
Cited and Uncited Publications on Artificial Intelligence Research Output

M. Kumaran

Ph.D Research Scholar, PG & Research Department of Lib & Information Science, Bishop Heber College (Autonomous), Trichy-620 017

A. Manoharan

Associate professor, PG & Research Department of Lib & Information Science, Bishop Heber College (Autonomous), Trichy-620 017

Abstract

This study reviews the bibliometric analysis of the published research outputs on Artificial Intelligence literature during the period 1996-2015. The data for the study has been downloaded from the Scopus database. The study analyzes and discusses on the yearly publications, citation analysis, uncited publications and highly cited publications during the study period. There are 51216 research outputs were recorded during the study period. Out of the total publications 49.35% has got citations so far and the remaining is yet to attract citations. United States of America has contributed nearly 20% of the total research outputs. 62.75% of the United Kingdom's publications have received citations. The researchers in this field preferred Conference papers ahead of articles to publish their research outputs. Only one third of the Conference Papers got cited whereas three-fourth of the Articles got citations

Keywords

Bibliometrics; Artificial Intelligence; Authorship Pattern; Citation Analysis; Uncited publications; Scopus Database.

Electronic access

The journal is available at www.jalis.in



Journal of Advances in Library and Information Science
ISSN: 2277-2219 Vol. 6. No.3. 2017. pp.191-195

INTRODUCTION

The aim of the study is to find out the latest global trend on Artificial Intelligence research outputs. Even though the authors are in the process of studying the research outputs on Artificial Intelligence for the past 30 years, they highlighted the trend only for the last 20 years in this study because of its rapid growing nature during the period. The terms bibliometrics and scientometrics was initiated by Pritchard, Nalimov & Mulchenko in 1969. Pritchard defined the term Bibliometrics as the application of mathematical and statistical methods to books and other communication medium. Nalimov & Mulchenko described Scientometrics as the application of those quantitative methods which are dealing with analysis of science viewed as an information process. The Scientometrics are used to measure scientific activities, mainly by producing statistics on scientific publications indexed in databases. They are particularly expensive methods for appraise research output, situation studies and perform insight studies in science and technology. The Scopus is multidisciplinary database and indexing more than 15000 International peer reviewed journals in the field of Science and Technology apart from that it covers over 500 International Conference/Seminar proceedings etc.

(TITLE-ABS-KEY-AUTH("artificial intelligence") AND PUBYEAR > 1995 AND PUBYEAR < 2016 AND (LIMIT-TO(SUBJAREA,"ENGI")))

The Statistical tools like Ratio of Growth (RoG), Citation and Citation per Paper (CPP) have been used to analyze the literature published during the study period. Also, top cited papers on the subject, highly published affiliations, and core journals on the related literature were analyzed. For analysis and making tables SPSS software and MS Office (Excel) has been used for the study.

REVIEW OF LITERATURE

Viswanathan, V & Tamizhchelvan, M (2016), analyzed cited and uncited publications on spacecrafts research outputs during the period 2000-2014 based on the Scopus database. There are 2,58,861 publications during the study period and out of that 1,41,422 were cited and yielded 20,88,967 citations. There are 1,17,439 uncited publications which constitute nearly 45% of the total publications. More Number of publications from Countries like United Kingdom, Canada and United States of

America gets cited whereas it is less in the case of publications from China, Russia and India. Among the bibliographic forms of publications, articles were highly cited. The review article authored by Uppala S.M. et al., which published in the year 2005, has yielded a maximum of 3495 citations during the study period. Peter Heneberg (2013) analyzed the uncitedness among two independent groups of highly visible mathematicians represented by field medalists, researchers in physiology or medicine represented by Nobel Prize laureates. Over 90% of the uncited database records of highly visible scientists have been presented in progress reports, meeting abstracts, letters to the editor, discussion, personalia by errors of omission and commission of the Web of Science (WoS) database and of the citing documents. Only 0.9 and 0.3%, of original articles and reviews were found to be uncited. Hu and Wu (2014) found current literature on citation distribution gives more focus on the distribution of the percentages and citations of papers receiving at least one citation, while there are fewer studies on the time-dependent patterns of the percentage of never-cited papers, on what distribution model can fit their time-dependent patterns, as well as on the factors influencing the non-citation rate.

