

# Contribution Of NIRF Ranked IITs In Artificial Intelligence & Machine Learning: A Scientometric Study of Research Publications

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**Abstract**— The purpose of this study is to assess the contribution of IITs Ranked in latest NIRF in published research output in Artificial Intelligence and Machine learning using Scientometric analysis. The published data were exported from Scopus databases. The Data were analyzed and interpreted using Rstudio, Biblioshiny, Bibexcel, Vosviewer, and MS Excel. A total 6482 no of documents in 2753 sources were published by IITs researchers since year 1968 till June 2024. Co-author per documents (6.63) indicates that multi-authored papers have been published more in compare to single-authored papers. The degree of collaboration (0.97) and relative growth rate (0.165) are noteworthy. Three authors' collaboration produced the greatest number of papers (28%) and, in terms of sources, the majority of the records were published as articles (46%). Kar, Arpan Kumar, author (76) and IIT Kharagpur (1001 articles) contributed more numbers of papers in the domain of Artificial Intelligence. 14.42 is the average citation per documents, which means the research quality in AI by IITs is excellent.

**Index Terms**- Artificial Intelligence, AI, Machine Learning, Scientometric Analysis, Research output, Indian Institute of Technology, IITs, NIRF.

## I. INTRODUCTION

Artificial intelligence has taken over some of our daily chores to make life easier in contemporary ICT-driven world. As a result, a significant amount of research is being done on "Artificial Intelligence" or "Machine Learning" to determine its potential for knowledge advancement and its implication on society. AI has evolved in such a way that it has made human life so easier and comfortable in day to day life. In present digital world, AI has become an integral part of any system to find the possible ways/solutions to the development of society and knowledge. AI is a broad field of engineering science that focuses on creating

intelligent machines/systems that can perform tasks that typically require human intelligence. Artificial Intelligence (AI) is a multifaceted science based on knowledge, but recent developments in machine learning and deep learning are revolutionizing nearly every aspect of technical education. The development of computer abilities akin to human intellect, such as learning, thinking, and problem-solving, is a major focus of artificial intelligence.

Intelligence usually means "the ability to solve hard problems" (Minsky, 1958). "AI is concerned with methods of achieving goals in situations in which the information available has a certain complex character. The methods that have to be used are related to the problem presented by the situation and are similar whether the problem solver is human, a Martian, or a computer program" (McCarthy, 1988).

Recognizing AI's potential to transform economies and the need for India to strategically approach the issue, the country with the fastest growing economy and second largest population in the world, the Hon. Finance Minister, in his budget speech for 2018–2019, instructed NITI Aayog to establish the National Program on AI with the goal of promoting research and development in new and emerging technologies. In light of the aforementioned, NITI Aayog has teamed up with a number of top providers of AI technology to carry out AI initiatives in vital fields like health and agriculture. The knowledge gained from these initiatives, which are in different phases of execution, along with our collaboration with some of the top organizations and specialists have improved our understanding of the work of developing the national plan for AI. The Indian government has started a national dialogue about how India should aim

to rank among the world's leading countries in the AI ecosystem. When it comes to the quantity of AI businesses and jobs, India is placed fifth globally. In terms of quality and standards, Indian Institutes of Technology are the premiere institution in India and regarded as the world's leading centers for engineering education and research. These institutes have launched numerous initiatives in the form of thought-provoking courses for students who aspire to pursue a career in artificial intelligence (AI). In the age of digital transformation, where every industry is in demand of professional Artificial Intelligence (AI) capabilities. The IITs has started study Programs in AI and Machine learning.

A total no of 1096397 research documents have been published in all over the world in AI and Machine learning. Total 106169 documents have been published by authors affiliated to Indian Institutions which is almost 10% of world literature published in AI and Machine learning. Out of these publications, IITs contribution is 8272 documents, and a total no of 5835 documents were published by first generation (first 7 IITs) IITs which is selected for the study. (Data extracted from Scopus on 22.01.2024)

Scientometric examination of scientific publications explained by the fact that Bibliometric studies are employed to determine growth of the subject, publishing patterns, authorship, citation trends, and coverage of tertiary journals. These elements may provide information about the dynamics of the subject topic. "Scientometrics," the scientific field that characterizes the characteristics of organizational research structures, resource inputs, and outputs, creates standards to assess the caliber of information produced. The growth pattern and other characteristics are used by Scientometric research to describe the fields. This study determines the contribution of IITs in AI research output in terms of publications using Scientometric study.

