

# Scientometric Analysis of Artificial Intelligence Research Output

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## ABSTRACT

This study is on the scientometric analysis of artificial intelligence research output from web of science database. Scientometrics is the field of study which concerns itself with measuring and analyzing scholarly literature. A total of 21,643 records have been retrieved and analysis is made yearwise, authorwise, document type, and language wise for a period of 21 years. The results show that double authors have contributed more number of publications, and English language is the most popular among the scientists for the dissemination of the information. Most of the literature on artificial intelligence was in the form of articles, and the growth of artificial intelligence literature is in the increasing trend during the study period.

**KEYWORDS:** Artificial Intelligence, web of science, rate of growth, scientometric.

## INTRODUCTION

John McCarthy, Professor emeritus of computer science at Stanford, coined the term "artificial intelligence" . Its application is used in all aspects of our daily life, Areas where artificial intelligence is being adopted are in Manufacturing robots, Self-driving cars, Smart assistants, Proactive healthcare management, Disease mapping, Automated financial investing. Virtual travel booking agent, Social media monitoring. Lots of research is being done on this subject. This paper analyses the research output on artificial intelligence from Web of Science database, from the year 1999 to 2019 for a period of 21 years. It is found that there are 21643 records that have been retrieved. Scientometrics is the field of study which concerns itself with measuring and analyzing scholarly literature.

## REVIEW OF LITERATURE

**Konur (2012)** made a study on “scientometric evaluation of the research on the production of bioenergy from biomass” In the literature on the production of bioenergy from biomass published during the last three decades, based on the databases of Science Citation Index-Expanded (SCIE) and Social Sciences Citation Index (SSCI) and its implications using the scientometric techniques.

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It is revealed that this field has grown exponentially during this period reaching to 5892 papers. The papers were mostly journal articles, reviews, and proceedings, being predominantly in English. The “Chinese Academy of Sciences” has been the most contributed institution where the most publishing author is “A Demirbas”.

**Sambandam (2017)** made as a Research Evaluation on Gender Studies in Informatics an Application of Scientometric Indicators and Mapping Techniques and the main objective are to study the continent wise and country wise research output performance in Gender Studies in Informatics. It is found the Some of the Asian countries have not done research in Gender Studies in Informatics. Hence these countries should motivate the researchers to do research in this area with a view to identify the impact of information technology on women empowerment.

The main objectives are to analyse the cognitive structure of Gender Studies in Informatics and to identify changes, shifts during the period of study. And the study showed the research output in Gender Studies in Informatics is quite low in many of the countries in North American Continent, except USA and Canada. Hence, they should develop research in the same field.

**SirjeVirkus, et al., (2020)** made a Scientometrics study on Data science and its relationship to library and information science a Content analysis of research publications on data science was made of papers published in the Web of Science database to identify the main themes discussed in the publications from the LIS perspective. A content analysis of 80 publications is presented. The articles belonged to the six broads’ categories: data science education and training; knowledge and skills of the data professional; the role of libraries and librarians in the data science movement, tools, techniques and applications of data science from the knowledge management perspective; and data science from the perspective of health sciences. The category of tools, techniques and applications of data science was most addressed by the authors, followed by data science from the perspective of health sciences, data science education and training and knowledge and skills of the data professional. The paper provides the first exploration by content analysis of the field of data science

### **Sample Details**

Sample time span is 1999 to 2019, total 21 years, the downloaded sample consists of 21643 records, contributing authors are 53798, contributing journals are 4796, types of document are 27, The different languages used in the Artificial Intelligence research are 24 languages, the frequently used words are 17456, 137 countries and 12960 Institutions have contributed, in this research. Total local citation scores are 20743 and Global citation scores totally is 341247 were cited as reference for the whole sample records.