OBJECTIVES OF THE STUDY

- To find the publication trend during the study period 1996-2015.
- To identify the quantum of cited publications and its citations during the study period.
- To identify and analyze the quantum of uncited publications.
- To compare the quality of the literature produced by the top ten countries
- To analyze the quantity of literature based on the type of documents.
- To study highly cited publications during the study period

DATA ANALYSIS

The following table illustrates the yearly distribution of publications on Artificial Intelligence literature during the period of study 1996-2015.

Table 1: Quantum of Literature from 1996 to 2015

| Year | TP | CTP | Citation | Citation % | RoG | CPP |
|--------------|--------------|--------------|---------------|---------------|--------------|--------------|
| 1996 | 1092 | 672 | 11678 | 2.57 | - | 17.38 |
| 1997 | 1204 | 754 | 16238 | 3.57 | 1.12 | 21.54 |
| 1998 | 1130 | 728 | 16581 | 3.65 | 0.97 | 22.78 |
| 1999 | 1150 | 771 | 22575 | 4.97 | 1.06 | 29.28 |
| 2000 | 1193 | 862 | 16794 | 3.70 | 1.12 | 19.48 |
| 2001 | 1040 | 716 | 21128 | 4.65 | 0.83 | 29.51 |
| 2002 | 1023 | 691 | 16691 | 3.67 | 0.97 | 24.15 |
| 2003 | 1305 | 809 | 18577 | 4.09 | 1.17 | 22.96 |
| 2004 | 2699 | 1767 | 50905 | 11.20 | 2.18 | 28.81 |
| 2005 | 2824 | 1752 | 59333 | 13.06 | 0.99 | 33.87 |
| 2006 | 3283 | 1933 | 54932 | 12.09 | 1.10 | 28.42 |
| 2007 | 3877 | 2281 | 51147 | 11.26 | 1.18 | 22.42 |
| 2008 | 5198 | 2506 | 37977 | 8.36 | 1.10 | 15.15 |
| 2009 | 2227 | 1194 | 15036 | 3.31 | 0.48 | 12.59 |
| 2010 | 2786 | 1397 | 13235 | 2.91 | 1.17 | 9.47 |
| 2011 | 2452 | 1250 | 9653 | 2.12 | 0.89 | 7.72 |
| 2012 | 3330 | 1278 | 7860 | 1.73 | 1.02 | 6.15 |
| 2013 | 3294 | 1160 | 4572 | 1.01 | 0.91 | 3.94 |
| 2014 | 4368 | 1628 | 6769 | 1.49 | 1.40 | 4.16 |
| 2015 | 5741 | 1128 | 2691 | 0.59 | 0.69 | 2.39 |
| Total | 51216 | 25277 | 454372 | 100.00 | 22.41 | 17.98 |

(TP- Total Publications, CTP- Cited Total Publications, RoG-Ratio of Growth, CPP- Citations per paper)

From the above table, it is found that there are 51216 total publications on the research area during the study period 1996-2015. The highest productivity recorded in the year 2015 with 5741 publications and the lowest numbers of publications were recorded in the year 2002 with 1023 publications. The table further reveals that of the 51216 overall publications, 25277 were cited which received 454372 citations with an average of 17.98 citations per paper. There is no uniform growth of literature during the period of study. The figure 1 represents the yearly distribution of Artificial Intelligence research outputs during the study period.

