

A CITATION ANALYSIS OF FUZZY RESEARCH BY UNIVERSITY AND COUNTRY

Victor G. Alfaro-García ^{a,*}, José M. Merigó ^{b,c}, Gerardo G. Alfaro Calderón ^a, Leobardo Plata-Pérez ^d, Anna M. Gil-Lafuente ^e, Enrique Herrera-Viedma ^f

^a *Facultad de Contaduría y Ciencias Administrativas, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, México.*

^b *Departamento de Control de Gestión y Sistemas de Información, Universidad de Chile, Santiago, Chile.*

^c *School of Systems, Management, and Leadership, Faculty of Engineering and Information Technology, University of Technology Sydney, Ultimo 2007, NSW, Australia.*

^d *Facultad de Economía, Universidad Autónoma de San Luis Potosí, San Luis Potosí, México.*

^e *Facultat d'Economia i Empresa, Universitat de Barcelona, Barcelona, Spain.*

^f *Department of Computer Science and Artificial Intelligence, University of Granada, Granada, Spain.*

Abstract. This paper presents the results of a citation analysis focusing on the universities and countries represented by publications in 22 highly oriented fuzzy research journals using bibliometric techniques. Bibliometric studies have recently gained significant relevance, and this fact is mainly due to the flexibility and dynamism that new information technologies provide. In our case, the structured gathered materials are thoroughly refined and offer a wide view of the influence that the selected journals have on territories and institutions around the globe. The results show the clear influence of countries located in the Asian continent and the high impact of institutions in Spain, the United States of America and China. This study sheds light on the visualization of the citation scope of these highly oriented fuzzy research journals with the aim of finding possible common ground for synergy and collaboration.

Keywords: bibliometry, fuzzy research, citation analyses, universities, countries.

1. Introduction

Fifty-three years ago the first publication on fuzzy research appeared; the pivotal paper, “Fuzzy Sets” was issued in the scientific Journal *Information and Control* authored by Lofti A. Zadeh in 1965 [1], and it opened the path for a novel perspective in several fields of science including artificial intelligence, computer science, medicine, control engineering, decision theory, expert systems, logic, management science, operations research, pattern recognition, and robotics, among others [2,3]. Much of the popularity of fuzzy sets theory relies on the intuitive approach that allows the assessment of subjective, ambiguous, unclear or non-well-defined problems. This characteristic feature

allows scientists to generate new insights into phenomena that cannot be well represented using traditional methods.

Currently, numerous journals focusing on fuzzy research exist, and they assemble the scientific products of authors from all over the world. Sponsored by the North American Fuzzy Information Processing Society (NAFIPS), the first journal to consolidate fuzzy research theories and applications was *Fuzzy Sets and Systems* (FSS) in 1978, which is now based in the Netherlands. However, this is not the oldest journal to develop as a reference for fuzzy research, as the *Journal Information Sciences* (IS) from the USA issued its first publication in 1968, *Cybernetics and Systems* (C&S) in 1971, *Kybernetes* (Kyb) in 1972 and the *International Journal of General Systems* (IJGS) in 1974.

According to the Thomson Reuters Web of Science Database (WoS), approximately 300 articles concerning fuzzy issues were published in the 1970s.

Fuzzy set theory continued to gain relevance in the academic community, and in the late 1980s, other journals appeared that were also highly influenced by fuzzy research, for example, the International Journal of Intelligent Systems launched its first issue in 1986, Knowledge-Based Systems (KBS) and the International Journal of Approximate Reasoning in 1987 and Expert Systems with Applications (ESA) in 1990.

By the early 1990s, the publication of articles had grown approximately 450% since the 1970s. It was evident that the concept of fuzzy research was gaining popularity, as had the need for specialized journals. In 1993, three specialized journals on fuzzy research appeared: the IEEE Transactions on Fuzzy Systems (IEEE TFS), the Journal of Intelligent & Fuzzy Systems (JIFS) and the International Journal of Uncertainty Fuzziness and Knowledge-Based Systems (IJUFKS). It is worth noting that the academic community in Europe and especially in Asia were favorably accepting this theory. Furthermore, in this decade, the concept of soft computing received much attention, and by the end of the 1990s, four other fuzzy-oriented relevant journals launched their first issues: Intelligent Automation and Soft Computing (IASC) in 1995, Soft Computing (SC) in 1997 and the International Journal of Fuzzy Systems (IJFS) in 1998. By the end of the decade, approximately 11,500 papers had been published.

The consolidation of the fuzzy research field became evident in this century; from 2010 to 2017, approximately 81,000 papers relevant to fuzzy research were published. Some examples of journals with a strong relevance to fuzzy research that launched their first issues in the year 2000 or later include the following: Information Fusion (IF) in 2000; Applied Soft Computing (ASC) in 2001; the International Journal of Information Technology & Decision Making (IJITDM) in 2002; Fuzzy Optimization and Decision Making (FODM) in 2002; the Journal of Multiple-Valued Logic and Soft Computing (JMVLS) in 2003; and the Iranian Journal of Fuzzy Systems (IrJFS); and the International Journal of Computational Intelligence Systems (IJCIS), in 2008.

Bibliometrics is the area of science that utilizes quantitative methods to review the scientific communication process, analyzing and measuring several aspects of written documents to monitor the extent of the literature and the trends and patterns that arise within a certain domain.[4] One of the first attempts to formalize this term and to define the path from statistical

bibliography to a consolidated field was made by Pritchard[5]; in this paper, bibliometrics is defined as *the application of mathematics and statistical methods to books and other media of communication*.

Recently, academics from a plethora of areas have utilized these methods to analyze the evolution of selected fields; according to the WoS, through the end of 2017, approximately 7,900 bibliometric studies have been published, and approximately 3,500 of those fall into the scope of information and computer science. Some of the most relevant bibliometric studies on fuzzy research include the following: Van Eck and Waltman [6] with an overall mapping of the computational intelligence field; Cobo et al. [7] with a bibliometric study on the scope of fuzzy set theory; and more specifically, Merigó et al. [8], with a general overview of fuzzy research; Blanco-Mesa et al. [9], with a study focused on fuzzy decision making; and Cabrerizo et al. [10], with a study on fuzzy consensus. Some interesting bibliometric studies that are now gaining popularity such as Ref. [11], which analyzes the trends across specific fuzzy-oriented journals including Information Sciences [12,13], the International Journal of Intelligent Systems [14], IEEE Transactions on Fuzzy Systems [15], the International Journal of Fuzzy Systems [16], Computers & Industrial Engineering [17] and the European Journal of Operational Research [18].

The increasing influence of fuzzy research demands an analysis that sheds light on the rapid evolution of the proposed concept, techniques and models. The objective of the present paper is to generate a citation analysis (see Ref. [19]) using bibliometric techniques on twenty-two highly cited fuzzy research journals. The aim is to advance knowledge of the trends that connect the selected journals by focusing on the most cited universities and countries that shape the broad fuzzy research scope, and with that visualize the trends that link academics and regions.

The remainder of this paper is as follows. Section 2 presents the methodology that guides our study. Section 3 presents the results obtained for each of the selected journals. Section 4 offers a summary of the results obtained. Finally, section 5 presents the concluding comments.

2. Methods

Bibliometrics is a useful tool for presenting an overview of a field of knowledge; however, it requires standard and traceable methods to ensure the validity

and fidelity of the presented data. [8] To ensure a neutral, broad and quality collection of the data, this paper retrieves information from the Core Collection of the WoS. The WoS includes several databases, such as the science citation index (SCI), the social sciences citation index (SSCI), and the arts and humanities citation index (A&HCI), among others. Overall, the WoS database comprises articles from over 20,000 scientific journals and a pool of 1.4 billion cited references tracing back to the year 1900. Because the WoS Core Collection is the largest citation database available in the

market, we have focused the research on this source rather than other databases such as Scopus or Google Scholar.

This paper focuses on 22 highly fuzzy-oriented scientific journals; see Table 1 for the specificities of the selected journals. These journals were chosen following the studies [8,9], according to diverse metrics such as the fuzzy h-index and the percentages of fuzzy papers published in the journals; therefore, we believe that these are some of the most representative journals in the field.

