EXPLORING GROWTH OF RESEARCH TRENDS IN ARTIFICIAL INTELLIGENCE: A BIBLIOMETRIC STUDY

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Abstract: Bibliometric analysis is one of the major techniques applied to measure the literature output on research in any subject. This study identifies the global literature output on 'Artificial intelligence or AI-related' research based on data retrieved from 'DOAJ' indexing database over a longitudinal period 1950-2024. Classification of data has been done using a spreadsheet package. Quantitative analysis to evaluate the trends in AI-related research has been undertaken using bibliometric statistics of open access publications. It is observed from the research output that the AI-related research began with research in Robotics followed by growth in Neural Network(s) and Natural Language Processing. The exponential growth in AI-related research is observed in the last ten years. The significant findings show that out of total 134025 Artificial Intelligence and AI-related open access publications available during the period 1950-2024, the publications of AI research with focus on Machine Learning are the highest (28.97%) followed by Neural Networks (27.86%) and Deep Learning (22.13%). Deep Learning has been the fastest growing research area since its origin as compared to other AI-related areas of research.

Keywords: Artificial intelligence, AI, Machine learning, Natural Language processing, Neural networks, Open access

I. INTRODUCTION

Artificial intelligence (AI) has evolved to be one of the most far-reaching technological advancements. Although the concept itself originated in 1950s, it has grown rapidly in recent years having applications in diverse areas impacting industries and individuals [1]. Machine learning, Robotics and Natural language processing are the major areas where AI applications have evolved [2]. AI has the potential to transform and augment replacement of humans with technology-based learning and decision making. AI has found application in a wide range of domains including education and research, manufacturing, healthcare, and other business applications [3]. From its initial application in the field of academics, it has crossed over to business applications owing to higher computing abilities and Big data [4].

Although the AI movement has seen a rapid growth in recent years, it has been evolving and gaining research interest right from its inception. It has become a leading area of comprehensive research and considerable literature has been produced in various aspects associated with AI. Bibliometric analysis helps in understanding the growth of research trends in any area of interest by studying the growth rate of publications in that area. Bibliometric analysis has been used to understand the growth rate in various specific areas. Researchers have analyzed specific health care and medical issues related research using Web of Science database to understand the research growth in specific area [5][6][7]. Research publications across Scopus, Web of Science and Google Scholar databases examined the scope of Artificial intelligence and Machine learning techniques in detecting prostate cancer [8]. Researchers identified the importance of AI tools in fraud detection by using bibliometric analysis of literature on Scopus database [9]. A study analyzed research trend of application of

AI in social science disciplines over a period of five years using Web of Science Database [10]. The bibliometric analysis has been used to survey the status of AI-related research in higher education [11]. Scopus and Web of science databases have been used to study the research trends regarding use of AI as enabler for innovative B2B marketing by using bibliometric research methods [12].

II. OBJECTIVE OF THE STUDY

The study aims to provide a holistic insight into the growth of research trends in the field of AI and related researches over a longitudinal time frame using quantitative analysis of bibliometric statistics.

III. RESEARCH METHODOLOGY

A. Data Source

The study has been conducted with the objective of analyzing the research output of AI literature as reflected in the publications in open access journals' output during 1950-2024 to examine the global research trend on AI over a longitudinal time frame. The relevant data on AI literature was extracted for the period 1950-2024 from DOAJ - Directory of Open Access Journals, an extensive index of open access scholarly research journals and articles from diverse disciplines, geographies, and languages [13]. The search feature of DOAJ allows journal-based and article-based search on specific parameters. For this study article-based search was carried out. The data was collected in first week of April 2025 within a minimum time frame possible to account for dynamic nature of the DOAJ website.

B. Data Analysis

As the focus of the study is to explore the growth of research trends in the field of AI, the research publications having terms associated with AI i.e. AI-related researches, have also been included. For analyzing the year-wise publication trends, the search strings included keywords such as 'Artificial intelligence,' 'Machine Learning,' 'Robotics,' 'Natural Language Processing,' 'Neural Network,' 'Neural Networks,' 'Deep Learning,' 'AI,' 'ML,' 'NLP' and 'DL' and their co-occurrence in the *Title* of the publication. For identifying publication outputs based on prolific keywords, the search included specific keywords in *Keywords section* of the research publications in DOAJ. The results of bibliometric analysis are presented in graphical and tabular form.