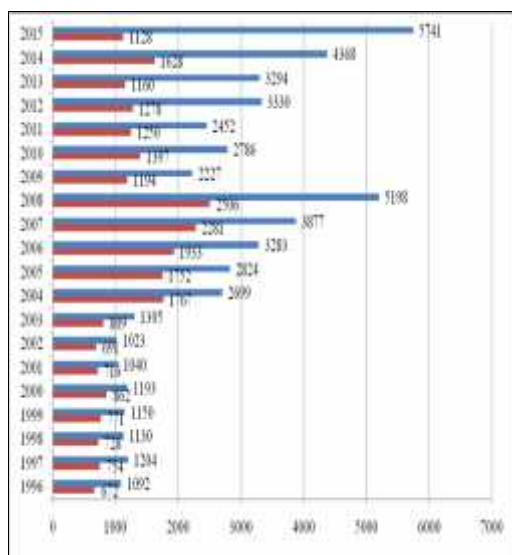


Figure 1: Yearly Distribution of Artificial Intelligence Research Outputs

Table 2: Yearly Distributions Vs Uncited Publications

| Year | TP | Uncited TP | Uncited TP % | Cum | Cum % | RoG |
|--------------|--------------|--------------|---------------|-------|-------|------|
| 1996 | 1092 | 420 | 1.6 | 420 | 1.6 | - |
| 1997 | 1204 | 450 | 1.7 | 870 | 3.4 | 1.07 |
| 1998 | 1130 | 402 | 1.5 | 1272 | 4.9 | 0.89 |
| 1999 | 1150 | 379 | 1.5 | 1651 | 6.4 | 0.94 |
| 2000 | 1193 | 331 | 1.3 | 1982 | 7.6 | 0.87 |
| 2001 | 1040 | 324 | 1.2 | 2306 | 8.9 | 0.98 |
| 2002 | 1023 | 332 | 1.3 | 2638 | 10.2 | 1.02 |
| 2003 | 1305 | 496 | 1.9 | 3134 | 12.1 | 1.49 |
| 2004 | 2699 | 932 | 3.6 | 4066 | 15.7 | 1.88 |
| 2005 | 2824 | 1072 | 4.1 | 5138 | 19.8 | 1.15 |
| 2006 | 3283 | 1350 | 5.2 | 6488 | 25.0 | 1.26 |
| 2007 | 3877 | 1596 | 6.2 | 8084 | 31.2 | 1.18 |
| 2008 | 5198 | 2692 | 10.4 | 10776 | 41.5 | 1.69 |
| 2009 | 2227 | 1033 | 4.0 | 11809 | 45.5 | 0.38 |
| 2010 | 2786 | 1389 | 5.4 | 13198 | 50.9 | 1.34 |
| 2011 | 2452 | 1202 | 4.6 | 14400 | 55.5 | 0.87 |
| 2012 | 3330 | 2052 | 7.9 | 16452 | 63.4 | 1.71 |
| 2013 | 3294 | 2134 | 8.2 | 18586 | 71.7 | 1.04 |
| 2014 | 4368 | 2740 | 10.6 | 21326 | 82.2 | 1.28 |
| 2015 | 5741 | 4613 | 17.8 | 25939 | 100.0 | 1.68 |
| Total | 51216 | 25939 | 100.00 | | | |

(TP- Total Publications, UCTP- Uncited Total Publications, RoG-Ratio of Growth)

The above table reveals that during the study period, 25939 (50.65%) publications are yet to receive its citations. The table further reveals that there was

more number of uncited publications in the second half of the study period when compares to research productivity in the first half. The ratio of growth of uncited publications lies between 0.38 and 1.88. The Ratio of Growth (RoG) of the uncited publications recorded its peak in the year 2004 and it is found to be low in the year 2009.