## II. OBJECTIVES OF THE STUDY

- i. To determine the authorship pattern and degree of collaboration
- ii. To find the most used keywords
- iii. To measure year wise distribution of the publications and growth

- iv. To calculate doubling time of the publication and RGR
- v. To find most productive author and institutions
- vi. To evaluate the citation count
- vii. To find top funding agencies

## III. SCOPE AND LIMITATION OF THE STUDY

This study is limited to the research output of IITs ranked in NIRF 2023, under top 10 institutions in overall category only, and the bibliographic data available in Scopus database. The publication data of selected institutions may differ in other indexing databases. The records were extracted from Scopus database searching the keywords "Artificial intelligence" and "Machine learning", the research publications in AI domain using different keywords may not be covered in the study.

## IV. METHODOLOGY

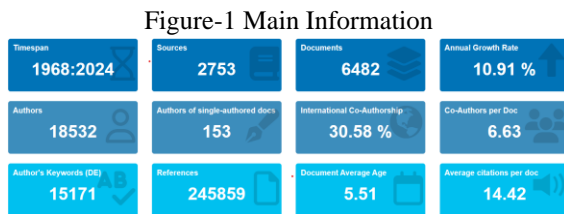
This study is based on the data extracted from Scopus using following search query;

*( TITLE-ABS-KEY ( {artificial intelligence} OR {AI} OR {Machine Learning} ) AND AFFIL ( indian AND institute AND of AND technology ) OR AFFILORG ( iit ) AND ( LIMIT-TO ( AF-ID , "Indian Institute of Technology Kharagpur" 60004750 ) OR LIMIT-TO ( AF-ID , "Indian Institute of Technology Guwahati" 60010126 ) OR LIMIT-TO ( AF-ID , "Indian Institute of Technology Bombay" 60014153 ) OR LIMIT-TO ( AF-ID , "Indian Institute of Technology Kanpur" 60021988 ) OR LIMIT-TO ( AF-ID , "Indian Institute of Technology Madras" 60025757 ) OR LIMIT-TO ( AF-ID , "Indian Institute of Technology Roorkee" 60031818 ) OR LIMIT-TO ( AF-ID , "Indian Institute of Technology Delhi" 60032730 ) )*

The extracted data were stored in .csv and .bib format. To organize and interpret the data, Rstudio, biblioshiny, VOSviewer, and excel package were used. Some of the analysed data and graphs were used already available is Scopus.

V. DATA ANALYSIS, INTERPRETATION, AND FINDINGS

The data file extracted from Scopus was uploaded into Biblioshiny package. Out of 5736 records successfully accepted and interpreted by Biblioshiny. figure-1 displays the main information of the uploaded records. The Research productivity in AI increased with annual growth rate of 10.91 %, which is very significant. The average citation per documents is 14.42, which shows the quality of research publications by IITs in AI domain.



5.1 Literature Growth

5.1.1 Year-wise production of literature on Artificial Intelligence (AI) & Machine Learning (ML) by selected IITs

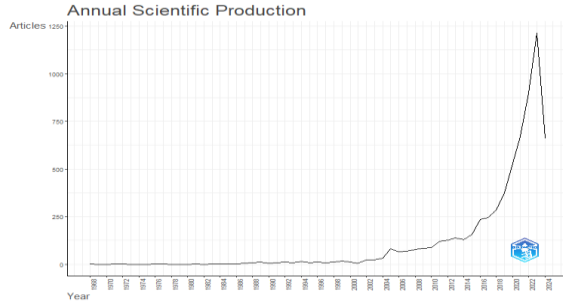
Table-1 represents the annual scientific productivity of selected IITs in AI & ML. Total no. of 6482 (data extracted from Scopus as on 26.06.2024) documents have been published on AI and ML till date, which is statistically significant. After the year 2002, the production of literature has increased rapidly.