IV. RESULTS AND DISCUSSION

To understand the trends of artificial intelligence related research, the analysis based on the parameters mentioned in above section is detailed as below:

A. Year-wise Publication Trends

Table I present the count of publications in the area of artificial intelligence and its related research categories during the period 1950-2024 based on 'specific keyword in the *Title* of the publication' search criteria of DOAJ. A total of 134025 Artificial Intelligence and AI-related open access publications were available in DOAJ database during the period 1950-2024 at the time of data collection. The distribution as in Table I shows that till 1990, the publications were focussed on Aritificial Intelligence and Robotics only. From 1991 – 2005, focus shifted to Neural Network(s) research. The variation in research progress in different lines of AI-related research is more evident from year 2005 onwards where the Neural Network(s) remained the most significant till year 2020, post which Machine Learning and Deep Learning research gained momentum.

It is observed from Fig. 1 that the publications of AI research having focus on Machine Learning are the highest (28.97%) followed by Neural Networks (27.86%) and Deep Learning (22.13%) taking into consideration the full time period of study. However, Deep Learning has been the fastest growing research area since its origin as compared to other AI-related lines of research.
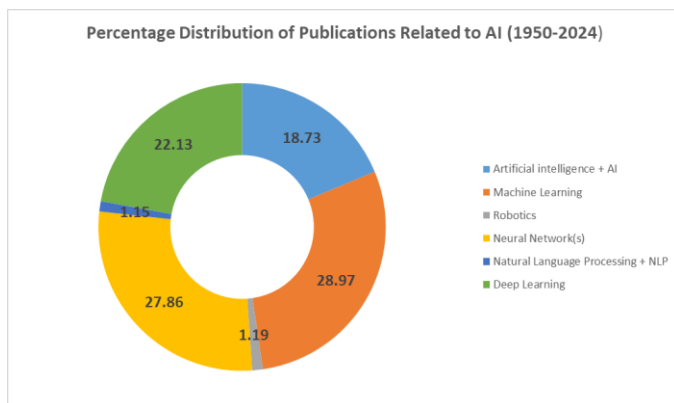

Fig. 1: Percentage Distribution of AI related Publications

Table I. Year-wise Distribution of AI Research Publications (Open access)

Year of Publication	Artificial intelligence or AI	Machine Learning	Robotics	Neural Network or Neural Network	Natural Language Processing or	Deep Learning
2024	9854	11206	257	6585	368	8044
2023	5809	8908	233	6425	335	6925
2022	3737	7260	218	6106	301	5866
2021	2308	5231	205	4968	229	4121
2020	1408	2952	161	3833	104	2629
2019	660	1549	117	2683	60	1273
2018	334	720	87	1748	39	556
2017	179	375	56	1040	23	141
2016	111	176	44	648	9	55
2015	84	117	37	480	12	10
2014	87	96	25	504	5	11
2013	81	48	33	472	8	5
2012	64	44	35	373	11	3
2011	51	33	18	281	5	4
2010	39	29	16	226	4	2
2009	62	21	8	235	2	2
2008	33	24	13	145	2	1
2007	36	11	3	121	6	1
2006	17	14	7	93	3	
2005	18	2	4	70	1	1
2004	17	1	9	55	2	
2003	15	3		48	3	
2002	10	2		38	1	
2001	8	1	1	28	2	
2000	8	1	1	17		
1999	6	1		19		
1998	4			20		
1997	3			30		
1996	1			11		
1995	10			11		
1994	3			4	1	
1993	4			3		
1992	3			5		
1991	2		1	1		
1990	1		1			
1988	4					
1987			1			
1986	2					
1985	1		2			
1984	1		1			
1983	1					
1982	2					
1980	2					
1978	3					
1977	5					
1976	1					
1972	2					
1962	1					
1956	1					
1950	1					
Total	25094	38825	1594	37326	1536	29650
Percentage	18.73	28.97	1.19	27.86	1.15	22.13

