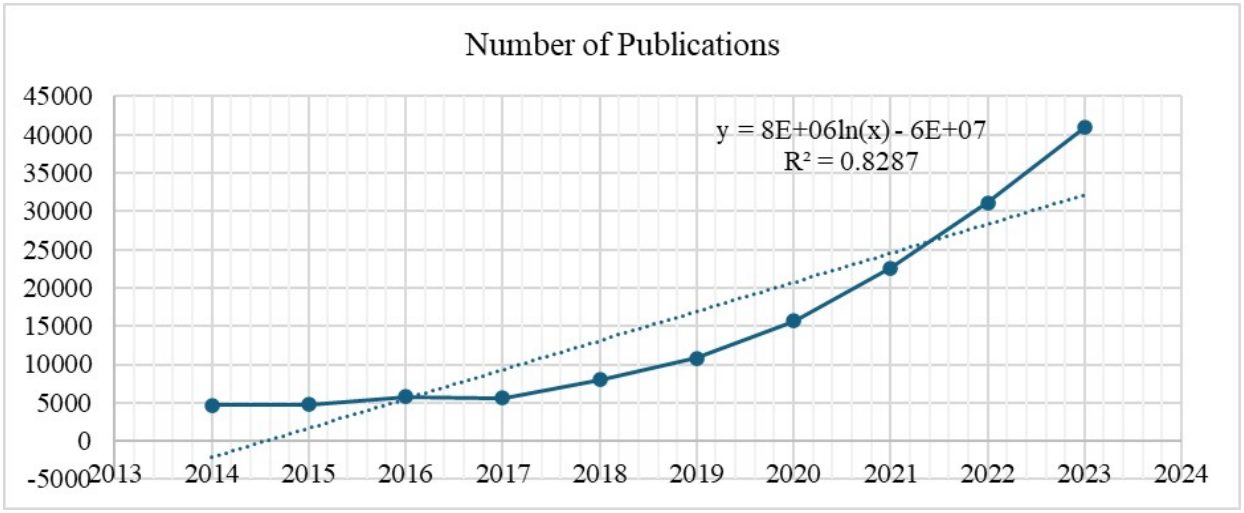

Figure 1. Growth trends of artificial intelligence from 2014 to 2023

doubling time (Dt) is 0.62 years, showing that the number of publications roughly doubles every 0.62 years. The RGR fluctuates over the years but remains relatively high, indicating continuous growth in the number of publications. The Doubling time (Dt) remains relatively consistent, reflecting a stable increase in publication. This table effectively depicts the rapid growth in the field, showcasing the expansion in research output year over year.

Table 2. Relative Growth Rate (RGR) and Doubling time (Dt)

S. No	Year	No. of Publications	% of Publications	Cumulative No. of Publications	% of Cumulative Publications	Log (p)1	Log (p)2	RGR(p)	Mean RGR	Dt(p)	Mean Dt(p)
1	2014	4642	3.09	4642	3.09		8.44	8.44			
2	2015	4790	3.19	9432	6.28	8.47	9.15	0.68		1.02	
3	2016	5792	3.86	15224	10.14	8.66	9.63	0.97		0.72	
4	2017	5644	3.76	20868	13.90	8.64	9.95	1.31		0.53	
5	2018	8031	5.35	28899	19.25	8.99	10.27	1.28	1.90	0.54	0.62
6	2019	10811	7.20	39710	26.45	9.29	10.59	1.30		0.53	
7	2020	15700	10.46	55410	36.91	9.66	10.92	1.26		0.55	
8	2021	22618	15.07	78028	51.98	10.03	11.26	1.24		0.56	
9	2022	31103	20.72	109131	72.70	10.35	11.60	1.26		0.55	
10	2023	40974	27.30	150105	100.00	10.62	11.92	1.30		0.53	
Total		150105									

5.3. Level of Application of Growth Models

The R^2 values provided for each growth model indicate the model's goodness of fit to the data. R^2 measures the proportion of the variance in the dependent variable that is predictable from the independent variable(s). The growth of publications depends on various independent variables like research funding, technological advancements, policies and incentives, new research areas gaining more importance, etc. A higher R^{22} value indicates a better fit of the model to the data. The exponential growth model has a high level of fit with an R^2 value of 0.985. The R^2 value of the polynomial growth model is 0.995, an exceptionally high fit to the data. This suggests that the polynomial model explains almost all of the variance in the dependent variable, indicating a strong relationship between the independent and dependent variables. The linear growth model has an R^2 value of 0.8292, indicating a good but comparatively lower fit than the exponential and polynomial models. The logarithmic model with an R^2 value of 0.5753 is the lowest fit among the models. This suggests that the logarithmic model explains only about half of the variance in the dependent variable, indicating a weaker relationship between the independent and dependent variables than the other models. Based on the R^2 values, the exponential and polynomial growth models exhibit the highest levels of application, followed by the linear model. In contrast, the logarithmic model appears to be the least applicable in explaining the relationship between the independent and dependent variables. We assume that the growth of publications is more influential due to technological developments and advanced research and development. The growth model fits exponential and polynomial growth models. A detailed study on the influential criteria, such as policies, research funding, industrial collaboration, and applications in problem-solving activities, may provide insight into it. It also helps in correcting the rate of publication growth.