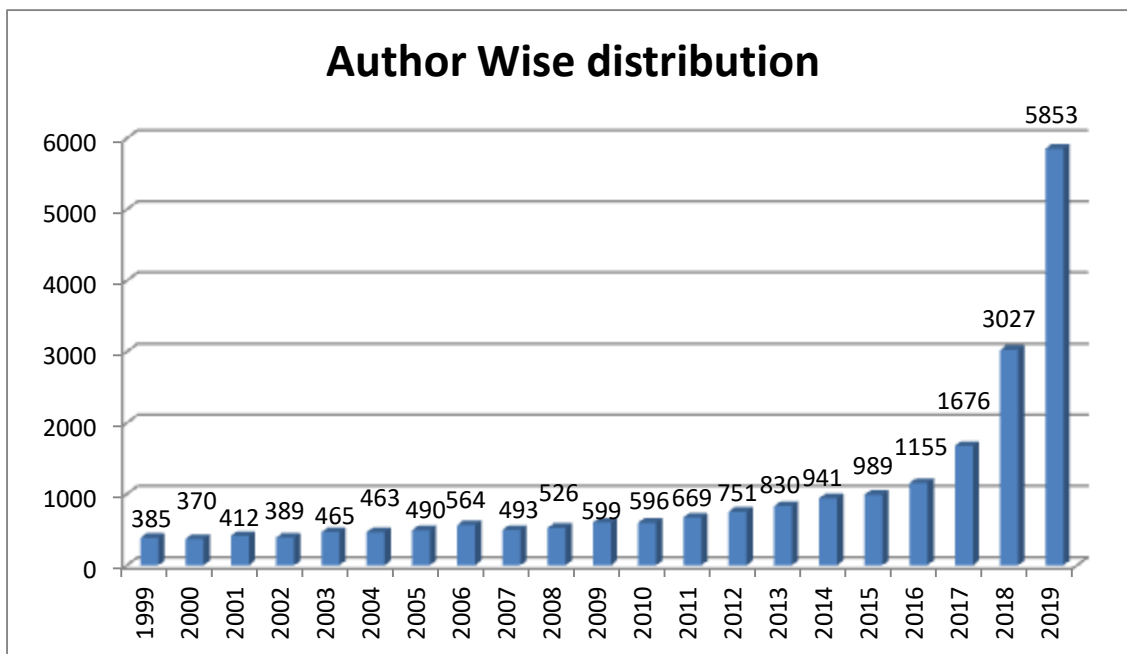
### **OBJECTIVES**

The main objective of this study is to

- To find out in which year the contribution is high by the different number of authors.
- To identify the various document types that have contributed to artificial Intelligence research.
- To find out the year wise contribution of the various document types.
- To list out the various languages used in artificial intelligence research.
- To analyse the year wise language wise distribution of artificial intelligence research.

**Table 1** Author wise Distribution of Artificial intelligence research publications

S. No	Years	Single Author	Multiple Author	Total
1	1999	119	266	385
2	2000	101	269	370
3	2001	120	292	412
4	2002	109	280	389
5	2003	121	344	465
6	2004	100	363	463
7	2005	140	350	490
8	2006	124	440	564
9	2007	113	380	493
10	2008	110	416	526
11	2009	113	486	599
12	2010	104	492	596
13	2011	116	553	669
14	2012	110	641	751
15	2013	101	729	830
16	2014	125	816	941
17	2015	147	842	989
18	2016	156	999	1155
19	2017	310	1366	1676
20	2018	451	2576	3027
21	2019	768	5085	5853
	Total	3658	17985	21643