Table 3: Cited & Uncited Publications Vs Countries

| Country | TP | CTP | CTP% | UCTP | UCTP% | Ratio |
|---------|--------------|--------------|-------|--------------|-------|-------|
| USA | 10172 | 5417 | 53.25 | 4755 | 46.75 | 0.88 |
| China | 8947 | 3591 | 40.14 | 5356 | 59.86 | 1.49 |
| UK | 2580 | 1619 | 62.75 | 961 | 37.25 | 0.59 |
| India | 2569 | 767 | 29.86 | 1802 | 70.14 | 2.35 |
| Japan | 1614 | 843 | 52.23 | 771 | 47.77 | 0.91 |
| Canada | 1711 | 994 | 58.09 | 717 | 41.91 | 0.72 |
| Germany | 1479 | 822 | 55.58 | 657 | 44.42 | 0.80 |
| Spain | 1655 | 957 | 57.82 | 698 | 42.18 | 0.73 |
| Italy | 1357 | 836 | 61.61 | 521 | 38.39 | 0.62 |
| France | 1169 | 683 | 58.43 | 486 | 41.57 | 0.71 |
| Others | 17963 | 8748 | 48.70 | 9215 | 51.30 | 1.05 |
| | 51216 | 25277 | | 25939 | | |

(TP- Total Publication, CTP - Citation Total Publication, UCTP - Uncited Total Publication)

The above table shows the top ten contributed Countries to the “Artificial Intelligence” literature during the study period. The United States of America contributed the maximum number of research outputs with 10712 publications followed by China with 8947 and United Kingdom with 2580 publications. India ranked fourth with 2569 publications. Among the highly contributing Nations productivity, more number of cited publications were reported from United Kingdom, Italy and France. Out of their individual total publications, United Kingdom’s 62.75% contributions have attracted citations followed by Italy’s 61.61% and France’s 58.43% of its total publications have attracted citations. The study also reveals that India’s 70.14% and China’s 59.86% contributions have yet to receive its citations. The Uncited/cited ratio is ranged between 0.59 and 1.49 among the highly contributed nations during the study period.

Table 4: Cited & Uncited Publications Vs Bibliographic Forms

| Bibliographical forms | TP | CTP | CTP % | UCTP | UCTP % | Ratio |
|-----------------------|-------|-------|-------|-------|--------|-------|
| Conference Paper | 29743 | 9957 | 33.48 | 19786 | 66.52 | 1.99 |
| Article | 19595 | 14532 | 74.16 | 5063 | 25.84 | 0.35 |
| Conference Review | 509 | 7 | 1.38 | 502 | 98.62 | 71.71 |
| Review | 830 | 603 | 72.65 | 227 | 27.35 | 0.38 |
| Editorial | 193 | 72 | 37.31 | 121 | 62.69 | 1.68 |
| Book | 54 | 18 | 33.33 | 36 | 66.67 | 2.00 |
| Book Chapter | 128 | 26 | 20.31 | 102 | 79.69 | 3.92 |
| Report | 5 | 1 | 20.00 | 4 | 80.00 | 4.00 |
| Short Survey | 56 | 13 | 23.21 | 43 | 76.79 | 3.31 |
| Note | 46 | 14 | 30.43 | 32 | 69.57 | 2.29 |
| Letter | 22 | 15 | 68.18 | 7 | 31.82 | 0.47 |
| Others | 35 | 19 | 54.29 | 16 | 45.71 | 0.84 |

Publications, UCTP – Uncited Total Publications)
 The above table shows that 29743 (58.07%) of the total productivity has been published in Conferences followed by articles (38.20%) and reviews (1.62%). Nearly one third (33.48%) of the total research outputs published in Conferences has got citations and the remaining two third (66.52%) of the total publications were yet to be cited. Whereas three fourth (74.16%) of the research outputs published in the form of Articles in journals received citations and the remaining 25.84% of them have to be cited. The alarming note is that only 7 (1.38%) out of the total 509 research outputs published in the form of Conference reviews have got citations so far. The Uncited/Cited ratio ranged between 0.35 and a 71.71%. The figure 2 represents the share of cited and uncited publications on Artificial Intelligence research outputs during the study period.