Table 1
Selected Fuzzy-oriented Journals

R	J	Y	C	TC	TP	TPC	H	IF	5YIF	MCP	>500	>250	>100	>50	<=50
1	ESA	1991	USA	207,128	11,023	75,178	147	3.768	3.711	598	1	19	200	676	10,127
2	FSS	1980	NLD	204,834	7,385	51,757	170	2.675	2.646	3,661	15	71	303	567	6,422
3	IS	1968	USA	176,107	8,433	67,052	139	4.305	4.378	6,515	14	38	177	514	7,684
4	IEEETFS	1994	USA	112,773	2,125	31,348	155	8.415	9.340	1,623	17	40	224	345	1,493
5	ASC	2004	NLD	64,819	4,246	31,082	88	3.907	4.004	1,428	1	3	58	181	4,002
6	KBS	1991	NLD	44,052	3,076	19,497	75	4.396	4.514	564	1	3	40	132	2,900
7	IJAR	1993	USA	29,110	1,592	12,782	73	1.766	2.504	494	0	8	29	105	1,450
8	IJIS	1987	USA	23,541	1,625	11,011	66	3.363	3.137	816	3	5	25	63	1,529
9	SC	2002	USA	22,109	2,638	11,521	54	2.367	2.204	547	1	3	12	44	2,578
10	IJUFKS	1995	SGP	15,482	1,152	8,128	50	1.159	1.377	2,193	1	2	19	26	1,103
11	IJGS	1974	GBR	15,145	1,277	8,387	53	2.931	2.531	1,117	2	1	18	35	1,220
12	IFs	2006	NLD	11,930	550	5,552	55	6.639	6.574	457	0	3	17	42	488
13	JIFS	1995	NLD	11,295	3,146	6,040	36	1.426	1.594	273	0	1	4	17	3,124
14	KYB	1977	GBR	8,898	2,776	4,859	30	0.980	0.799	346	0	1	2	8	2,765
15	C&S	1980	USA	7,121	1,298	4,155	31	1.197	1.085	372	0	1	6	9	1,282
16	IJITDM	2004	SGP	5,768	661	2,921	30	1.755	1.670	290	0	1	6	4	650
17	IJCIS	2008	FRA	4,556	860	2,828	30	2.000	1.246	158	0	0	2	8	850
18	IJFS	2007	TWN	3,799	640	2,094	26	2.396	2.227	108	0	0	1	4	635
19	FODM	2007	USA	3,755	256	2,209	28	2.022	3.076	278	0	1	5	7	243
20	JMVLSC	2004	USA	2,101	610	1,327	16	0.437	0.464	552	1	0	0	0	609
21	IASC	1998	USA	1,879	910	1,157	16	0.652	0.561	131	0	0	2	0	908
22	IrJFS	2007	IRN	1,652	476	1,066	16	1.270	0.978	71	0	0	0	1	475

Abbreviations: R, rank; J, journal; Y, first year available in WoS database; C, country; TC, total citations; TP, total publications; TPC, total publications citing; H, journal h-index; IF, 2017 impact factor; 5YIF, 2017 5-year impact factor; MCP, number of citations of the most cited paper; >500, >250, >100, >50 total number of papers with more than 500, 250, 100, 50 citations; <=50, total number of papers with fewer than 50 citations; ESA, Expert Systems with Applications; FSS, Fuzzy Sets Systems; IS, Information Sciences; IEEE TFS, IEEE Transactions in Fuzzy Systems; ASC, Applied Soft Computing; KBS, Knowledge-Based Systems; IJAR, International Journal of Approximate Reasoning; IJIS, International Journal of Intelligent Systems; SC, Soft Computing; IJUFKS, International Journal of Uncertainty Fuzziness and Knowledge-Based Systems; IJGS, International Journal of General Systems; IFs, Information Fusion; JIFS, Journal of Intelligent & Fuzzy Systems; Kyb, Kybernetes; C&S, Cybernetics and Systems; IJITDM, International Journal of Information Technology & Decision Making; IJCIS, International Journal of Computational Intelligence Systems; IJFS, International Journal of Fuzzy Systems; FODM, Fuzzy Optimization and Decision Making; JMVLSC, Journal of Multiple-Valued Logic and Soft Computing; IASC, Intelligent Automation and Soft Computing; IrJFS, Iranian Journal of Fuzzy Systems; USA, United States of America; NLD, Netherlands; SGP, Singapore; GBR, Great Britain; FRA, France; TWN, Taiwan; IRN, Iran.

The search process consists of examining each of the journal titles by publication name in the Core Collection of the WoS. In this article, we focus on the articles published from the beginning of the WoS timespan, from 1900 until 2017; please note that all the articles published in 2017 are included. Next, we filter the results for articles, reviews, letters and notes, and by performing this action, we focus on papers and articles rather than on other sources such as books or book reviews. From this point, we create a citation report and observe the general statistics of the citing articles of the journal, and then, we analyze the results of the selected journals and filter for articles, reviews, letters and notes. Finally, a manual search is performed retrieving the desired information, in this case, countries and universities. The search process is described in Figure 1.

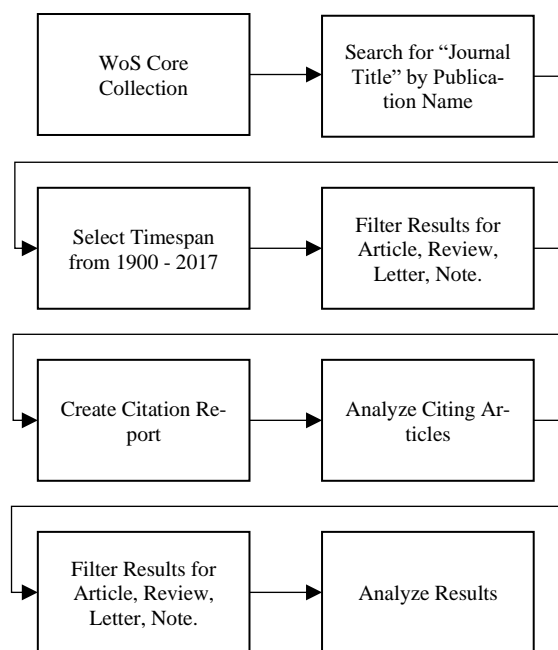


Fig. 1. Proposed Search Process

When assessing the manual search for countries and universities, some other considerations must be taken into account. For the countries' data, an actualization of the geopolitical regions has been performed, e.g., consolidating information from currently nonexistent regions to the actual territories, for instance, the information of the Federal Republic of Germany and the German Democratic Republic have been consolidated into Germany. Similar actions were performed with Yugoslavia, Czechoslovakia, the USSR and Serbia and Montenegro to consolidate the information in the

corresponding territories. Another action taken was the unification of information from bounded countries, e.g., England, Wales, Scotland and North Ireland into the United Kingdom and Hong Kong in China. In the case of universities, to ensure the correct dimension of the participation of each institution, we have omitted information from university systems such as the Islamic Azad University, the Indian Institutes of Technology, and the University of Alabama System, among others.

By March 2018 and closing the timespan of the search for the year 2017 (included), the 22 selected journals compile 977,854 total citations (TC), 56,755 total papers published (TP), and 361,951 total papers citing (TPC) the selected journals. The evolution of the published papers and the papers citing the journals can be observed in Figure 2. It is observable that both the publishing rates and the papers' influence have been increasing exponentially over the years; however, it was not until the year 2004 that the sum of all the journals reached 1,000 publications. Since then, and with a few exceptions, the publication rates have greatly increased each year.

Information Sciences has the most cited article from the 22 selected journals; the publication *Concept of a linguistic variable and its application to approximate reasoning* [20] has a total of 6,515 cites. However, this article consists of 3 parts, and the sum of all the cites for the 3 articles is 11,707. Fuzzy Sets and Systems published the second individually most cited article from the 22 journals; *Intuitionistic fuzzy sets* [21] has a total of 3,661 cites. Following, in the International Journal of Uncertainty Fuzzy and Knowledge-Based Systems, with a total of 2,193 cites, the article *K-anonymity: a model for protecting privacy* [22] is the third individually most cited article from the pool of journals. These 5 articles represent 0.01% of the total papers and the ones that have reached more than 2,000 cites. The general citation structure of the selected journals is presented in Table 2. Note that 7.43% of the published articles have 50 citations or more and the largest number of articles, 92.57%, are below that metric.