**Figure 1.** Author wise Publications in Artificial Intelligence research

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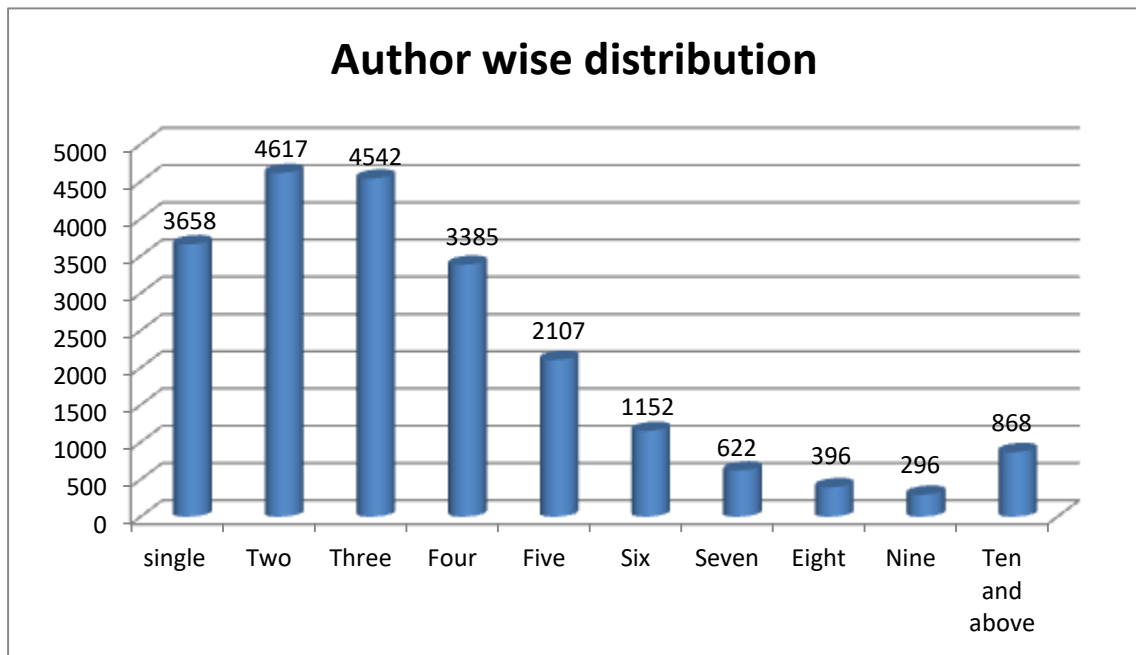
Table 1, analysis reveals the single Author Vs. Multi Authored contribution on Artificial Intelligence research output during the period 1999 to 2019 a total of 21643 publication were published. Single authored were published 3658 records, and the multiple authored were published 17985 records. From the entire sample duration period, the years of 2019 has the highest collaboration 5085 records. The table value showed that 2018 year of collaboration value is 2576 records were publications produced by collaborative mode. The table value showed that 2017 year of collaboration value is 1366 percent of records were publications produced by collaborative mode. This analysis strongly mentioned that the collaborative work has dominated in records publication producing from Artificial Intelligence research output and shows an increasing trend during the study period since it is a new discipline. The result of the degree of collaboration 21643 records of collaborative author's records published during the sample study period.

**Table 2** Year wise analysis Vs. Author wise Distributions of publications

Year	Single	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten and Above	Total
1999	119	125	74	37	15	8	2	3	0	2	385
2000	101	113	73	41	19	11	5	1	2	4	370
2001	120	111	92	48	23	7	6	1	1	3	412
2002	109	120	96	36	17	5	4	1	0	1	389
2003	121	137	93	61	23	12	9	2	3	4	465
2004	100	153	91	58	32	11	6	4	1	7	463
2005	140	135	108	54	22	12	9	3	4	3	490
2006	124	180	119	61	41	14	7	6	4	8	564
2007	113	138	111	62	36	16	5	7	3	2	493
2008	110	155	127	65	39	18	5	3	1	3	526
2009	113	161	149	104	32	15	13	7	2	3	599
2010	104	150	157	85	44	23	12	8	4	9	596
2011	116	163	174	119	52	19	8	6	2	10	669
2012	110	170	204	149	58	23	14	8	4	11	751
2013	101	184	214	174	80	33	18	12	5	9	830
2014	125	195	225	203	95	43	23	11	8	13	941
2015	147	206	257	169	113	44	22	6	9	16	989
2016	156	242	300	186	112	66	34	21	10	28	1155
2017	310	340	336	264	176	87	62	25	27	49	1676
2018	451	521	579	475	368	220	100	75	62	176	3027
2019	768	918	963	934	710	465	258	186	144	507	5853
	3658	4617	4542	3385	2107	1152	622	396	296	868	21643