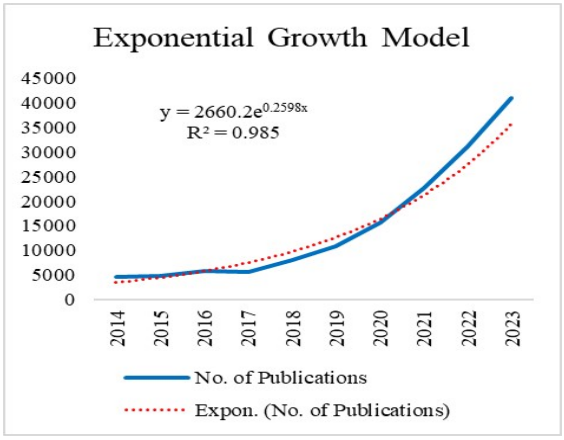

Figure 2a. Exponential Growth Model

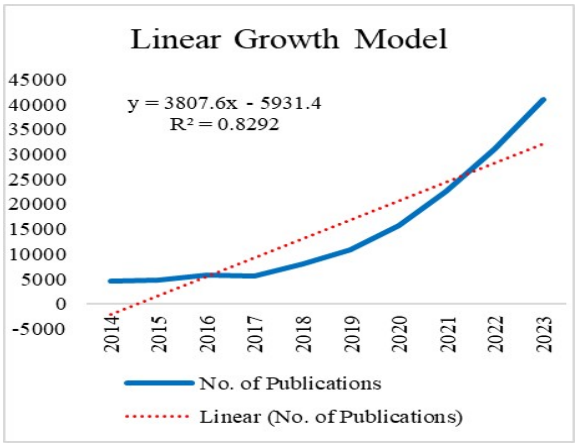

Figure 2b. Linear Growth Model

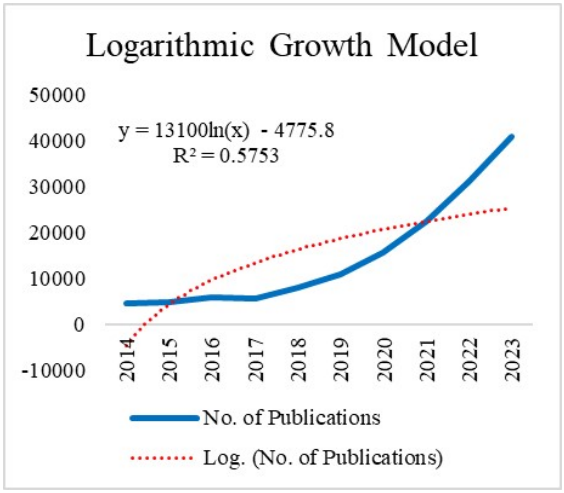

Figure 2c. Logarithmic Growth Model

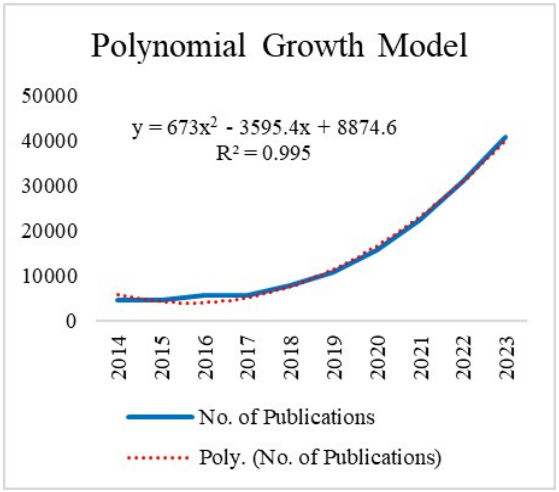

Figure 2d. Polynomial Growth Model

5.4. Authorship patterns of research publications

Table 3 presents the authorship patterns of research publications in artificial intelligence from 2014 to 2023. Publications contributed by a single author are 12.97 per cent, whereas those by two, three and four authors are 17.09 per cent, 17.82 per cent and 15.39 per cent, respectively. Papers with two or three authors consistently dominate the research publications each year. 74.63 per cent of publications are contributed by one to five authors. The publications with more than ten authors were fewer in the initial years, which grew significantly in recent years and represented 5.20 per cent of all publications. The authorship patterns indicate a growing trend towards collaborative research. These insights can help us understand the changing dynamics of research collaboration and the increasing importance of teamwork in producing scholarly work. The data reflects a shift towards increased teamwork and cooperation in the research community over the past decade.