Table 2

General Citation Structure of the Selected Journals		
Number of citations	Number of papers	% Papers
≥2000	5	0.01%
≥1000	17	0.03%
≥500	57	0.10%
≥250	201	0.35%
≥100	1,150	2.03%
≥50	2,788	4.91%
<50	52,537	92.57%
Total	56,755	

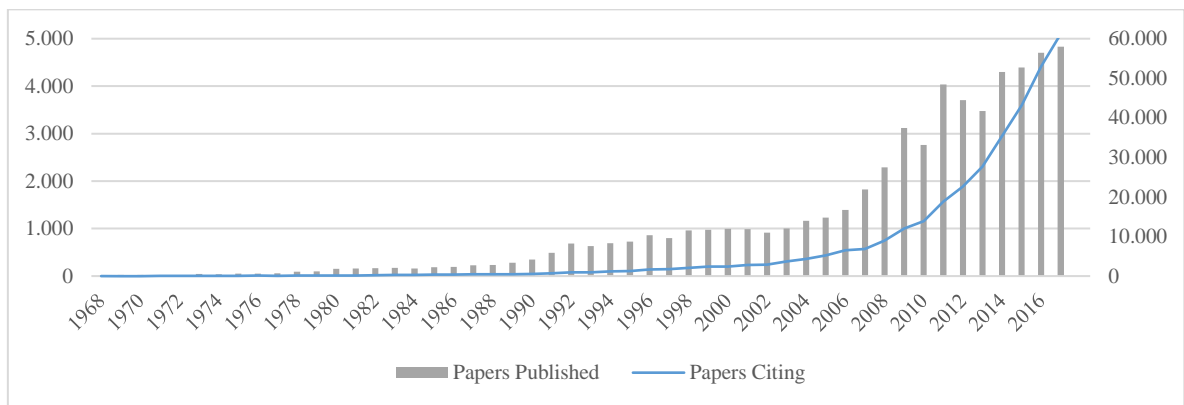


Fig. 2. Evolution of published articles

Along with the citation structure and the most influential papers from the selected journals, another interesting statistic is the h-index [23]. This index retrieves the number of h articles that have gotten at least h citations. This index has acquired much popularity in the scientific community because of several characteristic features that allow a robust measure of the impact of the research [24]. For the selected journals in this study, Fuzzy Sets and Systems displays the largest h-index, 170. This means that at least 170 of the published articles have obtained at least 170 citations or more. This is followed by the IEEE Transactions on Fuzzy Systems with an h-index of 155, Expert Systems with Applications with a score of 147 and Information Sciences with 139. A particularity of this index is aiding in the visualization of the wide scope of the field, in this case clearly led by these four journals. Note that in this case the quantity of articles does not necessarily mean a higher h-index, for example Applied Soft Computing published a total number of 4,246 articles and an h-index of 88; however, IEEE TFS with just half of the published articles displays a h-index of 155, approximately double.

One of the key advantages of utilizing the WoS database is the visualization of the 2017 impact factor (IF) and the 2017 5-year impact factor (5YIF). According to the most recent information available on the impact factor, with an IF of 8.415, the journal IEEE TFS is the most relevant scientific publication from the 22 selected journals. Remarkably, Information Fusion stands in the second position with an IF of 6.639, despite having an h-index of 55 and 457 cites for its MCP. Also note that the IF and the 5YIF proposed by Garfield [25] measures the average number of citations received in a particular year by papers published in a journal f during the two preceding years. Other

journals with a high IF are KBS with 4.396 and Information Sciences with 4.305.

It is worth noting that the total cites (TC), the total papers published (TP), the total papers citing (TPC) and the most cited paper (MCP) have been carefully retrieved applying the filters of articles, reviews, letters and notes. In this way, we try to ensure the quality of the citations recovered. Please note that the ranking of the journals has been established following the TC; however, this ranking should be considered along with the other metrics proposed, thus guaranteeing a holistic perspective of the information presented.

3. Top 30 most citing universities and countries per journal

By performing an in-depth citation analyses of each of the 22 selected journals focusing on universities and countries trends and patterns appear. This information is interesting as it offers the possibility of visualizing the fuzzy academic field and opens the path for collaboration and the establishment of synergies. Tables 3 to 24 compile the individual top 30 results per journal.

Table 3.
ASC (NLD, 2001)

R	University	UT	Country	CT
1	U Tehran	428	P.R. China	10,073
2	Huazhong U Sci Tech	351	India	3,655
3	Amirkabir U Tech	350	Iran	3,577
4	Dalian U Tech	328	USA	2,189
5	U Malaya	328	Taiwan	1,809
6	Iran U Sci Tech	308	Spain	1,690
7	Cent S U	283	Turkey	1,564
8	U Granada	263	UK	1,456
9	U Teknol Malaysia	261	Malaysia	1,177
10	Northeastern U	237	Canada	927
11	Sichuan U	233	Australia	913
12	Hong Kong Polytech U	232	South Korea	699
13	Xidian U	227	Brazil	633
14	Beihang U	221	France	629
15	Nanyang Tech U	218	Italy	619
16	Harbin Inst Tech	216	Mexico	551
17	Natl Taiwan U Sci Tech	213	Saudi Arabia	520
18	Zhejiang U	213	Poland	516
19	Xi An Jiao Tong U	201	Japan	407
20	Shanghai Jiao Tong U	199	Germany	366
21	Chongqing U	198	Greece	358
22	Tongji U	191	Pakistan	356
23	Southeast U	181	Singapore	353
24	City U Hong Kong	179	Egypt	317
25	Wuhan U	179	Algeria	270
26	Sharif U Tech	173	Portugal	265
27	U Alberta	167	Serbia	254
28	Northwestern Polytech U	162	Belgium	213
29	Tianjin U	155	Vietnam	193
30	Hunan U	154	Romania	187

Abbreviations: R, rank; UT, total number of papers from the university citing the journal; CT, total number of papers from the country citing the journal.

It is an observable trend for ASC that of the 10 universities with the largest numbers of papers citing the

journal, 9 are from Asia and 3 are from Iran. The natural results on countries confirm this trend as China, India and Iran are the in the top 3 countries citing the journal. In general, from the 30 top citing institutions of this journal, 27 are from Asia, highlighted by China with 19, America with 2 institutions and Europe with 1. For countries, the leading region is Asia with a total of 12 citations, followed by Europe with 11, America with 4, Africa with 2, and Oceania with 1.

Table 4.
C&S (USA, 1971)

University	UT	Country	CT
Natl Taiwan U Sci Tech	95	P.R. China	780
Wroclaw U Tech	63	USA	677
Nanjing U Sci Tech	62	UK	438
U Newcastle	51	Spain	344
U Alicante	45	Taiwan	304
Gdansk U Tech	44	Poland	186
U Barcelona	42	Iran	183
U Granada	38	India	180
Tsinghua U	36	Germany	174
U Maribor	36	Australia	168
Amirkabir U Tech	32	Canada	149
U St Andrews	30	France	128
Natl Chiao Tung U	29	Turkey	127
Arizona State U	27	Italy	125
Shanghai Jiao Tong U	27	Japan	115
U Basque Country	27	South Korea	104
U Politecn Valencia	26	Austria	55
City U Hong Kong	25	Netherlands	55
Hiroshima U	25	Brazil	54
Bulgarian Acad Sci	23	Malaysia	51
Huazhong U Sci Tech	23	Belgium	47
Polish Acad Sci	23	Israel	46
U Hertfordshire	23	Sweden	44
Yeungnam U	23	Slovenia	43
Istanbul Tech U	22	Switzerland	40
U Hull	22	Czech Republic	39
Chung Yuan Christian U	21	Russia	39
Hong Kong Polytech U	21	Greece	32
U Tehran	21	Portugal	30
U Valencia	21	Hungary	29

C&S has a wider variety of citations, e.g., the second most citing institution is in Poland, the fourth is in the UK and the fifth is in Spain. This is consistent with the top countries citing C&S, as a wider variety of nations in different continents cite this publication. However, the top citing universities are concentrated in Europe, specifically 6 in Spain, 4 in the UK, 3 in Poland and the remainder in Slovenia and Bulgaria. For Asia, the top citing organizations are concentrated in China

with 7, 2 are in Iran, 2 are in Taiwan, 1 is in Japan, 1 is in Turkey and 1 is in South Korea. For countries, the largest number are concentrated in Europe with a total of 17, 9 in Asia, 3 in America and 1 in Oceania.