Table 5: Top Ten Highly Cited Publications

| Year | Authors | Title | Source | Citations | Document Type |
|------|--|--|--|-----------|------------------|
| 1999 | Mitola III J., Maguire Jr. G.Q. | Cognitive radio: making software radios more personal | IEEE Personal Communications | 4100 | Article |
| 2005 | Mikolajczyk K., Schmid C. | A performance evaluation of local descriptors | IEEE Transactions on Pattern Analysis and Machine Intelligence | 3145 | Article |
| 2001 | Kschischang F.R., Frey B.J., Loeliger H.-A. | Factor graphs and the sum-product algorithm | IEEE Transactions on Information Theory | 2645 | Article |
| 2005 | Do M.N., Vetterli M. | The contour let transform: An efficient directional multiresolution image representation | IEEE Transactions on Image Processing | 1951 | Article |
| 2005 | Peng H., Long F., Ding C. | Feature selection based on mutual information: Criteria of Max-Dependency, Max-Relevance, and Min-Redundancy | IEEE Transactions on Pattern Analysis and Machine Intelligence | 1946 | Article |
| 2005 | He X., et al., | Face recognition using Laplacianfaces | IEEE Transactions on Pattern Analysis and Machine Intelligence | 1740 | Article |
| 2004 | Yang J., Zhang D., Frangi A.F., Yang J.-Y. | Two-Dimensional PCA: A New Approach to Appearance-Based Face Representation and Recognition | IEEE Transactions on Pattern Analysis and Machine Intelligence | 1647 | Article |
| 2002 | Chawla N.V., Bowyer K.W., Hall L.O., Kegelmeyer W.P. | SMOTE: Synthetic minority over-sampling technique | Journal of Artificial Intelligence Research | 1635 | Article |
| 2006 | Ahonen T., Hadid A., Pietikainen M. | Face description with local binary patterns: Application to face recognition | IEEE Transactions on Pattern Analysis and Machine Intelligence | 1530 | Article |
| 2001 | Eberhart R.C., Shi Y. | Particle swarm optimization: Developments, applications and resources | Proc. of the IEEE Conference on Evolutionary Computation, ICEC | 1504 | Conference Paper |

The above table shows the top ten highly cited research outputs on “Artificial Intelligence” literature during the study period. An article on “Cognitive radio: making software radios more personal” authored by Mitola III J. and Maguire Jr. G.Q. published in the year 1999 in IEEE Personal Communications has received a maximum of 4100 citations.

FINDINGS

- There are 51216 publications on the research area during the study period 1996-2015.
- There is no steady growth of literature during the study period.
- Out of the total publications, 25277 were cited and received 454372 citations with an average of 17.98 citations per paper.
- There are 25939 (50.65%) publications have yet to receive its citations. The ratio of growth of uncited publications lies between 0.38 and 1.88.
- The United States of America contributed the maximum number of research outputs with 10712 publications during the study period.
- India ranked fourth with 2569 publications.
- United Kingdom's 62.75% of the total contributions have attracted citations
- India's 70.14% and China's 59.86% contributions have yet to receive its citations.
- The researchers in this field highly preferred Conference Papers ahead of articles to publish their productivity. But nearly one third of the research outputs published in the form of Conference Paper got citations and the remaining have yet to get its citations. Whereas three fourth of the research output published in the form of Articles got citations.

CONCLUSION

There is no steady growth of literature on “Artificial Intelligence” during the period of study even though there was fivefold increase in the productivity of the literature from the beginning of the study period to its end. The research outputs published in the first half of the study period attracts citations than the one published in the second half. Nearly 20% of the total publications reported during the study period were contributed by United States of America. But only

53.25% of its contributions got citations so far and the remaining publications are yet to attract citations. Even though India ranked fourth in terms of productivity, a major share of 70.14% of its publications is yet to attract citations. The researchers in this field preferred Conference Papers ahead of Articles to publish their research productivity but only one third of Conference papers attracted citations whereas three fourth of the published literature in the form of Articles attracted Citations. It is suggested that the researchers in this field have to publish their research productivity in the form of articles to attract more citations than preferring to publish as Conference papers since the approach of the researchers

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