Table 3. Authorship patterns of research publications

Years	No. of Authors											No. of Publications
	1	2	3	4	5	6	7	8	9	10	>10	
2014	464	956	1204	906	518	241	155	76	42	23	57	4642
2015	498	1066	1246	926	509	241	124	59	48	21	52	4790
2016	636	1229	1423	1109	684	346	145	86	45	24	65	5792
2017	854	1169	1229	1023	589	325	197	97	58	34	69	5644
2018	1277	1519	1671	1371	889	543	274	151	96	62	178	8031
2019	1924	2144	2008	1621	1132	698	351	248	173	143	369	10811
2020	2410	2653	2853	2351	1758	1160	715	476	317	241	766	15700
2021	2806	3660	3739	3328	2673	1917	1217	855	564	447	1412	22618
2022	3478	4941	4892	4556	3670	2752	1791	1283	913	710	2117	31103
2023	5117	6309	6483	5914	4639	3537	2439	1759	1132	923	2717	40969
Total	19464	25646	26748	23105	17061	11760	7408	5090	3388	2628	7802	150105
%	12.97	17.09	17.82	15.39	11.37	7.83	4.94	3.39	2.26	1.75	5.20	100.00

5.5. Single vs multi authorship pattern and degree of collaboration

Table 4 presents single vs multi authorship patterns and degree of collaboration from 2014 to 2023. The percentage of single-author publications is between 10 and 17.80, and multi-author publications are the majority each year. In 2014, 10 per cent of the publications were by single authors, whereas 90 per cent were by multiple authors. In 2023, the proportion of single-author publications increased to 12.49 per cent, while multiple-author publications remained dominant at 87.51 per cent. The degree of collaboration is highest in the earlier years, with 0.90 in 2014 and 2015, and it slightly declines to 0.82 in 2019. It shows a slight increase in some subsequent years, 0.88 in 2023 and overall, 0.87. The trend indicates more collaborative work, with multiple authorship being predominant throughout the years, though the proportion of single-author publications has slightly increased. The inferences drawn suggest that while collaboration is key to scientific advancement, individual contributions also continue to play a continuing role in the research landscape. It also indicates that research collaborations have been predominant since the beginning of the 21st century.

5.6. Authorship pattern and average number of citations

Table 5 presents the authorship patterns of publications and average citations. The publications contributed by three authors are highest at 17.82 per cent, by two authors at 17.09 per cent, and the lowest at 1.75 per cent, with ten authors. Publications with fewer authors have a lower average number of citations, and the average number of citations increases with the number of authors. The publications without citations decreased as the number of authors increased. Single-author publications with no citations contribute 32.29 per cent, while more than ten authors are only 6.64 per cent. Publications with more than ten authors have the highest average number of citations (39.36), and single-authored is (12.34). This could indicate that more significant collaborative efforts might have higher visibility or impact in their field. As the number of authors increases, the average number of citations per publication increases, implying that collaborative research might be more influential or well-recognized in the academic community.

Table 4. Single vs Multi-authorship pattern and degree of collaboration

Years	Single Authors	%	Multiple Authors	%	Total No. of Publications	Degree of Collaborations
2014	464	10.00	4178	90.00	4642	0.90
2015	498	10.40	4292	89.60	4790	0.90
2016	636	10.98	5156	89.02	5792	0.89
2017	854	15.13	4790	84.87	5644	0.85
2018	1277	15.90	6754	84.10	8031	0.84
2019	1924	17.80	8887	82.20	10811	0.82
2020	2410	15.35	13290	84.65	15700	0.85
2021	2806	12.41	19812	87.59	22618	0.88
2022	3478	11.18	27625	88.82	31103	0.89
2023	5117	12.49	35852	87.51	40969	0.88
Total	19464	12.97	130636	87.03	150105	0.87

Table 5. Authorship pattern and average number of citations

No. of Authors	No. of Publications	%	Publications without Citations	%	Total Citations	Average Citations
1	19464	12.97	6284	32.29	240221	12.34
2	25646	17.09	4524	17.64	505961	19.73
3	26748	17.82	3622	13.54	654096	24.45
4	23105	15.39	2507	10.85	593567	25.69
5	17061	11.37	1786	10.47	444878	26.08
6	11760	7.83	1105	9.40	300505	25.55
7	7408	4.94	697	9.41	196099	26.47
8	5090	3.39	458	9.00	129209	25.38
9	3388	2.26	305	9.00	87193	25.74
10	2628	1.75	227	8.64	69417	26.41
>10	7802	5.20	518	6.64	307084	39.36
Total	150105	100.00	22033	14.68	3528230	23.51