Table 5
ESA (USA, 1990)

R	University	UT	Country	CT
1	U Tehran	1,045	P.R. China	20,478
2	Hong Kong Polytech U	811	USA	7,410
3	U Malaya	748	Taiwan	6,627
4	Huazhong U Sci Tech	737	Iran	6,424
5	Natl Taiwan U Sci Tech	657	India	5,512
6	Shanghai Jiao Tong U	591	Spain	4,494
7	Natl Cheng Kung U	586	UK	4,159
8	Amirkabir U Tech	574	Turkey	3,899
9	Zhejiang U	568	South Korea	3,171
10	Harbin Inst Tech	562	Canada	2,418
11	City U Hong Kong	549	Australia	2,405
12	Natl Chiao Tung U	538	Malaysia	2,397
13	Iran U Sci Tech	516	Italy	1,824
14	Tsinghua U	514	France	1,664
15	U Granada	504	Brazil	1,615
16	Southeast U	483	Germany	1,315
17	Xi An Jiao Tong U	473	Poland	1,052
18	Beihang U	466	Greece	1,045
19	Northeastern U	453	Mexico	1,022
20	Dalian U Tech	443	Japan	997
21	Nanyang Tech U	436	Saudi Arabia	935
22	Tongji U	431	Singapore	913
23	U Teknol Malaysia	421	Portugal	749
24	Chongqing U	419	Netherlands	729
25	Sichuan U	418	Belgium	728
26	Istanbul Tech U	416	Serbia	640
27	Cent S U	395	Pakistan	590
28	Wuhan U	363	Egypt	524
29	Tianjin U	331	Finland	476
30	Tarbiat Modares U	330	Algeria	433

ESA is the most cited journal in the list, and it is also the journal with the largest number of publications. The University of Tehran in Iran is the top citing institution of ESA, along with Hong Kong Polytechnic University and the University of Malaya in Malaysia, which show a clear path towards Asia as the most influential area of the Journal. Along with these results, apart from the USA as the second top citing country, all the top 5 belong to universities in Asia. This trend is observable as 28 of the top citing universities are located in countries from Asia, e.g., China with a total of 18. From Europe, 1 organization reached the top 30 and 1 from America. However, there are different trends in the regions as the 12 top citing countries are

located in Europe, 11 in Asia, 4 in America, 2 in Africa and 1 in Oceania.

Table 6
FODM (USA, 2002)

University	UT	Country	CT
Sichuan U	112	P.R. China	1,179
U Granada	72	Spain	187
Tsinghua U	70	Iran	145
Cent S U	67	India	142
Southeast U	54	USA	141
Zhejiang U Finance Econ	50	Taiwan	114
Pla U Sci Tech	48	Turkey	83
Beihang U	36	UK	78
Tianjin U	36	Canada	66
Fuzhou U	33	Saudi Arabia	52
Chang Gung U	32	Italy	51
Iona Coll	32	Poland	43
Beijing Inst Tech	30	Australia	40
Jiangxi U Finance Econ	29	Malaysia	40
North China Elect Power U	29	South Korea	29
Hebei U	27	Czech Republic	28
Nanjing U Sci Tech	26	Japan	26
Renmin U China	26	France	25
Shanghai Jiao Tong U	25	Slovakia	23
Shanghai U	25	Brazil	22
Istanbul Tech U	24	Pakistan	22
Tongji U	23	Germany	21
U Jaen	23	Lithuania	18
Nanjing U Informat Sci Tech	21	Belgium	17
U Chinese Acad Sci	21	Serbia	17
De Montfort U	20	Chile	16
U Alberta	20	Vietnam	15
U Barcelona	20	Norway	12
U Manchester	20	Greece	11
Anhui U	19	Romania	11

For the case of the FODM journal, the extent of its influence on Asia is indisputable, but the second top university citing the Journal is from Granada, Spain, and Spain is also the second top citing country. In general, 23 top citing institutions are located in Asia, specifically China with 21. The regions with the largest number of top citing countries are located in Europe with 14, followed by Asia with 11, America with 4 and Oceania with 1.

Table 7
FSS (NLD, 1978)

R	University	UT	Country	CT
1	U Granada	764	P.R. China	13,486
2	Polish Acad Sci	577	USA	5,079
3	U Alberta	535	Taiwan	4,583
4	Northeastern U	532	Iran	3,719
5	U Tehran	488	Spain	3,536
6	Harbin Inst Tech	470	India	3,352
7	Sichuan U	453	UK	2,274
8	Natl Cheng Kung U	424	Canada	2,245
9	Natl Chiao Tung U	418	Turkey	2,090
10	Natl Taiwan U Sci Tech	394	France	1,874
11	Hong Kong Polytech U	388	South Korea	1,871
12	City U Hong Kong	386	Italy	1,809
13	Southeast U	382	Poland	1,552
14	U Ghent	369	Japan	1,477
15	U Oviedo	359	Germany	1,228
16	Dalian U Tech	339	Australia	1,192
17	Cent S U	330	Czech Republic	938
18	Beijing Inst Tech	325	Belgium	870
19	Slovak U Tech Bratislava	313	Greece	692
20	U Regina	310	Brazil	689
21	Istanbul Tech U	300	Malaysia	653
22	Iona Coll	294	Slovakia	641
23	Shanghai Jiao Tong U	294	Saudi Arabia	632
24	Nanyang Tech U	276	Romania	518
25	Iran U Sci Tech	259	Singapore	518
26	Tsinghua U	258	Egypt	500
27	Amirkabir U Tech	255	Serbia	482
28	Huazhong U Sci Tech	252	Pakistan	412
29	Shaanxi Normal U	245	Mexico	374
30	Natl Cent U	243	Austria	368

As the first specialized journal in fuzzy research and the second most cited journal, FSS has a broad scope of influence, in the case of institutes, the University of Granada in Spain, the Polish Academy of Sciences in Poland, the University of Alberta in Canada and the Northeastern University in the USA are the most citing organizations, which describes a wide influence on occidental academia. However, in terms of countries, Asia still has the lead with China, Taiwan, and Iran being the 1st, 3rd and 4th most citing countries, respectively. Following this trend, 21 of the 30 top citing universities are located in Asia, highlighting China with 14, Europe with 5 top citing universities and America with 4. Europe still leads the top citing countries with a total of 13 nations, Asia with 11, America with 4, and Africa and Oceania with 1.

Table 8
IEEE TFS (USA, 1993)

University	UT	Country	CT
Northeastern U	703	P.R. China	12,302
Harbin Inst Tech	698	Taiwan	2,967
U Granada	488	USA	2,756
City U Hong Kong	465	Spain	1,877
Southeast U	419	UK	1,734
U Alberta	414	India	1,715
Polish Acad Sci	344	Canada	1,417
Nanyang Tech U	318	Iran	1,410
Shanghai Jiao Tong U	316	South Korea	1,272
Nanjing U Sci Tech	315	Australia	1,162
Dalian U Tech	292	France	1,014
Hong Kong Polytech U	291	Italy	782
Nanjing U Aeronaut Astronaut	287	Poland	746
Huazhong U Sci Tech	285	Japan	732
Sichuan U	283	Turkey	710
Tsinghua U	281	Singapore	568
Liaoning U Tech	271	Germany	526
Natl Cheng Kung U	267	Saudi Arabia	510
U Elect Sci Tech China	265	Brazil	491
Cent S U	262	Mexico	458
Beihang U	258	Greece	385
Bohai U	257	Malaysia	367
Natl Taiwan U Sci Tech	252	Belgium	319
Natl Chiao Tung U	242	Algeria	251
Victoria U	241	Tunisia	219
Zhejiang U	234	Norway	211
Natl U Singapore	230	Czech Republic	207
Yuan Ze U	224	Slovakia	184
Beijing Inst Tech	223	Pakistan	176
Natl Cent U	222	Romania	165

The IEEE TFS influences highly recognized occidental institutes, such as Northeastern University in Boston, Massachusetts, USA and the University of Granada in Spain, and it is also clearly preferred by recognized Asian institutes, such as the Harbin Institute of Technology in China and the City University in Hong Kong. Furthermore, China, Taiwan and USA stand as the countries citing this journal most often. Asia has the largest number of top citing institutes for this journal with a total of 25, China alone has 20, Europe 2, America 2 and Oceania 1. On the other hand, Europe has the largest number of top citing countries with a total of 12 nations, Asia has 11, and America has 4.