In 2001, 2005 the single authors contributions were high that is in the years 2001(120 contributions ) and 2005(140 contributions) is in the First Place, and followed by two authors contribution is high in the years 1999(125 contributions), 2000(113 contributions), 2002(120 contributions), 2003(137 contributions), 2004(153 contributions), 2006(183 contributions), 2007(138 contributions), 2008(155 contributions), 2009(161 contributions) and 2017(340

contributions) the second place. Three authors contribution is high in 2010(157 contributions), 2011(174 contributions), 2012(204 contributions), 2013(214 contributions), 2014(225 contributions), 2015(257 contributions), 2016(300 contributions), 2018(579 contributions) and 2019(963 contributions) third place of the publication.



**Figure 2** Author wise distribution of Artificial Intelligence research output.

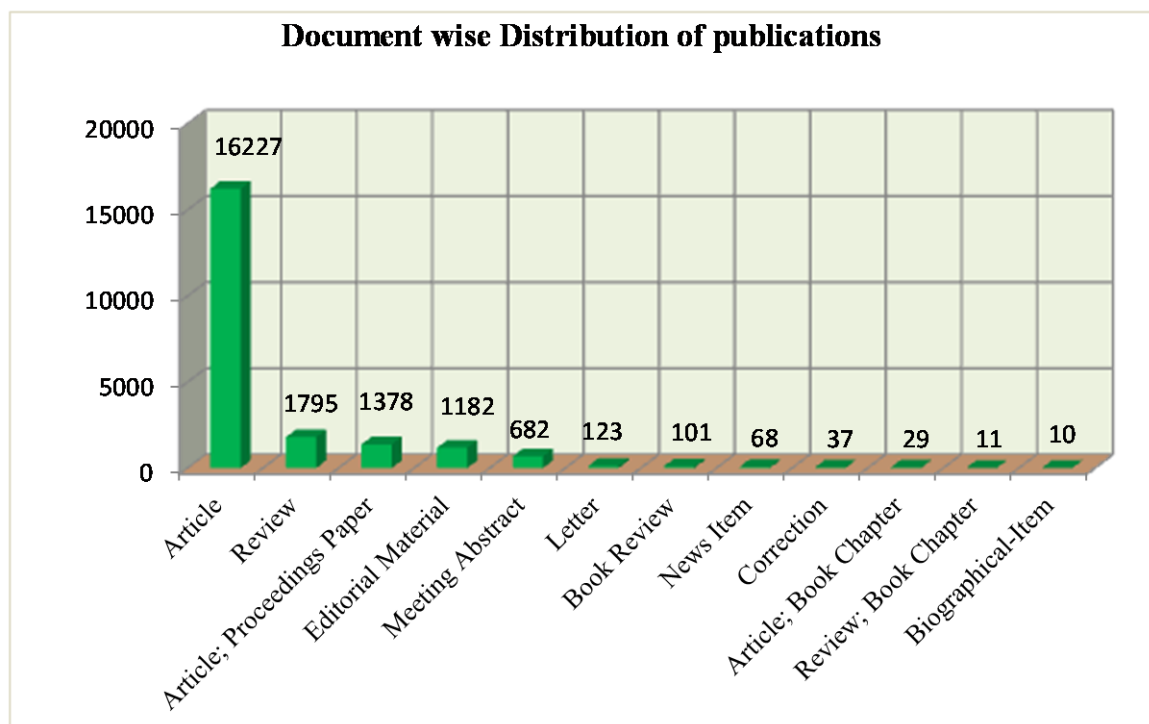
From a Total of 21643 records, 3658 (16.90%) records are single author; 4617 (21.33%) are two authors; 4542(20.99%)are three authors; 3385(15.64%)are from four authors; 2107(9.74%)are five authors; 1152(5.32%)are six authors; 622(2.87%)are seven authors; 396(1.83%)are eight authors; 296(1.37%)are nine authors; 868(4.01%)are ten and above authors. It could be identified the two authors contribution is top most that authors group from this analysis; two authors group has been highest productivity of Artificial Intelligence during sample period.