Fig 2. presents the trend in growth of AI-related publication output. The publications having 'Deep Learning' in their *Title* showed a rapid increase as compared to other keywords despite it being the newest concept under AI. Exponential growth patterns are observed in Machine Learning, Artificial Intelligence, and Deep Learning oriented research from year 2016 onwards.
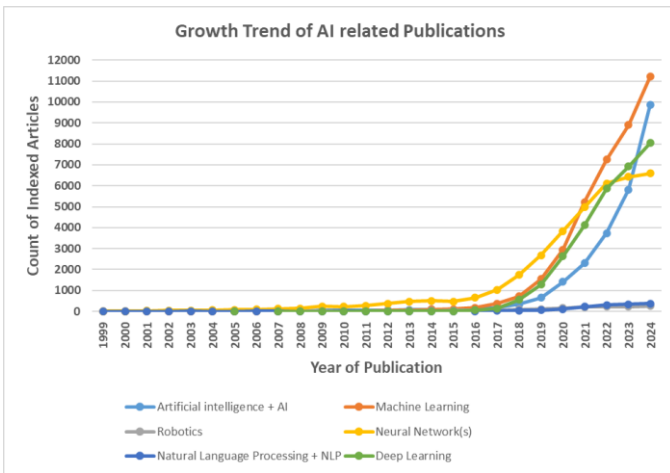
Fig. 2: Growth Trend of AI related Publications

B. *Distribution Based on Co-occurring keywords in Title*

Fig. 3 shows the data about spread of AI publications with co-occurring keywords during the period 2009 - 2024. The period 2009 - 2024 is taken as the publications having co-occurring keywords with Artificial intelligence and AI were not available prior to this period in the DOAJ database during the timeframe of data collection. The main keywords taken are 'Artificial Intelligence' and 'AI' as they are used interchangeably. The co-occurring keywords taken into consideration are: 'Machine Learning,' 'ML,' Robotics,' Natural Language Processing,' 'NLP,' 'Neural Networks,' 'Neural Network' and 'Deep Learning'. A total of 889 publications had a co-occurring keyword from the chosen set along with keyword 'Artificial Intelligence' and 548 with keyword 'AI'.
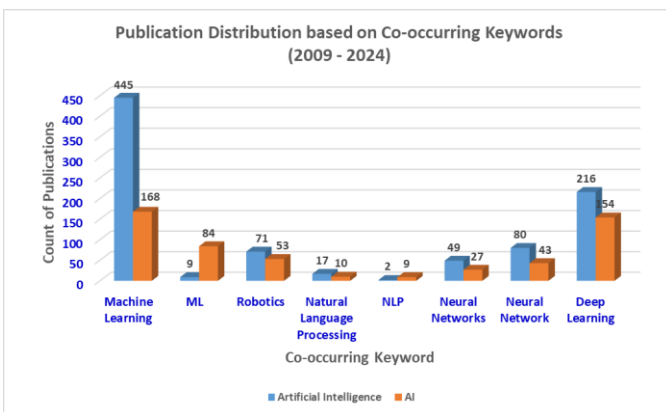

Fig. 3: Publication Distribution based on Co-occurring Keywords in *Title*

It is observed from Fig. 3 that the most prominently found combination is of keyword 'Artificial intelligence' with co-occurring keyword 'Machine Learning' followed by the combination 'Artificial Intelligence' and 'Deep Learning' (445 and 216 respectively). Similar observation is made regarding combination of co-occurring keywords 'Machine Learning' and 'Deep Learning' with keyword 'AI' although the number of publications is comparable in this case (168 and 154 respectively). The order of prominently co-occurring keywords is: Machine Learning, Deep Learning, Neural Network and Robotics. Natural language Processing and NLP are the least used co-occurring words with keywords 'Artificial

Intelligence' and 'AI'. The co-occurring keyword 'ML' has been found to be used more with keyword 'AI' than with 'Artificial intelligence.' The order of prominence of co-occurring keywords shows the variation in research trends in AI-related areas.