Table 9
IFs (NLD, 2000)

R	University	UT	Country	CT
1	U Granada	117	P.R. China	2,798
2	Sichuan U	103	USA	655
3	Cent S U	95	Spain	506
4	Northwestern Polytech U	86	UK	413
5	Beihang U	73	India	369
6	Wuhan U	73	Canada	274
7	Beijing Inst Tech	66	France	273
8	Southeast U	66	South Korea	204
9	Xidian U	65	Italy	203
10	Xi An Jiao Tong U	60	Iran	202
11	U Elect Sci Tech China	55	Australia	200
12	Huazhong U Sci Tech	54	Saudi Arabia	170
13	Anhui U	49	Taiwan	131
14	Tianjin U	49	Poland	123
15	Tsinghua U	49	Malaysia	114
16	Jiangxi U Finance Econ	48	Brazil	113
17	U Jaen	47	Germany	109
18	Hohai U	45	Japan	100
19	Dalian U Tech	44	Pakistan	93
20	Heilongjiang U	44	Turkey	91
21	Nanjing U Infor Sci Tech	44	Netherlands	74
22	Chongqing U	41	Belgium	71
23	Hefei U Tech	41	Portugal	66
24	Northeastern U	41	Greece	65
25	Harbin Engn U	39	Sweden	62
26	U Malaya	39	Singapore	57
27	Shanghai Jiao Tong U	38	Finland	44
28	Harbin Inst Tech	37	Mexico	43
29	Hunan U	37	Czech Republic	40
30	Zhejiang U	34	Austria	35

For Information Fusion, a clear trend is seen as 90% of the institutes citing the journal come from Asia, 7% from Europe and 3% from America. However, there is a little representation from institutes outside Asia, as there is an occidental influence of the journal as USA, Spain, the UK, Canada and France stand as the 2nd, 3rd, 4th and 6th most citing countries for the journal.

Table 10
IS (USA, 1968)

University	UT	Country	CT
U Granada	792	P.R. China	23,119
Harbin Inst Tech	733	USA	8,109
Northeastern U	715	India	4,461
Huazhong U Sci Tech	676	Taiwan	4,426
Xidian U	616	Iran	4,069
City U Hong Kong	576	Spain	3,920
Polish Acad Sci	548	UK	3,261
Dalian U Tech	536	Canada	2,652
U Elect Sci Tech China	517	South Korea	2,496
Zhejiang U	516	Turkey	2,304
Southeast U	510	Australia	2,277
Tsinghua U	499	Italy	1,982
Sichuan U	493	France	1,978
U Alberta	483	Japan	1,701
Shanghai Jiao Tong U	479	Poland	1,561
Cent S U	468	Germany	1,468
Hong Kong Polytech U	464	Malaysia	1,204
Nanyang Tech U	456	Saudi Arabia	1,141
U Tehran	449	Brazil	1,082
Wuhan U	443	Singapore	879
Xi An Jiao Tong U	399	Mexico	755
Natl Chiao Tung U	393	Pakistan	754
Tongji U	391	Greece	712
Beihang U	390	Belgium	700
Nanjing U Sci Tech	388	Czech Republic	679
Tianjin U	386	Netherlands	522
Nanjing U Infor Sci Tech	377	Egypt	479
Chongqing U	368	Romania	436
Natl Taiwan U Sci Tech	352	Portugal	386
Beijing Inst Tech	347	Austria	370

Information Sciences is a journal with a long trajectory, in general, of the 30 top citing universities, 26 come from China; this means that 74 out of 100 papers citing the journal are from institutes in China. For regions, there are 13 top citing countries in Europe, 10 in Western Europe, 11 in Asia, and the rest are in America, Africa and Oceania.

Table 11
IASC (USA, 1995)

R	University	UT	Country	CT
1	China Agr U	19	P.R. China	355
2	Cent S U	18	USA	182
3	U Tehran	18	Canada	76
4	Southwest U	15	Iran	69
5	Boston U	13	South Korea	63
6	Hohai U	13	Spain	50
7	Zhejiang U	13	Taiwan	50
8	Natl U Singapore	11	India	46
9	U Guelph	11	Mexico	46
10	U Western Ontario	11	Turkey	46
11	Amirkabir U Tech	10	UK	41
12	Inst Politecn Nacl	10	Japan	34
13	Kn Toosi U Tech	10	Germany	28
14	China Three Gorges U	9	Australia	26
15	Chongqing U	9	France	23
16	Fatih U	9	Italy	21
17	Northeastern U	9	Malaysia	21
18	U Seville	9	Poland	16
19	China U Geosci	8	Singapore	16
20	Natl Res Council Canada	8	New Zealand	13
21	U Guadalajara	8	Saudi Arabia	13
22	Ferdowsi U Mashhad	7	Brazil	10
23	Huazhong U Sci Tech	7	Jordan	10
24	Kyungpook Natl U	7	Pakistan	10
25	Natl Cheng Kung U	7	Egypt	9
26	Shanghai Maritime U	7	Greece	9
27	U Jordan	7	Netherlands	9
28	U Putra Malaysia	7	Tunisia	9
29	U Waterloo	7	Israel	8
30	Wuhan U	7	Sweden	8

For the Intelligent Automation and Soft Computing Journal, 21 out of the top 30 institutions come from Asia, 11 of them are from China, 4 from Iran, 4 from Canada, 2 from Mexico and 2 from the USA. The countries that cite this journal the most are 13 from Asia, more specifically 4 from the Near East, 9 are from Europe, of which 1 is located in Eastern Europe, 4 from America and 2 from Africa.

Table 12
IJAR (USA, 1999)

University	UT	Country	CT
U Granada	479	P.R. China	3,611
Polish Acad Sci	205	Spain	1,491
U Oviedo	172	USA	1,457
U Ghent	169	UK	946
Sichuan U	164	France	755
U Alberta	159	Canada	658
Southeast U	140	Italy	658
U Jaen	140	Iran	595
U Regina	122	Taiwan	509
Xi An Jiao Tong U	95	Poland	507
Southwest Jiaotong U	86	India	480
U Manchester	86	Germany	365
U Tech Compiegne	86	Australia	308
U Publ Navarra	79	Belgium	300
Cent S U	78	Japan	294
Slovak U Tech Bratislava	78	Czech Republic	271
U Elect Sci Tech China	77	Turkey	264
Pla U Sci Tech	76	Brazil	216
Tongji U	75	South Korea	202
Dalian U Tech	74	Netherlands	178
U Ostrava	74	Slovakia	154
Iona Coll	73	Switzerland	147
Tsinghua U	73	Greece	143
Northwestern Polytech U	72	Saudi Arabia	142
U Tehran	72	Malaysia	131
Hong Kong Polytech U	71	Austria	126
City U Hong Kong	70	Sweden	109
Shanghai Jiao Tong U	70	Finland	99
U Politecn Madrid	70	Serbia	97
U Toulouse 3	70	Tunisia	92

The International Journal of Approximate Reasoning has a larger influence on occidental institutes. From the total of 30 top citing universities, 14 are from China, and 12 are from Europe, of which 5 are located in Spain, 2 in France, 1 in the UK, 1 in Poland, 1 in Slovakia and 1 in the Czech Republic. The top citing countries include a group of 16 in Europe, of which 12 are from Western Europe, 9 are in Asia, and the rest are in Oceania, America and Africa.

Table 13
IJCIS (France, 2008)

R	University	UT	Country
1	U Granada	95	P.R. China
2	Cent S U	73	Spain
3	Southwest Jiaotong U	72	USA
4	Sichuan U	67	Turkey
5	U Jaen	65	India
6	Istanbul Tech U	56	Iran
7	Beijing Inst Tech	49	UK
8	Shandong U Finance Econ	48	Australia
9	Beijing Jiaotong U	40	Taiwan
10	Dalian U Tech	39	Malaysia
11	Southeast U	39	Canada
12	U Barcelona	38	Italy
13	Jilin U	36	France
14	U Manchester	36	Saudi Arabia
15	Chongqing U Arts Sci	33	Belgium
16	Fuzhou U	32	South Korea
17	U Putra Malaysia	32	Japan
18	Zhejiang U Finance Econ	31	Germany
19	Tongji U	30	Mexico
20	U Elect Sci Tech China	30	Brazil
21	Beijing U Tech	29	Poland
22	Jiangxi U Finance Econ	29	Vietnam
23	Tsinghua U	29	Lithuania
24	Wuhan U	28	Norway
25	Northwestern Polytech U	26	Pakistan
26	U Tehran	26	Cuba
27	Galatasaray U	25	Denmark
28	Nanjing U	25	Greece
29	U Publ Navarra	24	Singapore
30	Xi An Jiao Tong U	24	Serbia

The International Journal of Computational Intelligence Systems has as the most citing institutions the University of Granada in Spain, The Central South University from China and the Southwest Jiaotong University. In fact, there are only Asian and European institutions as the top citing institutions for this journal, 21 are established in China, 4 in Spain, 2 in Turkey, 1 in Malaysia and 1 in the UK. However, in the list of countries we can find 5 American countries, 12 European countries, 1 country from Oceania and the rest are countries located in Asia.