**Table 3** Document wise distributions of publications

S. No	Document wise	Records	%	TLCS	TGCS
1	Article	16227	75.0	15517	247122
2	Review	1795	8.3	3412	66134
3	Article; Proceedings Paper	1378	6.4	835	21495
4	Editorial Material	1182	5.5	840	5289
5	Meeting Abstract	682	3.2	21	92
6	Letter	123	0.6	47	379
7	Book Review	101	0.5	5	64
8	News Item	68	0.3	30	104
9	Correction	37	0.2	4	38
10	Article; Book Chapter	29	0.1	28	400

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11	Review; Book Chapter	11	0.1	2	120
12	Biographical-Item	10	0.0	2	10
	Total	21643	100	20743	341247



**Figure .3** Document wise Distribution of publication

### 3. Document wise Distributions of publications

Table 3 depicts the document wise distribution of publications. The research output of Artificial Intelligence spreads over variety of publication media such as Article, Review, Proceedings Paper, Editorial Material, Meeting Abstract, Letters, and Book Review, News Item and correction and some other forms. It is clear that the share of journal articles is the most prominent with 16227 (75.0%) of total publications and received 15517 Local Citation Scores and 247122 Global Citations Scores, followed by Review with 1795(8.3%) and 3412 Local Citation Scores, 66134 Global citation score. Proceedings paper with 1378(6.4%) Publications and 835 Local Citation Score, 21495 Global Citation Scores. Editorial Material with 1182(5.5%) publications and 840 Local Citation Scores and 5289 Global Citation Scores. Meeting Abstract with 682(3.2%) and Letter is having 123(0.6%) research publication observed in the study. The rest of the publications are published are in other forms. It could be deduced from the above discussion that journal articles predominate over scientific communication than any other form of publication, majority of the scientists have published their research papers in journals.

### 4 Year wise analysis Vs. Document Distributions of publications

Table 4. shows the year wise analysis vs document wise distributions of Artificial Intelligence research output for from the year 1999 to 2019. The sample of 21643 records related to Artificial Intelligence was downloaded for the Web of Science database. It is found that Articles, Review, Article; Proceedings Paper, Editorial Material, Meeting Abstract and Letter, Book Review, News Item, Correction, etc., The journal Article is highest number published in

the year 2019(4065) records, Review occupy the second position in the year 2019(793) records, Article; Proceedings Paper occupy the third position in the year 2006(175) records.