Table-1 (Year-wise productivity of selected IITs)

Y	P	Y	P	Y	P	Y	P	Y	P
ea	u	ea	u	ea	u	ea	u	ea	u
r	b.	r	b.	r	b.	r	b.	r	b.
2	0	2	0	2	0	2	0	2	0
0	6								
2	5								
4	9								
2	1	2	1	1	1	1	1	1	1
0	2	0	1	9	9	9	9	9	9
2	1	1	2	9	1	8	7	7	7
3	4	1	3	9	1	7	3	5	0
2		2		1		1		1	
0	8	0		9	9	9	9	9	9
2	9	1	8	9	1	8	7	7	7
2	8	0	9	8	3	6	0	4	0

2		2		1		1		1	
0	6	0		9		9		9	
2	7	0	6	9	1	8		7	
1	2	9	6	7	1	5	2	3	0
2		2		1		1		1	
0	5	0		9		9		9	
2	2	0	7	9		8		7	
0	8	8	9	6	8	4	4	2	1
2		2		1		1		1	
0	3	0		9		9		9	
1	7	0	5	9		8		7	
9	6	7	7	5	7	3	1	1	1
2		2		1		1		1	
0	2	0		9		9		9	
1	8	0	5	9	1	8		7	
8	3	6	4	4	0	2	0	0	0
2		2		1		1		1	
0	2	0		9		9		9	
1	4	0	5	9		8		6	
7	5	5	9	3	7	1	2	9	0
2		2		1		1		1	
0	2	0		9		9		9	
1	3	0	3	9	1	8		6	
6	5	4	3	2	6	0	0	8	2
2		2		1		1			
0	1	0		9		9			
1	5	0	1	9		7			
5	8	3	9	1	8	9	0		
2		2		1		1			
0	1	0		9		9			
1	3	0	3	9		7			
4	8	2	1	0	5	8	0		
2		2		1		1			
0	1	0		9		9			
1	4	0		8	1	7			
3	9	1	5	9	5	7	2		
2		2		1		1			
0	1	0		9		9			
1	3	0	1	8		7			
2	4	0	3	8	5	6	1		

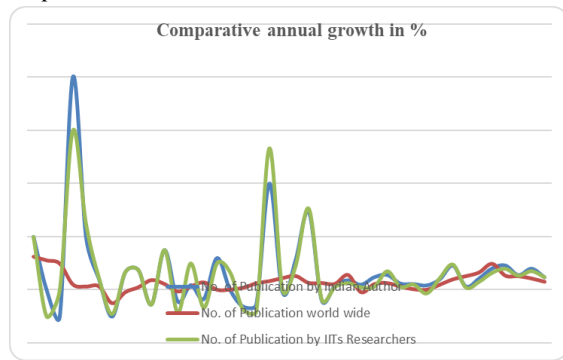
Graph-1



5.1.2 Comparative growth in AI & ML research

The overall annual growth (%) in AI & ML publications is compared with the annual growth (%) of publications by India, and selected IITs in a graphical representation (graph-2). It is noticed that overall annual growth % (Red line) is almost linear since 1984, while the annual growth % trend is similar in case of the publications by Indian authors and selected IITs authors since 1984.

Graph-2



5.1.3 RGR and Doubling time

Relative growth rate (RGR), which is frequently used to measure the number of publications each year, is the expression of the growth rate of the research literature for each year. To determine when to double the publication, utilise Doubling Time (Dt) as well.

$$\text{Relative Growth Rate (RGR)} = \frac{\ln W_2 - \ln W_1}{T_2 - T_1}$$

$\ln W_2$  = log of the final number of articles in a specific period of interval

$\ln W_1$  = log of the initial number of articles.