Table 14
IJFS (Taiwan, 1998)

CT	University	UT	Country	CT
1,400	Cent S U	74	P.R. China	1,040
288	U Barcelona	54	Taiwan	348
189	Wuhan U	37	India	169
176	Yuan Ze U	34	Iran	139
172	Shandong U Finance Econ	31	Spain	94
167	Yazd U	31	USA	83
153	Anhui U	30	UK	63
82	Hubei U Nationalities	28	South Korea	59
82	Sichuan Normal U	28	Turkey	57
77	Harbin Inst Tech	26	Pakistan	54
75	Natl Taipei U Tech	26	Australia	45
68	Natl Taiwan Normal U	26	Malaysia	42
60	Zhejiang U Finance Econ	26	Canada	40
60	Natl Taiwan U Sci Tech	25	Saudi Arabia	36
46	Northeastern U	25	France	27
46	Sichuan U	25	Singapore	25
43	Dalian Maritime U	23	Italy	22
42	U Manchester	23	Japan	17
37	Tamkang U	22	Poland	17
36	Liaoning U Tech	21	Mexico	16
35	Shaoxing U	21	Tunisia	15
27	Zhejiang Wanli U	21	Lithuania	14
26	Natl Cheng Kung U	20	Chile	13
23	Natl Chiao Tung U	20	Egypt	13
23	Natl Taipei U	20	Vietnam	13
22	U Elect Sci Tech China	20	Algeria	12
18	Hunan U	19	Germany	12
18	Southeast U	19	Romania	11
18	Hohai U	18	Serbia	11
17	Natl Chung Hsing U	18	Brazil	8

The International Journal of Fuzzy Systems has a big influence on Asian institutes, as 90% of the top universities citing this journal are located in Asia, with a distribution of 21 in China, 5 in Taiwan and 1 in Iran, and the locations of the remainder are 1 in Spain, 1 in the UK and 1 in the USA. The results on countries show that 12 of the top citing countries are located in Asia, 9 in Europe, 5 in America, 3 in Africa and 1 in Oceania.

Table 15
IJGS (GBR, 1972)

R	University	UT	Country	CT
1	Iona Coll	168	P.R. China	2,581
2	U Granada	158	USA	1,417
3	Southeast U	127	Spain	596
4	Sichuan U	116	UK	587
5	Suny Binghamton	102	India	404
6	Shanxi U	99	Canada	395
7	Polish Acad Sci	96	France	385
8	U Alberta	95	Taiwan	279
9	Pla U Sci Tech	82	Italy	254
10	Cent S U	80	Czech Republic	252
11	Xi An Jiao Tong U	78	Japan	232
12	U Elect Sci Tech China	70	Iran	230
13	Harbin Inst Tech	67	Poland	222
14	U Ghent	67	Germany	220
15	U Ostrava	66	Saudi Arabia	192
16	Brunel U London	65	Turkey	189
17	U Manchester	64	Australia	181
18	City U Hong Kong	61	Belgium	165
19	Tsinghua U	60	South Korea	142
20	Yangzhou U	59	Netherlands	110
21	U Publ Navarra	57	Russia	109
22	U Toulouse 3	57	Slovakia	89
23	Palacky U	54	Brazil	71
24	Tongji U	54	Austria	70
25	Zhejiang Ocean U	53	Portugal	63
26	U Oviedo	52	Mexico	60
27	Zhejiang U Finance Econ	51	Malaysia	57
28	Northeastern U	51	Pakistan	57
29	U Jaen	51	Sweden	57
30	Chinese U Hong Kong	50	Israel	56

The International Journal of General Systems has as top citing institutions Iona College in the USA, followed by the University of Granada in Spain and Southeast University in China. In general, from the top 30 institutes, 15 are located in China, 11 in Europe and 4 in America. That information is consistent with the results over countries in which 14 of the top citing countries are grouped in Europe, followed by 11 in Asia, 4 in America and 1 in Oceania.

Table 16
IJITDM (SGP, 2002)

University	UT	Country	CT
Vilnius Gediminas Tech U	116	P.R. China	1,112
U Granada	92	USA	396
Sichuan U	85	Taiwan	263
U Elect Sci Tech China	66	Spain	246
Cent S U	65	Iran	145
Southeast U	43	UK	141
Natl Chiao Tung U	40	Lithuania	124
Hefei U Tech	35	Turkey	124
Tianjin U	35	Canada	84
U Jaen	32	Australia	80
Hong Kong Polytech U	31	India	77
Chang Gung U	30	Portugal	76
City U Hong Kong	30	Japan	67
Shanghai Jiao Tong U	27	Malaysia	64
Beijing U Chem Tech	26	South Korea	53
U Sci Tech China	26	Germany	51
Zhejiang U Finance Econ	26	Poland	50
Hohai U	24	Saudi Arabia	50
Huazhong U Sci Tech	24	Italy	49
U Tech Sydney	24	France	46
U Tehran	24	Finland	45
Natl Taiwan U Sci Tech	23	Brazil	44
Northeastern U	23	Belgium	34
Pla U Sci Tech	23	Greece	33
Southwestern U Finance Econ	23	Sweden	33
U Lisbon	23	Pakistan	30
Harbin Inst Tech	22	Singapore	24
Nanjing U Infor Sci Tech	22	Netherlands	20
Tsinghua U	22	Austria	19
Aalto U	21	Switzerland	19

The International Journal of Information Technology & Decision Making has a big influence on the publications from the Lithuanian institute Vilnius Gediminas Technologic University, the University of Granada and the Sichuan University; however, in general terms 23 out of the 30 top citing institutions are located in Asia, 5 in Europe, 1 in Oceania and 1 in America. For regions, the top citing countries include a group of 15 in Europe, 11 in Asia, 3 in America and 1 in Oceania.

Table 17
IJIS (USA, 1986)

R	University	UT	Country	CT
1	U Granada	466	P.R. China	3,396
2	Sichuan U	207	USA	1,482
3	Iona Coll	181	Spain	1,366
4	Southeast U	170	UK	784
5	U Jaen	159	Italy	548
6	Polish Acad Sci	155	Taiwan	525
7	Cent S U	154	Canada	500
8	U Ghent	117	France	464
9	City U Hong Kong	110	Iran	374
10	U Alberta	106	Poland	371
11	Pla U Sci Tech	105	India	349
12	U Manchester	102	Turkey	312
13	Northeastern U	98	Australia	293
14	Tsinghua U	96	Belgium	246
15	Tongji U	83	Germany	242
16	Xi An Jiao Tong U	82	Japan	237
17	Zhejiang U Finance Econ	78	South Korea	207
18	Shanghai Jiao Tong U	76	Czech Republic	149
19	U Barcelona	76	Netherlands	146
20	U Publ Navarra	76	Saudi Arabia	144
21	Southwest Jiaotong U	75	Greece	117
22	Anhui U	72	Brazil	116
23	Chinese U Hong Kong	68	Malaysia	102
24	Hohai U	67	Singapore	97
25	Natl Taiwan U Sci Tech	66	Israel	88
26	Beijing Inst Tech	64	Mexico	86
27	Istanbul Tech U	64	Slovakia	84
28	De Montfort U	63	Pakistan	69
29	Hong Kong Polytech U	63	Sweden	67
30	Shandong U Finance Econ	62	Austria	56

The International Journal of Intelligent Systems has as top citing institutions 19 universities from Asia, of which 17 are from China, 8 institutes from Europe, including 4 from Spain, 2 from the UK and the rest from Belgium and Poland, and finally 3 organizations from America, 2 from the USA and one in Canada. The largest region is Europe with 13 top citing countries, followed by 12 Asian countries, 4 from America and 1 from Oceania.