**Table 4** Year wise analysis Vs. Document Distributions of publications

Document wise	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Article	282	249	278	258	296	259	291	332	364	408	469	504	569	661	734	834	846	992	1316	2220	4065	16227
Review	24	20	24	13	20	26	15	26	30	31	33	32	32	37	39	45	59	66	131	299	793	1795
Article; Proceedings Paper	51	72	79	100	111	156	147	175	64	49	54	33	26	9	17	16	25	22	34	66	72	1378
Editorial Material	16	23	21	8	22	14	19	20	16	24	32	23	25	32	34	33	31	53	114	219	403	1182
Meeting Abstract	3	3	2	2	9	1	12	4	10	6	2	-	2	2	4	9	12	13	39	164	383	682
Letter	4	-	2	1	-	-	-	1	4	2	1	-	1	1	-	1	2	5	27	25	46	123
Book Review	5	3	3	5	6	6	2	3	1	3	5	2	4	6	-	1	6	-	7	12	21	101
News Item	-	-	3	1	-	-	1	1	1	-	2	1	2	1	-	-	4	1	4	11	35	68
Correction	-	-	-	1	-	1	-	1	-	1	-	-	3	1	1	1	1	1	3	3	19	37
Article; Book Chapter	-	-	-	-	-	-	3	-	1	-	-	1	2	-	-	-	3	-	-	5	14	29
Review; Book Chapter	-	-	-	-	-	-	-	-	1	-	1	-	1	-	1	-	-	2	1	2	2	11
Biographical-Item	-	-	-	-	1	-	-	1	1	2	-	-	2	1	-	1	-	-	-	1	-	10
Total	385	370	412	389	465	463	490	564	493	526	599	596	669	751	830	941	989	1155	1676	3027	5853	21643

## **Scientometric Analysis of Artificial Intelligence Research Output**

Editorial Material has 403 records; Meeting Abstract has 383 Letters constituting for 46 records; News items with 35 records, were in the form 'Book Review' with 21 records; Correction with 19 records; Article; Book Chapter, Review; Book Chapter and Biographical –items are the other form of publications.

**Table 5** Language wise Distributions of publications

S. No	Language wise	Records	%	TLCS	TGCS
1	English	21139	97.7	20669	340381
2	German	127	0.6	9	116
3	Spanish	120	0.6	6	236
4	French	60	0.3	7	46
5	Portuguese	52	0.2	37	233
6	Polish	24	0.1	3	36
7	Russian	23	0.1	0	16
8	Chinese	18	0.1	4	59
9	Croatian	14	0.1	3	18
10	Hungarian	12	0.1	1	2
11	Turkish	10	0.0	1	35
12	Czech	9	0.0	1	29
13	Japanese	8	0.0	0	2
14	Italian	4	0.0	0	3
15	Slovak	4	0.0	0	2
16	Slovene	4	0.0	2	19
17	Dutch	3	0.0	0	0
18	Korean	3	0.0	0	3
19	Icelandic	5	0.0	0	10
20	Finnish	1	0.0	0	0
21	Lithuanian	1	0.0	0	0
22	Swedish	1	0.0	0	1
23	Ukrainian	1	0.0	0	0
		21643	100	20743	341247



**Table 6:** Year wise analysis Vs. Language wise Distributions of publications

Language wise	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
English	375	359	403	382	461	457	484	562	483	513	578	575	644	732	807	919	959	1134	1644	2941	5727	21139
German	2	2	3	5	3	-	2	1	-	2	1	4	1	1	-	-	5	-	8	21	66	127
Spanish	1	2	1	-	1	-	-	-	2	5	10	6	10	6	8	9	7	6	6	21	19	120
French	5	1	4	1	-	-	-	-	4	-	-	-	2	-	3	-	2	1	9	11	17	60
Portuguese	-	2	-	-	-	-	-	-	1	1	2	5	5	5	4	6	8	6	3	1	3	52
Polish	-	-	-	-	-	3	-	-	1	2	4	3	5	-	1	-	1	-	1	1	2	24
Russian	-	1	-	1	-	1	-	-	-	1	-	-	-	1	-	3	-	1	2	7	5	23
Chinese	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	8	6	18
Croatian	1	-	-	-	-	-	1	-	-	-	2	2	-	-	1	1	2	-	-	4	-	14
Hungarian	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	3	1	1	3	1	12
Turkish	-	-	-	-	-	-	-	-	-	-	-	-	1	1	3	2	-	2	-	-	1	10
Czech	-	1	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	1	2	1	1	9
Japanese	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	3	1	8
Italian	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	4
Slovak	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2	-	4
Slovene	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	1	-	4
Dutch	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	3
Korean	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	3
Icelandic	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-	-	-	-	2	5
Finnish	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Lithuanian	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Swedish	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Ukrainian	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
	<u>385</u>	<u>370</u>	<u>412</u>	<u>389</u>	<u>465</u>	<u>463</u>	<u>490</u>	<u>564</u>	<u>493</u>	<u>526</u>	<u>599</u>	<u>596</u>	<u>669</u>	<u>751</u>	<u>830</u>	<u>941</u>	<u>989</u>	<u>1155</u>	<u>1676</u>	<u>3027</u>	<u>5853</u>	21643