$T_2$  - upper limit time interval,

$T_1$  - lower limit time interval,

$$\text{Doubling timing (Dt.)} = 0.693 / \text{RGR}$$

Table-2

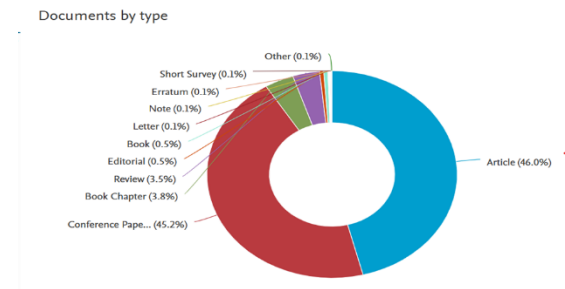
Time Interval	No. of Publ. (1981-2024)	Cumulative No.	$\ln W_1$	$\ln W_2$	$\text{RGR}(\frac{\ln W_2 - \ln W_1}{T_2 - T_1})$	Mean RGR	Dt	Mean Dt
1981-1984	4	4	1.386294	1.386294	0		0	
1985-1988	15	19	2.70805	2.944439	0.059097195		11.726445	
1989-1992	36	55	3.583519	4.007333	0.105953562		6.5406013	
1993-1996	42	97	3.73767	4.574711	0.20926034		3.3116643	
1997-2000	46	143	3.828641	4.962845	0.283550808		2.4440064	
2001-2004	82	225	4.406719	5.4161	0.252345289	0.165	2.7462371	4.210
2005-2008	296	521	5.690359	6.25575	0.141347647		4.9028054	

2009-2012	416	937	6.030685	6.842683	0.202999505		3.4138014	
2013-2016	662	1599	6.495266	7.377134	0.220467039		3.143327	
2017-2020	1432	3031	7.266827	8.016648	0.187455132		3.6968846	
2021-2024	3443	6474	8.144098	8.775549	0.157862743		4.3898895	

Table 2 indicates Relative Growth Rate (RGR) and Doubling time (Dt) of publications on AI & ML research productivity by selected IITs. Each four year publication combined in one block period, and total eleven block year period set up to analyse and interpret the sample data. The 1997-2000 block period has marked highest RGR i.e., 0.283 and block year 1985-1988 has gained highest doubling time 11.726 (Dt). Mean value of Relative Growth Rate and doubling time is 0.165 and 4.210 respectively.

5.1.4 Type of publications

Graph -3

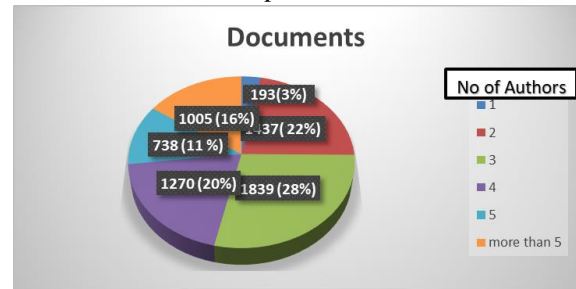


The above graph -3 represents that the most no of document were published in the form of Articles (2983) equally with conference papers (2927).

5.2 Authorship Pattern

Figure 1 represents that joint authorship is mostly preferred by the researcher of IITs, 97.36% of the total publications were written in collaboration. Out of these multi-authors publications, 31.43% co-authors are International authors. Most no of papers were published in collaboration of three authors.

Graph -4 & 5



Country Collaboration Map



Degree of collaboration-

The degree of collaboration is a measure of the collaborative research pattern; it is defined as the ratio of the number of collaborative research publications to the total number of research publications in the subject within a given period.