Table 18
IJUFKS (SGP, 1993)

University	UT	Country	CT
U Granada	265	P.R. China	2,598
Sichuan U	131	USA	1,045
U Ghent	126	Spain	1,037
Slovak U Tech Bratislava	116	Taiwan	489
Southeast U	102	Iran	418
Polish Acad Sci	97	UK	391
U Oviedo	93	Italy	346
Cent S U	91	India	328
U Jaen	89	Canada	300
Tsinghua U	88	France	300
U Publ Navarra	87	Turkey	246
U Barcelona	77	Poland	239
Natl Cheng Kung U	76	Australia	228
Hebei U	72	Belgium	210
U Alberta	71	Germany	181
Iona Coll	64	Czech Republic	179
U Roma La Sapienza	64	Slovakia	172
Tianjin U	61	Japan	166
U Manchester	61	South Korea	129
Chongqing U Arts Sci	60	Austria	100
Xi An Jiao Tong U	60	Brazil	97
Beijing Jiaotong U	59	Saudi Arabia	94
Beijing Inst Tech	58	Serbia	80
Deakin U	58	Malaysia	78
U Elect Sci Tech China	58	Singapore	67
Amirkabir U Tech	55	Greece	62
Beihang U	55	Chile	53
City U Hong Kong	53	Sweden	51
De Montfort U	53	Hungary	50
Hohai U	53	Netherlands	49

The International Journal of Uncertainty Fuzziness and Knowledge-Based Systems has in total 16 top citing organizations located in Asia, of which 14 are from China, 11 from Europe highlighted by Spain with 5 institutes and the UK with 2; in America there are 2 institutes and 1 in Australia. The largest region with the top citing countries is Europe with 15 elements, followed by Asia with 10 countries, America with 4 and Oceania with 1 country.

Table 19
IrJFS (IRN, 2004)

R	University	UT	Country	CT
1	Yazd U	47	P.R. China	326
2	Beijing Inst Tech	36	Iran	294
3	Shahid Bahonar U Kerman	32	India	124
4	U Tehran	32	Turkey	92
5	Sichuan Normal U	28	Pakistan	56
6	Ferdowsi U Mashhad	22	Spain	44
7	Quaid I Azam U	19	South Korea	39
8	Alexandru Ioan Cuza U	18	Romania	36
9	U Granada	17	Saudi Arabia	33
10	U Birjand	16	Italy	24
11	Vidyasagar U	16	USA	23
12	Gyeongsang Natl U	15	Malaysia	21
13	Hubei U Nationalities	14	Czech Republic	18
14	U Jaen	14	Serbia	15
15	U Latvia	13	UK	15
16	Amirkabir U Tech	12	Egypt	14
17	Xidian U	12	Latvia	14
18	Iran U Sci Tech	11	Thailand	13
19	Aligarh Muslim U	10	Greece	10
20	Damghan U	10	Taiwan	9
21	Wuyi U	10	Canada	8
22	Hubei Inst Nationalities	9	Algeria	7
23	Hunan U	9	France	7
24	U Oviedo	9	Poland	7
25	U Politecn Valencia	9	Slovenia	7
26	Hanyang U	8	Vietnam	7
27	Hebei U	8	Australia	6
28	Renmin U China	8	Germany	6
29	U Kebangsaan Malaysia	8	Oman	6
30	U Novi Sad	8	Albania	5

The Iranian Journal of Fuzzy Systems strongly influences Asian institutes, with 23 of the 30 top citing institutes established in Asia, 9 of them are located in China, 8 in Iran, 2 in India, 2 in South Korea, 1 in Malaysia and 1 in Pakistan; on the other hand, 7 of the top citing institutes are located in Europe, specifically 4 in Spain, and the rest in Eastern Europe. In terms of regions, 13 belong to European states, 12 to Asia, 2 American, 2 African and 1 in Oceania.

Table 20
JIFS (NLD, 1993)

University	UT	Country	CT
Cent S U	125	P.R. China	2,547
Nanjing U Informat Sci Tech	121	Iran	753
Sichuan U	102	USA	490
Yazd U	89	India	479
U Granada	80	Turkey	398
Shandong U Finance Econ	75	Spain	272
Beijing Inst Tech	72	UK	263
Southeast U	72	Taiwan	233
U Tehran	70	South Korea	180
Northwestern Polytech U	57	Pakistan	178
Istanbul Tech U	56	Canada	169
Northeastern U	53	Malaysia	138
Tongji U	53	Saudi Arabia	129
Shahid Bahonar U Kerman	51	Australia	124
Tsinghua U	50	Japan	118
Shiraz U Tech	47	Poland	103
Hubei U Nationalities	46	Italy	88
Thapar U	46	France	72
Shaoxing U	45	Mexico	71
Amirkabir U Tech	44	Greece	68
Southwest U	43	Germany	61
Vidyasagar U	43	Romania	58
Xidian U	43	Vietnam	53
China U Min Tech	42	Brazil	52
Harbin Inst Tech	42	Czech Republic	50
U Elect Sci Tech China	42	Egypt	49
Beihang U	41	Belgium	40
Sichuan Normal U	41	Singapore	38
U Alberta	41	Serbia	37
North China Elect Power U	40	Portugal	33

Similarly, the Journal of Intelligent & Fuzzy Systems influences a total of 27 institutes located in Asia, of which 19 are in China and the rest in Turkey, Iran and India, and from Europe there is 1 institute and in America 2 institutes often cite the journal. In terms of regions, 12 countries from Asia and 12 countries in Europe are the top citing, followed by 4 in America, 1 in Oceania and 1 in Africa

Table 21
JMVLS (USA, 2003)

R	University	UT	Country	CT
1	U Granada	106	P.R. China	274
2	Yazd U	79	Spain	219
3	U Jaen	61	Iran	162
4	Palacky U	34	Turkey	96
5	Istanbul Tech U	28	USA	91
6	U Oviedo	23	Czech Republic	69
7	Shahid Bahonar U Kerman	21	India	68
8	U Burgos	21	Saudi Arabia	58
9	U Publ Navarra	20	Romania	55
10	U Bucharest	19	Canada	52
11	Hubei U Nationalities	17	UK	52
12	Slovak Acad Sci	17	Japan	46
13	U Cordoba	15	Italy	44
14	Southwest Jiaotong U	14	Poland	44
15	U Ghent	14	Brazil	34
16	U Luxembourg	14	Australia	29
17	U Szeged	13	France	29
18	Polish Acad Sci	12	Slovakia	26
19	Shahid Beheshti U	12	Germany	24
20	Tohoku U	12	South Korea	24
21	Yildiz Tekn U	12	Pakistan	23
22	De Montfort U	11	Serbia	23
23	U Iowa	11	Belgium	20
24	U Punjab	11	Greece	19
25	Wroclaw U Tech	11	Taiwan	19
26	Alexandru Ioan Cuza U	10	Hungary	18
27	U Udine	10	Argentina	17
28	Hanyang U	9	Luxembourg	15
29	Sichuan U	9	Austria	14
30	U Politehn Bucuresti	9	Cuba	14

The Journal of Multiple-Valued Logic has a stronger influence in occidental institutions, as a total of 18 organizations are located in Europe including 6 in Spain, 3 in Romania and 2 in Poland, and on the other hand, there are 11 top citing universities in Asia, highlighted by 3 from China and 3 from Iran. Following this trend, the most numerous region is Europe with 15 top citing countries, Asia with 9 nations, America with 5 and Oceania with 1.