5.7. Document type and average citations

Table 5 presents data on various document types, including the number of publications, their percentage of total publications, the total number of citations they have received, and the average number of citations per document type. Articles are the most preferred document type, comprising 77.49 per cent of the total publications. They received a total citation of 2,625,550 with an average citation of 22.57. In contrast, reviews are only 12.86 per cent of the publications and receive the highest

average citations of 40.14, indicating their significant impact and frequent referencing. Data papers and articles in the press are fewer, and the average citation counts are 16.24 and 10.38, respectively. Other document types are given in Table 5. This nature of reviews in summarising and synthesising existing knowledge makes them highly valued and frequently referenced in academic research. The high citation count for reviews reflects their critical role in shaping ongoing research and providing comprehensive overviews of specific fields. The data papers that offer valuable datasets and articles in the press by providing early access to emerging research here are of considerable interest and importance to researchers. Reviews often have a broader interdisciplinary and are highly visible in the academic community due to their broad scope. They are more likely to be read and cited by a wider audience, spanning multiple subfields. At the same time, original articles are more specialised and ready by researchers with specific areas of interest.

Table 5. Document type and average citations

Document Type	No. of Publications	%	Citations	Average Citations
Article	116311	77.49	2625550	22.57
Review	19307	12.86	774946	40.14
Editorial	5777	3.85	31277	5.41
Note	3303	2.20	37236	11.27
Letter	1826	1.22	12111	6.63
Conference Paper	1698	1.13	25642	15.10
Short Survey	634	0.42	15535	24.50
Erratum	627	0.42	378	0.60
Retracted	415	0.28	2973	7.16
Data Paper	135	0.09	2192	16.24
Book Chapter	56	0.04	307	5.48
Conference Review	8	0.01	0	0.00
Article in press	8	0.01	83	10.38

5.8. Area of Research

Figure 3 depicts the distribution of publications across various subject areas. Computer Science leads with 58,154 (38.74 per cent) publications, followed by engineering with 44,618 (29.72 per cent), indicating its significant role in technological advancements and innovations. Medicine holds a substantial share with 38,245 (25.48 per cent) publications. Social sciences and mathematics have relatively smaller shares, with 16,058 (10.70 per cent) and 15,953 (10.63 per cent) publications, respectively. Biochemistry, genetics, molecular biology, and materials science account for 9.40 per cent and 7.36 per cent of publications. Fields with less representation include Dentistry and Veterinary sciences, with 0.50 per cent and 0.22 per cent of the publications; other research areas are illustrated in Figure 3. Computer Science, Engineering, and Medicine dominate the distribution, collectively accounting for over 90 per cent of the publications. This broad integration across disciplines highlights AI's transformative role in modern research and its ability to enhance and innovate within various domains. Also, AI's integration into various aspects of life enhances efficiency, personalization, and innovation, shaping how we live, work, and interact.

5.9. Top subject keywords

The most frequently occurring keywords strongly emphasise artificial intelligence and human-related studies. This includes general terms like Artificial Intelligence, Machine Learning, Deep Learning and specific algorithms like Neural Networks and Support Vector Machines. Various algorithms (e.g., Neural Networks, Convolutional Neural Networks, Support Vector Machine) and techniques (e.g., Image Processing, Data Mining) are prominently featured, highlighting the computational aspects of the research. Keywords like "Diagnostic Imaging," "Sensitivity and Specificity," and "Diagnostic Accuracy" suggest a significant focus on medical applications of AI. The presence of terms like Internet of Things, Telemedicine, and Virtual Reality shows the integration of AI with other emerging technologies.