### **5. Language wise Distribution of Publications**

Language is one of the important criteria for dissemination of scientific information at global level. The researcher throughout the world does not know all languages. From the research output on Artificial Intelligence, it is found that apart from English, many contributions of research output have been made in other languages. The table no shows the language wise distribution of research output on Artificial.

The table 5. shows the distribution of preferred languages published on Artificial Intelligence. The present data reveals that twenty-three languages have been used in the publication. The most of the researcher published their 21139(97.8%) articles in English language during the years 1999 to 2019, followed by German language which is the second with 127(0.6%) records, Spanish language which is the third position with 120(0.6%) publications. French language with 60(0.3%) records published in the fifth position and Portuguese language with 52(0.2%) records in the next position.

It could be inferred from the analysis, less than 1% of the publications has been published by French, Portuguese, Polish, Russian, Chinese, Croatian, Hungarian, Turkish, Czech, Japanese, Italian, Slovak, Slovene, Dutch, and Korean, Icelandic, Lithuanian, Swedish and Ukrainian languages.

### **6. Year wise analysis Vs. Language wise Distributions of publications**

To analyse the year wise versus language wise distributions publication of research on Artificial Intelligence. The mention table is depicting the research output in a comprehensive level. From this, it is clear that during the period 1999 to 2019 a total of 21643 publication were published. (Refer table - 6)

Contribution of Artificial Intelligence research is high in the English, German, French, Dutch, and Korean in the year 2019. English (5727), German (66), French (17), Dutch (1), and Korean (1) are in First place; and followed by Spanish, Russian, Chinese, Croatian, Hungarian, Japanese, Italian, Slovak and Slovene in the year 2018. Language contribution is high Spanish (21), Russian (7), Chinese (8), Croatian (4), Hungarian (3), Japanese (3), Italian (2), Slovak (2) and Slovene (1) in second place. Portuguese in the year 2015. Language contribution is high the Portuguese (8) and is in third place. Polish in the year 2011. Language contribution is high the Polish (5) is in fourth place. Turkish, Dutch, Korean and Ukrainian in the year 2013. Language contribution is high Turkish (3), Dutch (1), Korean (1) and Ukrainian (1) Fifth place, and the remaining the table.

## **FINDINGS**

### **Year wise distribution and citation Scores**

The result of year wise (twenty-one years) distribution from different source of research output on Artificial Intelligence publications at global level. During this study period from 1999 to 2019 consisting of 21643 records of publication. It is found that the maximum contribution is in the year of 2017, 2018 and 2019. The year 2018 has earned highest Total Local Citation Scores and Total Global Citation Scores are 2665 and 27285 respectively.

### **Source wise Distribution**

The analysis result of source wise publications output on Artificial Intelligence research shows the fact that journal articles predominate over other (Twelve) different sources of publications. Journals occupy as a necessary medium

for the scientific communication in comparison with other forms of publication which proves the affinity of Artificial Intelligence research scientists to choose journals as their first preference. In 2019, 4065 Artificial Intelligence Research Output were mostly in the form of Journal articles and occupies the first place.

### **Language Wise Analysis**

In the analysis of language resorted by scientists it is found that English (97.7 percent) is the preferred medium of research communication, as it is generally recognized all over the world. It covers 21139 (97.7%) publications whereas other languages are only 2.3 Percent of publications. The German, Spanish and French language have 127, 120, and 60 records respectively. However, **377** research papers have been published in other twenty-three Languages.

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