$$\text{Degree of Collaboration (DC)} = \frac{Nm}{Nm + Ns}$$

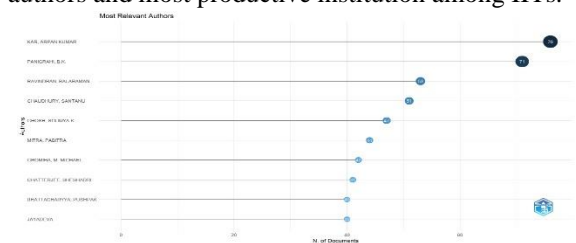
Nm= No. of Multi author Publication

Ns= No. of Single Author T

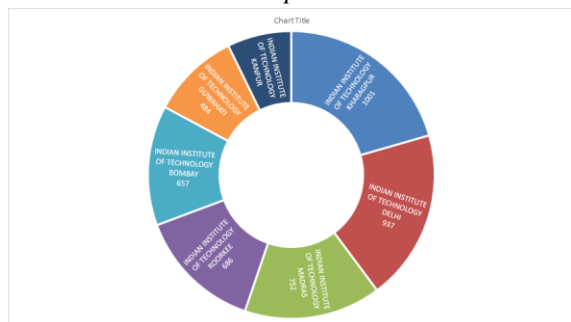
$$\text{Degree of Collaboration : } 6289/6482 = 0.97$$

5.3 Most productive Institutions and Authors

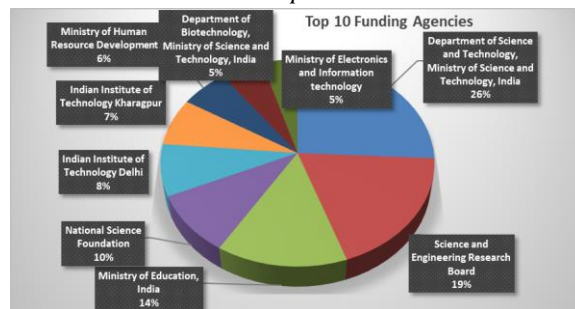
Graph 5 & 6, are the representation of most productive authors and most productive institution among IITs.



Graph -6



Graph -7



5.5 Most used Keywords and Trend topics

Following are the keyword mostly used in research in selected domain, Artificial Intelligence and machine learning are the most frequent keywords.

Table-3

Terms	Frequency
artificial intelligence	2053
machine learning	1810
learning systems	1020
learning algorithms	610
machine-learning	603
deep learning	551
forecasting	523
neural networks	437
support vector machines	386
decision trees	374
algorithms	373
classification (of information)	347
algorithm	315



5.6 Top funding agencies-

Department of Science & Technology, Ministry of S&T, India sponsored 26% of research to promote research AI in India. Individual IITs also sponsored the researcher for AI research. Other ministries of GOI also contributed in funding for research.

CONCLUSION

Using scientometric analysis tools, this study examined Indian AI research on literature indexed in the Scopus database between 1960 and 2024. The growth of knowledge management research, the frequency of keywords and topic terms, the productivity level of the institutions, and the most cited authors and publications have all been described in the study.

The major findings are;

- I. The research productivity of knowledge management in India has grown significantly with annual growth rate of 10.91%. Year 2023, topped with 1214 articles in one year. Relative Growth rate (RGR) and Doubling time (Dt) is 0.16 and 4.2 respectively.
- II. Most of the articles were published in Computer Science, Engineering and Mathematics subject area, 3903, 2377, and 1261 articles respectively.
- III. Nearly 28% of articles are written by three authors, and 97% by more than one author, witness the strong co-authorship pattern in AI research. Degree of Collaboration is 0.97 which represents the strong co-authorship works.
- IV. IIT Kharagpur and IIT Delhi topped in AI research.
- V. ‘Artificial Intelligence’, ‘Machine Learning’, ‘learning System’, ‘deep learning’, learning algorithms’ are most used keyword in published research by IITs in AI.
- VI.
- VII.
- VIII.

This study may help the researcher to get the research trends and productivity of AI research in India. This study demonstrates that the growing trend of authorship patterns in publications has been quite

good, with high-quality sources of publishing and joint authorship patterns present in these publications. It is noteworthy and encouraging to the researchers that the citations that the writers have gotten show that papers on this subject are highly cited. There are much visibility and impact of the research work has published during the last 20 years on AI in India.

Results of this study suggest that research in AI is growing year by year in India with doubling time 4.8 units which is significant. The Indian academic institution may give more speed to the study of AI and contribute more to the discipline/area. This paper will be a point of reference for identifying and evaluating journal quality, funding agencies, and most productive author in communicating high-quality research work in AI.

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