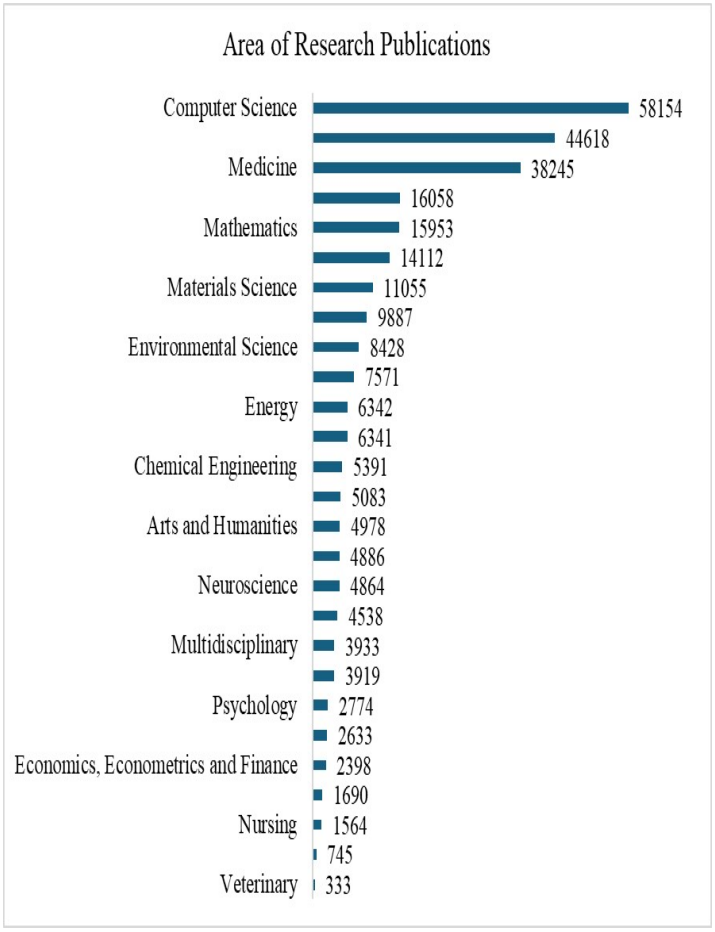

Figure 3. Area of Research Publications

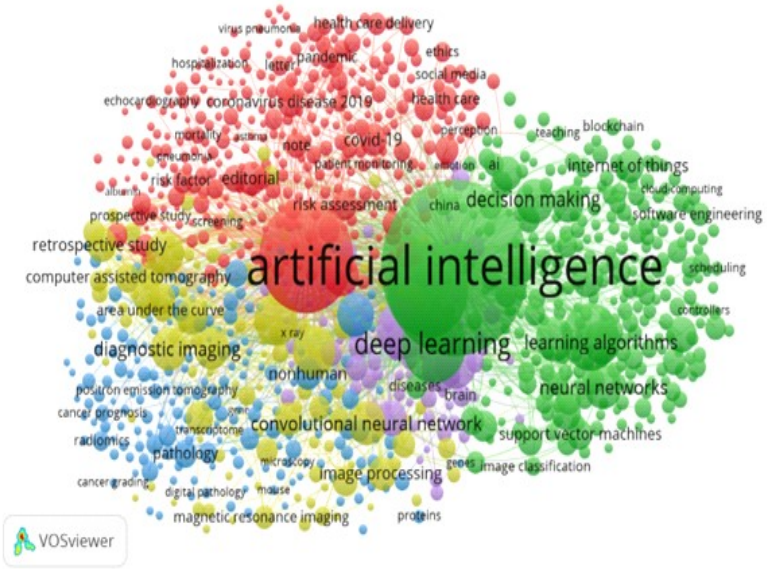

Figure 4a. Networked visualization for the frequency of the keywords

Figures 4a and 4b present the network visualisation and density visualisation maps created with VOS viewer software for the top 1000 keywords; the circle size and the font size signify the strength of occurrences. The total number of author keywords and index keywords is 362237, and the threshold value of 10 occurrences meets 27149 keywords. The top 1000 keywords were grouped into Cluster 1(309), Cluster 2 (301), Cluster 3 (196), Cluster 4 (139) and Cluster 5 (58). The keywords “artificial intelligence” occurred highest with 108975 and link strength is 988063, followed by “Human” 44690 with 722389 link strength, “Machine Learning” 32711 with 397153 link strength “Deep Learning” 21086 with 261136 linked strength, “Learning Systems” 16058 with 144284 link strength, “Algorithm” 12468 with link strength 209563, so on.

