Soft Computing: A Bibliometric Analysis on Research Outputs during 2005 – 2014

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Abstract

This study presents the bibliometric analysis of literature on Soft Computing during the period 2005 – 2014. The data for the study has been downloaded from the Scopus database. The study analyses and discusses on the yearly productivity of literature, authorship pattern, citation pattern, major contributors, countries contributing to the literature, most preferred document of publications, Institution wise distribution, etc. There are 9919 publications during the study period. Single authored contribution is 15% of the total publications and multi authored contributions occupy a major share in the publications. There are 3791 cited publications which yielded 26392 citations and 6158 publications are not cited even once.

Keywords

Bibliometrics; Soft Computing; Authorship Pattern; Citation Pattern; Relative Quality Index; Scopus Database.

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INTRODUCTION

Soft Computing[1] is an emerging approach to computing which parallel the remarkable ability of the of the human mind to reason learn in a environment of uncertainty and imprecision. Some of its principle components includes: Neural Network (NN), Fuzzy Logic (FL), Generic Algorithm (GA) and these methodologies form the core of soft computing. Its aims to exploit the tolerance for approximation, Uncertainty, Imprecision, and Partial Truth in order to achieve close resemblance with human like decision making. The main goal of soft computing is to develop intelligent machines to provide solutions to real world problems, which are not modeled or too difficult to model mathematically. Some of the applications of soft computing are consumer appliances like Air-Conditioner, Refrigerators, Heaters, Washing machine, Robotics like emotional pet robots, Food preparation appliances like Rice cookers and Microwave ovens. Future scope of the soft computing are it can be extended to include bio-informatics aspects, Fuzzy System can applied to the construction of more advanced intelligent industrial systems. Soft Computing is very effective when it is applied to real world problems that are not able to solve by traditional hard computing. Soft Computing enables industrial to be innovative with it characteristics like traceability, low cost and high machine intelligent quotient.

METHODOLOGY

The data has been downloaded from the Scopus database. This study covers a period of ten years from 2005 to 2014. The following search string is used to download the data from the database.

(TITLE-ABS-KEY("soft computing") AND PUBYEAR > 2004 AND PUBYEAR < 2015)

Bibliometric Indicators like authorship pattern, citation pattern were analyzed in the study. For analysis and making tables SPSS and Excel software has been used for the study.

RELATED EARLIER LITERATURE

A. G. Lopez-Herrera, M. J. Cobo, E. Herrera-Viedma and F. Herreara (2010), in this paper they studied the interconnections between the Fuzzy Logic Theory filed and other Soft Computing field techniques. Bibliometric Maps were used to show the

associations between the main concepts in these research fields are provided for the period 1990-1999, 200-2003, 2004-2007. The maps provided the insight the structure of these fields. They visualize the division of the filed into several subfields and they indicated the relations between these subfields. Co-ward analysis was used in the study. These maps used to forecast the emerging trends for hybrid intelligent systems. M. Gunasekaran and R. Balasubramani (2012) has analyzed in their study the Artificial Intelligence Research output carried out during the year 1973-2011. The used the different parameters including authorship pattern, growth, rank with global publication, Institutions contribution, most productivity journals were analyzed. M. Surulinathi, R. Balasubramani and Kalisdha (2013) have studied the continent wise analysis of Green Computing Research. In their study the analyzed the growth and development of Green Computing research outputs during the period 1956-2011. They downloaded the data from the Web of Science Database. In their study they found that in the European continent, Germany has produced the maximum number of publications with 270 (16.24%) articles followed by France and Italy. In the case of North American continent, USA has contributed (33.36%) of the 1317 total contributions and occupies the top position in the rankings followed Canada and Mexico. Suresh Kumar (2013) studied the research output of India in human computer interaction (HCI) research during the period 1987-2011. He several parameters including total research output, its growth, rank and global publication share, citation impact. The paper also analyses the characteristics of most productive institutions, authors and high-cited papers. It is found that India is at 16 th position in the world in HCI research publications with 2656 papers by 3691 Indian authors from 693 institutions of India. The Transformative activity index suggests that India's research activity in the field of HCI is improved greatly in the last 5 years. Although highest number papers are contributed by Indian Statistical Institute, about half of publications are contributed by engineering colleges. All the papers published by Indian researchers have appeared in journals with impact factors between 0.090 and 5.211 with an average impact factor of 1.455. Indian authors preferred to publish in journals originated from United Kingdom, the Netherlands, USA and Germany. Citation analysis for Indian publications gives 9.8 citations/paper.