C. *Identifying Research Trend from Prolific Keywords*

Fig 4 depicts the growth of research trends in artificial intelligence and its related research categories based on occurrence of specific keyword in the '*Keywords of the publication*' search criteria of DOAJ for retrieving count of publications. It is observed that Machine Learning, Deep Learning and Artificial intelligence are the top three keywords in AI-related publications showing that the Machine Learning and Deep Learning are the AI-related research trends that are growing exponentially.
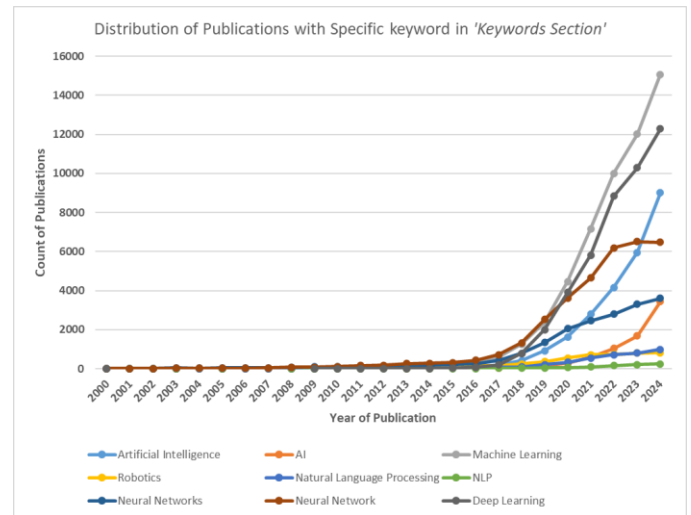

Fig. 4: Publication Distribution based on Keywords in '*Keywords Section*'
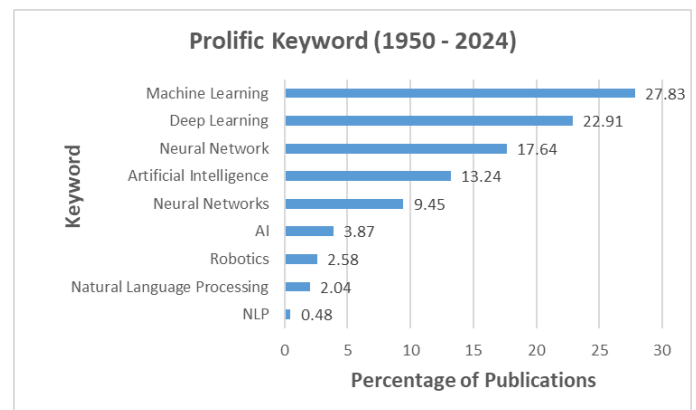

Fig. 5: Most Prolific Keyword

Fig. 5 shows percentage of publications having specific keywords. The trend shows a growing body of research publications in the category of Machine Learning literature followed by Deep Learning.

V. FINDINGS

The present study has been conducted to analyze growth of trends in Artificial Intelligence research. The Open access

research articles/publications in DOAJ indexing database have been considered for the study. This study does not take into account any research produced beyond the coverage of DOAJ. The major findings of the study are:

- There exist 134025 Artificial Intelligence and AI-related open access publications during the period 1950-2024. This number includes publications having at least one of the keywords from the given set: Artificial Intelligence, AI, Machine Learning, Robotics, Natural Language Processing, NLP, Neural Networks, Neural Network, and Deep Learning. Keyword 'Machine Learning' is the highest occurring word in AI-related research output on DOAJ during the chosen period of study. Post year 2020, the research output in Deep Learning is growing at a rapid pace indicating it to be the main focus of current research in AI.
- The highest number of co-occurring keywords in combination with Artificial Intelligence or AI are Machine Learning and Deep Learning thus showing that the research trend in these two AI-related areas is significantly increasing.
- Machine Learning and Deep Learning are the most prolific keywords appearing in *Keywords* section of the research output. This show that there is increasing growth in these two categories of AI-related research.
- There is a substantial increase in the AI related research publications during the last decade with Machine Learning and Deep learning being the focus of growth.

VI. CONCLUSION

Bibliometric analysis of research literature in any specific area available through online open access databases provides detailed information on the corresponding research output. The bibliometric analysis conducted on longitudinal data on AI-related research output has provided useful insight into growth of research trends in AI. Various parameters of DOAJ are considered for evaluation. The significant growth has occurred in AI-related research output especially during the last decade with research trend having focus on Machine learning and Deep learning.

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