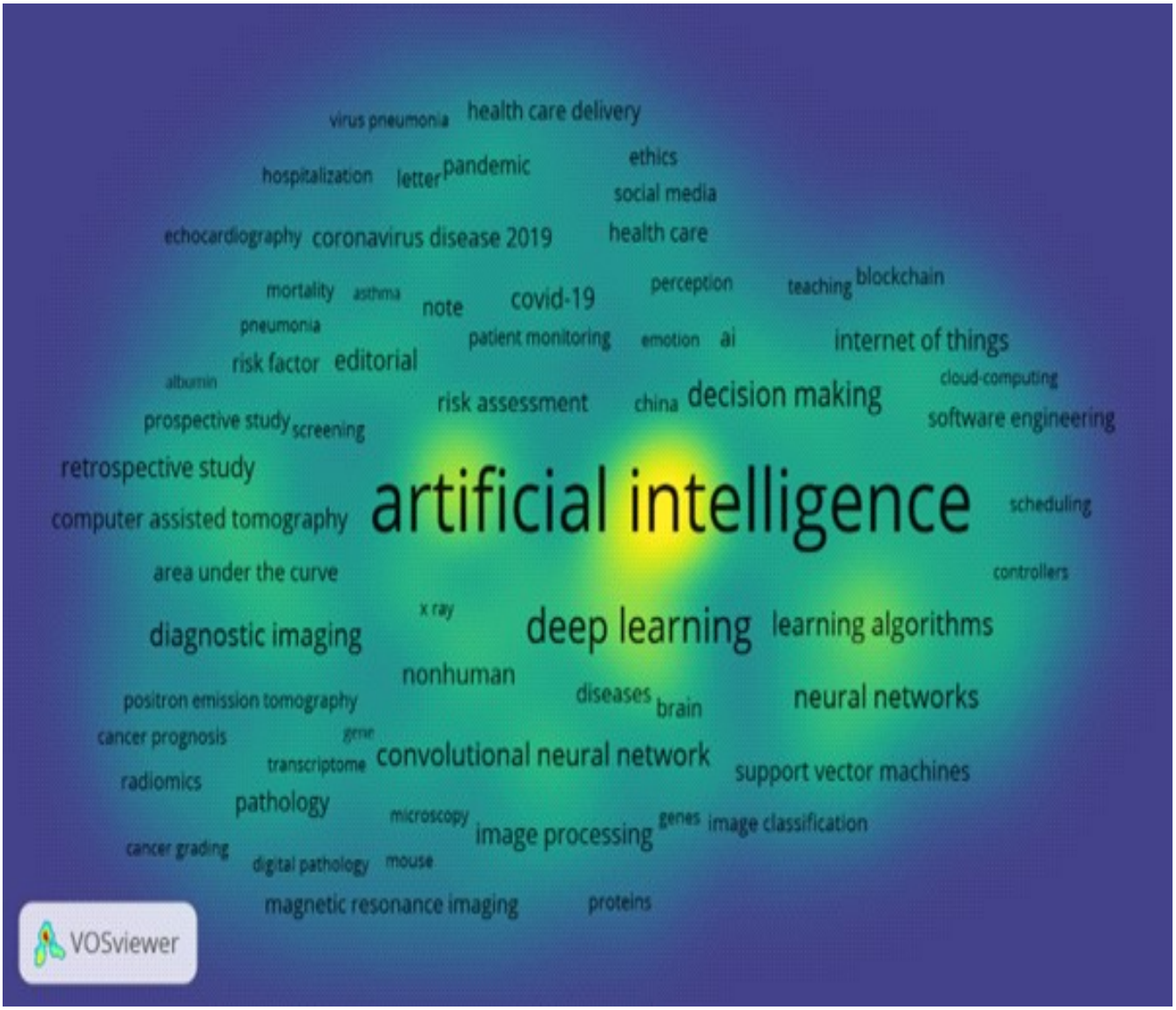

Figure 4b. Density visualization for the frequency of the keywords.

5.10. Top ten prolific countries

Table 6 indicates the share of the top ten countries regarding the number of publications and their respective percentages and ranks for the top ten countries. Researchers from 159 countries contributed a total of 150105 publications. China leads with 33,496 (22.32 per cent) publications, followed by the United States with 31,580 (21.04 per cent). The United Kingdom and India hold the 3rd and 4th ranks in contribution with 12213 (8.14 per cent) and 11694 (7.79 per cent), respectively. China

and the United States are the two most prolific countries, accounting for 43.36 per cent of the total publications (22.32 per cent + 21.04 per cent). Several European countries are in the top ten, including the United Kingdom (3rd), Germany (5th), Italy (6th), and Spain (7th). These four countries contribute 22.75 per cent of the total publications (8.14 per cent + 5.37 per cent + 4.98 per cent + 4.26 per cent). This indicates a significant concentration of research output in these two countries. Besides China and India, South Korea also makes the top ten, ranked 8th with 4.17 per cent of the total publications. This highlights the growing research output from Asian countries. China and the United States are leading research powerhouses, suggesting substantial research funding, infrastructure, and publication emphasis. The distribution of publications can help policymakers and academic institutions learn about the global landscape of research output and the need for strategic investments to enhance their country's research impact.

Table 6. Top ten prolific countries

Country	No of Publications	%	Rank
China	33496	22.32	1
United States	31580	21.04	2
United Kingdom	12213	8.14	3
India	11694	7.79	4
Germany	8054	5.37	5
Italy	7480	4.98	6
Spain	6401	4.26	7
South Korea	6253	4.17	8
Canada	6137	4.09	9
Australia	5874	3.91	10

5.11. Top ten most preferred source titles

Table 7 provides an overview of the top ten most preferred source titles in terms of the number of publications, their

Table 7. Top ten most preferred source titles

Source Title	Publisher	No of Publications	%	Rank
IEEE Access	IEEE	2977	1.98	1
Applied Sciences Switzerland	Multidisciplinary Digital Publishing Institute (MDPI)	1415	0.94	2
Sensors	Multidisciplinary Digital Publishing Institute (MDPI)	1143	0.76	3
Sustainability Switzerland	Multidisciplinary Digital Publishing Institute (MDPI)	1085	0.72	4
Journal of Intelligent and Fuzzy Systems	IOS Press	1046	0.70	5
Scientific Reports	Springer Nature	850	0.57	6
Diagnostics	Multidisciplinary Digital Publishing Institute (MDPI)	810	0.54	7
Information Sciences	Elsevier	810	0.54	8
Expert Systems with Applications	Elsevier	782	0.52	9
Electronics Switzerland	Multidisciplinary Digital Publishing Institute (MDPI)	695	0.46	10