Rosy Jan, Wasim Rashid Wani and Obaid Hafiz (2015) have studied the growth pattern of Cloud Computing literature during the period 2009-2013 using the Web of Science database. They found that the cumulative publications on the output of top ten countries and India in the field accounts to 1879 publications. They calculated the total number of citations and analyzed the high quality papers. The study further includes the growth of publications through Relative Growth Rate (RGR) and Doubling Time (Dt). They also measure Authorship Pattern by different Collaborative parameters like Collaborative Index (CI) and Modified Collaboration Coefficient (MCC).

OBJECTIVES

1. To find out the yearly publications of the literature during the period 2005 - 2014
2. To study the country wise research output of the literature
3. To analyze the Authorship Pattern of the publications
4. To study the Citation Pattern on publications including Relative Quality Index (RQI)
5. To Track the uncited publications on the literature output
6. To find the most preferable form of publications

DISCUSSIONS AND INTERPRETATIONS

The yearly distribution of research outputs on Soft Computing has been given below.

Table 1: Yearly Distribution of Research Outputs on Soft Computing

S.No	Year	Number of Publications	Percentage	Cumulative Percentage
1	2005	371	3.74	3.74
2	2006	335	3.38	7.12
3	2007	429	4.33	11.45
4	2008	762	7.68	19.13
5	2009	959	9.67	28.80
6	2010	1590	16.03	44.83
7	2011	838	8.45	53.28
8	2012	1743	17.57	70.85
9	2013	1108	11.17	82.02
10	2014	1784	17.98	100.00
	Total	**9919**	**100.00**	

From the above table it is observed that during the study period, the highest numbers of publications

were made in the year 2014 with 1784 articles followed by 1743 articles in the year 2012 and 1590 articles in the year 2010. The least numbers of publications were made in the year 2006 in the year with 335 articles. It is pointed out that even though the number of publications has increased to five fold between the year 2005 and 2014, there is no uniformity in the publication trend.

Country wise publications on Soft Computing

The country wise distribution of research outputs on Soft Computing has been given below

Table 2: Top 15 Most productive Countries on Soft Computing Literature

S.No.	Country	Number of Publications
1	India	1552
2	Japan	1170
3	China	1000
4	Poland	762
5	Spain	753
6	United States	637
7	Iran	431
8	Malaysia	340
9	Taiwan	339
10	United Kingdom	292
11	Italy	286
12	South Korea	266
13	Czech Republic	248
14	Turkey	231
15	Canada	213
16	OTHERS	1399

The above tables shows that India has contributed more number of research outputs with 1552 (15.65%) publications in the area of study followed by Japan with 1170 (11.80%) and China with 1000 (10.08%) publications. This shows that more number of research activities in the area of study is taking place in the Asian region.

Authorship Pattern

The authorship pattern in the area of study has been given in the following table**:**

Table 3:Authorship Pattern on Soft Computing Research Outputs

Authors	Total Publications	Percentage	Cumulative Percentage
Single Author	1488	15.00	15.00
Two Authors	3031	30.56	45.56
Three Authors	2736	27.58	73.14
Four Authors	1564	15.77	88.91
Five Authors	652	6.57	95.48
Six Authors	286	2.89	98.37
Seven & More Authors	162	1.63	100.00
Total	**9919**	**100.00**	

It is interpreted from the above table 3 that highest numbers of 3031 (30.56%) publications were made by two authors followed by three authors with 2736 (27.58%) publications and four authors with 1564 (15.77%) publications. It is further interpreted that Single authored publications contribute 1488 (15%) of the total publications. Since 85% of the total publications were made by two and more authors it seems that collaborated research works takes place in the field of study rather than individual research work.

Citation Pattern:

The Citation pattern in the area of study has been given in the following table**:**

Table 4. Citation Pattern on Soft Computing Research Outputs

Year	Total Publications	Cited Publication	Total Citation	Citation %	CPP	RQI
2005	371	182	2438	9.24	6.57	2.4697
2006	335	168	2200	8.34	6.57	2.4681
2007	429	230	3585	13.58	8.36	3.1442
2008	762	409	3928	14.88	5.15	1.9378
2009	959	472	3534	13.39	3.69	1.3861
2010	1590	548	2735	10.36	1.72	0.6464

2011	838	392	2703	10.24	3.23	1.2122
2012	1743	597	2604	9.87	1.49	0.5616
2013	1108	462	1856	7.03	1.68	0.6295
2014	1784	301	809	3.07	0.45	0.1704
Total	**9919**	**3761**	**26392**	**100.00**		