percentage share, and their rank. A total of 150105 publications are published in 14996 source titles. IEEE Access is the most preferred source title, significantly leading with 2977(1.98 per cent) of the total publications. Followed by Applied Sciences Switzerland with 1415 (0.94 per cent) publications, Sensors with 1143 (0.76 per cent) publications, and Sustainability Switzerland with 1085 (0.72 per cent) publications; other source titles are given in Table 7. Out of the top ten journals, five journals (Applied Sciences Switzerland, Sensors, Sustainability Switzerland, Diagnostics, and Electronics Switzerland) were published by the Multidisciplinary Digital Publishing Institute (MDPI). They contributed 5148 (3.42 per cent) publications. The percentages indicate that even the most preferred source titles constitute a relatively small portion of the total publications. IEEE Access, the top source, accounts for only 1.98 per cent, while the tenth-ranked journal, Electronics Switzerland, accounts for 0.46 per cent. Out of the top ten, eight source titles are open access, which indicates that authors prefer to publish in open-source journals.

5.12. Top ten prolific authors

Table 8 lists the top ten prolific authors based on the number of publications. Mosavi, A. from Obuda University, Budapest, Hungary, leads with 103 (0.07 per cent) publications, followed by Ting, D.S.W. from the National University of Singapore with 97 (0.06 per cent), Saba, L. from the University of Cagliari, Italy with 95 (0.06 per cent), and Suri, J.S. from Graphic Era Deemed to be University, India, has 94 (0.06 per cent) details of other authors are given in Table 8. The number of publications in the top ten authors ranges from 77 to 103, a relatively narrow range among the top prolific authors. The authors come from various fields, including radiology, computer engineering, cardiovascular medicine, mathematics, and philosophy. This diversity suggests that high research productivity is not confined to a single field but spans multiple disciplines. The authors come from diverse institutions across various countries, including Hungary, Singapore, Italy, India, the United States, Slovakia, Japan, and China. This highlights a wide geographic distribution of prolific authors.

Table 8. Top ten prolific authors

Author Name	Institute	No of Publications	%	Rank
Mosavi, A.	Obuda University, Budapest, Hungary	103	0.07	1
Ting, D.S.W.	National University of Singapore, Singapore, Singapore	97	0.06	2
Saba, L.	Department of Radiology, University of Cagliari, Cagliari, Italy	95	0.06	3
Suri, J.S.	Department of Computer Engineering, Graphic Era Deemed to be University, Dehradun, 248002, India	94	0.06	4
Noseworthy, P.A.	Department of Cardiovascular Medicine, Mayo Clinic, Rochester, MN, United States	90	0.06	5
Acharya, U.R.	School of Mathematics Physics and Computing, University of Southern Queensland, Springfield Central, 4300, QLD, Australia	89	0.06	6
Friedman, P.A.	Department of Cardiovascular Medicine, Mayo Clinic, Rochester, MN, United States	88	0.06	7
Mesiar, R.	Department of Mathematics and Descriptive Geometry, Faculty of Civil Engineering, Slovak University of Technology, Radlinského 11, Bratislava, Slovakia	84	0.06	8
Mori, Y.	Digestive Disease Center, Showa University Northern Yokohama HospitalThe institution will open in a new tab, Kanagawa, Japan	79	0.05	9
Wang, F.Y.	Institute of Philosophy, Chinese Academy of SciencesThe institution will open in a new tab, Beijing, 100190, China	77	0.05	10

5.13. Top ten prolific affiliated institutes

Table 9 presents the top ten institutions based on the number of publications. Chinese Academy of Sciences leads with 2243 (1.49 per cent) publications, followed by the Ministry of Education of the People's Republic of China with 1939 (1.29 per cent) publications, Harvard Medical School ranks with 1365 publications (0.91 per cent) and Tsinghua University with 1,230

(0.82 per cent) publications other institutes details are given in table 9. Of the top ten institutions, four institutes are from China, two are from the United Kingdom, two are from the United States, one is from France, and one is from Canada. The high number of publications from these institutions suggests a strong research focus and output, which can indicate their contributions to their respective fields. The dominance of Chinese institutions points to China's growing influence in global research and publication.

Table 9. Top ten prolific affiliated institutes

Affiliation	Country	No of Publications	%	Rank
Chinese Academy of Sciences	China	2243	1.49	1
Ministry of Education of the People's Republic of China	China	1939	1.29	2
Harvard Medical School	United States	1365	0.91	3
Tsinghua University	China	1230	0.82	4
CNRS Centre National de la Recherche Scientifique	France	1111	0.74	5
Stanford University	United States	1030	0.69	6
University of Chinese Academy of Sciences	China	1007	0.67	7
University College London	United Kingdom	954	0.64	8
University of Toronto	Canada	939	0.63	9
University of Oxford	United Kingdom	924	0.62	10

5.14. Major Findings of the study

The publication growth significantly increased from 4,642 in 2014 to 40,974 by 2023, approximately nine-fold in 2023 compared to 2014. It highlights a substantial acceleration in research activity, possibly driven by increased interest, funding, and advancements within the field. The relative growth rate (RGR) is 1.90, which suggests that the research output is expanding at a very rapid pace. The doubling time (Dt) is 0.62, a relatively short period, specifically in less than a year. This emphasises the fast pace of growth in the field and the highly dynamic evolving research environment. The R^2 value of the polynomial growth model is 0.995, an exceptionally high fit to the growth model's application level. A detailed analysis of funding, policies, industrial collaborations, applications, and development is needed to gain more insight into the influential characteristics of independent variables. Most publications were written by two, three, and four authors, and 74.63 per cent were contributed by one to five authors. The average number of citations per publication is 23.51. Single-author publications with no citations are 32.29 per cent, while more than ten authors are only 6.64 per cent. A collaborative effort of small and medium-sized teams of two to five authors contributed most of the research. It also reflects the balanced collaboration of diverse expertise and smaller research teams. In practicality, collaborating with a large group of contributors is challenging and time-consuming. However, solving complex problems and biomedical research demands more research contributors and investments. 77.49 per cent of publications are articles; the average citation is 22.57, whereas the citations per publication to the review is 40.14. This infers that reviews are generally more influential or valued within academic circles than standard articles. Computer Science, Engineering, and Medicine dominated, collectively accounting for over 90% of the publications. Researchers from 159 countries contributed to the papers, and China led with 33,496 (22.32 per cent) publications. Out of the top ten, eight source titles are open access, which indicates that authors prefer to publish in open-source journals. Of the top ten institutions, four institutes are from China, two are from the United Kingdom, two are from the United States, one is from France, and one is from Canada, China and the United States are leading research powerhouses, suggesting strong research funding, infrastructure, and publication emphasis.

6. Conclusion

The present study aims to analyze the global research publications in artificial intelligence published in the Scopus database for ten years from 2014 to 2023, limited to journals. Scientometric studies provide valuable insights into the global landscape of AI research, highlighting trends, impact, and collaborative efforts. Researchers from 159 countries contributed to the research publications in artificial intelligence, and China led the list with 22.32 per cent of the contributions. In the study by Niu et al. 2014, China was in second place, which moved to the top in 2023. This study also indicated that 90 per cent of

the publications covered the subject areas of Computer Science, Engineering, and Medicine. In contrast, AI is used across the fields of health, decision, management, and social science. The citations of publications increase as the number of authors increases. With increasing numbers of authors and the collaboration of researchers from different fields and regions, the work would be more visible and cited. These studies inform researchers, funding agencies, and policymakers, helping to guide the future direction of AI research and development. As AI grows and integrates into various aspects of society, scientometric analysis will play a crucial role in understanding and shaping its evolution.

References

[1] Cheng, S., Wang, B. (2012). An overview of publications on artificial intelligence research: A quantitative analysis of recent papers. In *Proceedings of the Fifth International Joint Conference on Computational Sciences and Optimization* (pp. 23–26). IEEE. https://doi.org/10.1109/cso.2012.156

[2] Darko, A., Chan, A. P. C., Adabre, M. A., et al. (2020). Artificial intelligence in the AEC industry: Scientometric analysis and visualisation of research activities. *Automation in Construction, 112*, Article 103081. https://doi.org/10.1016/j.autcon.2020.103081

[3] Gupta, B., Dhawan, S. (2018). Artificial intelligence research in India: A scientometric assessment of publications output during 2007–2016. *DESIDOC Journal of Library & Information Technology, 38*(6), 416–422. https://doi.org/10.14429/djlit.38.6.12309

[4] Mahapatra, M. (1985). On the validity of the theory of exponential growth of scientific literature. In *Proceedings of the 15th IASLIC Conference* (pp. 61–70).

[5] Niu, J., Tang, W., Xu, F., Zhou, X., Song, Y. (2016). Global research on artificial intelligence from 1990–2014: Spatially explicit bibliometric analysis. *International Journal of Geo-Information, 5*(5), Article 66. https://doi.org/10.3390/ijgi5050066

[6] Pandey, S., Verma, M. K., Shukla, R. (2021). A scientometric analysis of scientific productivity of artificial intelligence research in India. *Journal of Scientometric Research, 10*(2), 245–250. https://doi.org/10.5530/jscires.10.2.38

[7] Tjebane, M. M., Musonda, I., Okoro, C., Onososen, A. (2023). Artificial intelligence (AI) in sustainable construction management: A scientometric review. In Haupt, T. C., Akinlolu, M., Simpeh, F., Amoah, C., Armoed, Z. (Eds.), *Construction in 5D: Deconstruction, Digitalization, Disruption, Disaster, Development* (Vol. 245, Lecture Notes in Civil Engineering). Springer, Cham. https://doi.org/10.1007/978-3-030-97748-1_12