(CPP – Citation per Paper; RQI – Relative Quality Indicator)

From the above table it is observed that 3761(37.92%) out of the 9919 total publications are cited and the total citations received for the cited publications is 26392. Even though the citation trend shows some increasing trend in the middle of the study period when it compares to its beginning, it shows decreasing trend for the past 8 years. The Citation per Paper (CPP) shows some fluctuations in its trend during the study period. It is high in the year 2007 with 8.36 citations to 0.45 citations in the year 2014. The Relative Quality Indicator (RQI) is the ratio of the proportion of the total citations of the year to total citations and to the proportion of the total publications of the year to the total publications. The measure relates to the incidence of high quality papers for a Country or an Institution, a value of RQI > 1 indicates higher than average value, whereas a value of RQI < 1 indicates lower than average quality. From the above table it is observed that the research output between the year 2005 to 2009 and 2011 higher than the average value and 2012 to 2014 and for the year 2010 shows lower than the average value. It shows that the publications of high quality papers are declining in the field of study during recent times
.

Table 5. Cited versus Uncited Publications on Research outputs on Soft Computing

Year	Total Publications	Cited Publication	Percentage %	UnCited Publication	Percentage %
2005	371	182	49.06	189	50.94
2006	335	168	50.15	167	49.85
2007	429	230	53.61	199	46.39
2008	762	409	53.67	353	46.33
2009	959	472	49.22	487	50.78
2010	1590	548	34.47	1042	65.53
2011	838	392	46.78	446	53.22
2012	1743	597	34.25	1146	65.75
2013	1108	462	41.70	646	58.30
2014	1784	301	16.87	1483	83.13
Total	**9919**	**3761**	**37.92**	**6158**	**62.08**

From the above table it is observed that the 6158 (62.08%) publications out of the total 9919 publications are not cited even once. It is further interpreted that during the study period of ten years, more than half of the research productivity are cited only in the following three years 2006, 2007 and 2008. The quantum of uncited publications is ranged between 46.33% and 83.13% and for the last six years, the uncited publications are in increasing trend, which shows that quality work on the specified area is the need of the hour and efforts have to be taken for the published literature to reach the unreached peers in the area of study.

Table 6: Soft Computing Research outputs on Different Document Types

Type of Document	Number of Publications	Percentage
Conference Paper	7253	73.12
Article	2130	21.47
Editorial	138	1.39
Conference Review	129	1.30
Review	108	1.09
Book Chapter	78	0.79
Others	83	0.84

Total	**9919**	**100.00**

From Table 5 shows that Conference Proceedings has been preferred as the most preferable form of publication on the research output in the area of study with 7253 (73.12%) publications followed by Article with 2130 (21.47%) publications.

FINDINGS

- There are 9919 publications during the study period 2005 to 2014. The highest number of productivity is in the year 2014 with 1784 publications and the lowest being in the year 2005 with 371 publications. The publications trend shows fluctuations during the study period.
- It is found that single authored work contributes 1488 (15%) publications and two authored work contributed 3031 (30.56%) publications. Multi authored work contributes 85% of the productivity shows that collaborative research work takes place in the field of study.
- From the study it is found that 3791 (37.92%) of the total publications has been cited and yielded 26392 citations during the study period. The number of citations received by research outputs and the below average value of Relative Quality Index (RQI) in the recent times shows that there is a decrease in high quality publications in the area of study.
- There are 6158 (62.08%) publications are not cited even once during the study period. More than half of the yearly publications have gone uncited in seven out of the ten years of the study period.
- Conference Papers are the most preferable form of publications in the field which produced 6158 (62.08%) of the total publications.

CONCLUSION

It is evident that even though there are some fluctuations in the publication trend considerable number of research output has been produced in recent year shows that there is some scope of increase in trend in near future. The contribution to this literature from the western countries is comparatively low when its compares with Asian contribution. More number of research output in this area has been published in Conference Proceedings which reaches only to minimum number of peers in the area of study when it compares to Journal articles is one of the main reasons for low citations score to the research outputs and maximum number of publications went uncited. It is suggested that necessary action has to be taken to bring Conference Papers also in consortia like journals to pave way for the Institutions in economically weaker countries and self supporting Institutions to subscribe it, which in turn will reach more number of researchers across the world. It is a welcoming fact that India has contributed the highest number of publication in this area and it is mainly because of the higher educational Institutions in the country which produces around 17 lakhs of engineers and technologists every year and most of them are employed in Information Technology and its related sector and these human resources are working tirelessly for the advancement of the technology.

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