Table 22
KBS (NLD, 1987)

University	UT	Country	CT
Sichuan U	272	P.R. China	7,537
U Granada	262	USA	2,104
Cent S U	227	UK	1,366
U Malaya	218	Spain	1,332
Huazhong U Sci Tech	198	Taiwan	1,178
Xi An Jiao Tong U	186	India	1,091
Southeast U	179	Iran	955
Harbin Inst Tech	174	Australia	748
Tongji U	153	Canada	691
Hong Kong Polytech U	152	South Korea	616
Tsinghua U	148	Turkey	586
U Tehran	148	Malaysia	545
Zhejiang U	148	France	482
Shanghai Jiao Tong U	144	Italy	459
Nanjing U Aeronaut Astronaut	139	Japan	389
U Elect Sci Tech China	137	Germany	363
City U Hong Kong	136	Singapore	341
Northeastern U	135	Poland	327
Xidian U	130	Brazil	316
Dalian U Tech	129	Saudi Arabia	316
Northwestern Polytech U	129	Greece	271
Chongqing U	128	Pakistan	230
Nanyang Tech U	124	Netherlands	210
Tianjin U	124	Belgium	179
Nanjing U Informat Sci Tech	123	Mexico	165
Wuhan U	123	Portugal	152
Jilin U	122	Vietnam	140
Hefei U Tech	116	Egypt	132
U Alberta	116	Sweden	129
Beijing Inst Tech	115	Czech Republic	104

The Knowledge-Based Systems Journal [26,27] has a robust influence in Asia, with just 3 high citing institutions from countries outside this continent, and 24 top citing organizations are from China, the rest are from Singapore, Iran and Malaysia; the institutions from outside Asia are 1 in Spain, 1 in the USA and 1 in Canada. However, this trend is not followed with the top citing countries, as the regions with the most citations are Europe and Asia with a total of 12 countries each, followed by 4 in America, 1 in Africa and 1 in Oceania.

Table 23
Kyb (GBR, 1972)

R	University	UT	Country	CT
1	U Paris 06	116	P.R. China	849
2	Nanjing U Aeronaut Astronaut	111	USA	782
3	U Maribor	94	UK	551
4	U Alicante	73	Spain	297
5	Slippery Rock U	62	Iran	292
6	Firat U	61	France	284
7	Shanghai Inst Tech	36	Turkey	215
8	Bialystok Tech U	35	India	198
9	St Xavier U	35	Canada	186
10	U Toulouse 3	35	Poland	153
11	U Primorska	33	Slovenia	145
12	U Tehran	33	Germany	139
13	Amirkabir U Tech	32	Australia	129
14	U Sao Paulo	32	Taiwan	127
15	U W England	32	Italy	96
16	Huazhong U Sci Tech	31	Brazil	80
17	Polish Acad Sci	31	Malaysia	75
18	Iran U Sci Tech	30	Netherlands	75
19	Wuhan U Tech	29	Belgium	73
20	U Oviedo	28	Austria	71
21	Iona Coll	27	Saudi Arabia	70
22	Abo Akad U	26	Finland	63
23	Liverpool John Moores U	26	Greece	62
24	Technion Israel Inst Tech	26	Japan	56
25	U Sheffield	26	South Korea	48
26	U Complutense Madrid	25	Egypt	47
27	Nanjing U	24	Israel	47
28	De Montfort U	23	Sweden	47
29	U Reading	23	Algeria	46
30	Indian Stat Inst	22	South Africa	45

Kybernetes Journal has a denoted influence on Europe, as a total of 15 top citing institutes are on this continent, and it is not a coincidence that 5 of the top citing organizations are from the UK, also highlighted by Spain with 3 institutes; Asia counts a total of 11 top citing institutions, with China having the largest number of 5, followed by Iran with 3, and outside of Europe and Asia, America as a continent displays a total of 4 top citing organizations for this journal. For countries, the region with the most top citing countries is Europe with 13, followed by Asia with 10 countries, America and Africa with a count of 3 each and Oceania with 1.

Table 24
SC (USA, 1997)

University	UT	Country	CT
U Granada	358	P.R. China	3,918
U Jaen	160	Spain	1,195
Cent S U	127	Iran	969
Xidian U	117	USA	844
Nanyang Tech U	109	India	832
Palacky U	104	UK	691
Tongji U	104	Taiwan	495
U Cordoba	104	Italy	432
Northeastern U	99	Turkey	383
Tsinghua U	96	Czech Republic	347
Yazd U	96	Canada	327
Polish Acad Sci	95	Australia	323
Slovak Acad Sci	94	France	300
Huazhong U Sci Tech	89	Malaysia	280
Sichuan U	89	South Korea	260
Shahid Bahonar U Kerman	88	Saudi Arabia	250
U Tehran	86	Poland	244
Wuhan U	86	Japan	231
U Alberta	81	Germany	204
Hong Kong Polytech U	76	Romania	184
Dalian U Tech	75	Mexico	177
Amirkabir U Tech	74	Pakistan	172
U Seville	74	Slovakia	172
City U Hong Kong	72	Singapore	160
Harbin Inst Tech	72	Greece	153
Xi An Jiao Tong U	71	Brazil	148
Beihang U	69	Belgium	124
U Ghent	69	Austria	101
China U Geosci	66	Finland	92
U Malaya	65	Egypt	90

Finally, the Soft Computing Journal demonstrates a stronger relevance in Asia with a total of 20 top citing institutes, China leads with 14, followed by Iran with 4, and for the case of Europe, a total of 8 institutions comprise the top citing organizations of this journal; Spain is the most citing with 4, and America has 2 top citing institutions. For the case of countries, Europe has the most top citing countries for SC with a total of 13, followed by Asia with 11, America with 4, Africa with 1 and Oceania with 1.

4. Aggregated results

A total of 196 different Universities and Institutions are shown in the individual top 30 results. Of these, the vast majority come from Asia, with a total of 122, of which 77 of the top citing institutes are located in China, 13 in Iran, 7 in Taiwan, 5 in Turkey, 5 in India, 4 in South Korea, 4 in Malaysia, 2 in Japan, 2 in Singapore 1 in Israel, 1 in Pakistan, and 1 in Jordan. For European top citing institutions, there are a total of 53,

and Spain leads the count with 14 organizations, followed by the UK with 11, Poland with 4, Romania 3, France 3, Slovakia 2, Finland 2, Italy 2, Czech Republic 2, Slovenia 2, Serbia 1, Bulgaria 1, Luxembourg 1, Portugal 1, Hungary 1, Latvia 1, Belgium 1, and Lithuania 1. In America 17 institutes are top citing including 8 in the USA, 6 in Canada, 2 in Mexico and 1 in Brazil. Finally, in Australia there are 4 top citing institutions. Table 25 shows the top 30 Universities per number of published articles citing the selected journals. For a detailed composition of the top universities citing a specific journal please see Table 27.

Table 25.
Top 30 Universities Citing Fuzzy Research Journals

R	University	UT	Country	Type	QSR	QSRO	Students
1	U Granada	5,416	SPA	Public	495	Very high	51,016
2	Sichuan U	3,362	CHN	Public	601-650	Very high	59,998
3	Northeastern U	3,174	USA	Private	326	Very high	20,849
4	Harbin Inst Tech	3,119	CHN	Public	285	Very high	29,931
5	Cent S U	3,012	CHN	Public	801-1000	Very high	53,069
6	Southeast U	2,986	CHN	Public	511-520	Very high	33,433
7	U Tehran	2,940	IRN	Public	701-750	Very high	55,645
8	Huazhong U Sci Tech	2,727	CHN	Public	415	Very high	56,369
9	City U Hong Kong	2,712	HKG	Public	55	Very high	9,566
10	Hong Kong Polytech U	2,600	HKG	Public	106	Very high	21,870
11	Tsinghua U	2,369	CHN	Public	17	Very high	36,403
12	Dalian U Tech	2,299	CHN	Public	571-580	Very high	40,728
13	U Alberta	2,288	CAN	Public	109	Very high	31,982
14	Shanghai Jiao Tong U	2,286	CHN	Public	59	Very high	40,830
15	Polish Acad Sci	2,183	POL	Public	-	-	-
16	Natl Taiwan U Sci Tech	2,077	CHN	Public	257	Very high	8,169
17	Nanyang Tech U	1,937	SGP	Public	12	Very high	25,088
18	Xi An Jiao Tong U	1,729	CHN	Public	313	Very high	35,424
19	Zhejiang U	1,726	CHN	Public	68	Very high	33,650
20	Natl Chiao Tung U	1,680	CHN	Public	208	Very high	10,467
21	Beihang U	1,609	CHN	Public	491	Very high	29,761
22	Tongji U	1,588	CHN	Public	291	Very high	36,176
23	Amirkabir U Tech	1,438	IRN	Public	498	Very high	11,918
24	U Malaya	1,398	MYS	Public	87	Very high	15,139
25	Natl Cheng Kung U	1,380	CHN	Public	234	Very high	20,623
26	Wuhan U	1,339	CHN	Public	257	Very high	50,250
27	U Elect Sci Tech China	1,337	CHN	Public	751-800	Very high	33,000
28	Xidian U	1,210	CHN	Public	-	-	33,000
29	Tianjin U	1,177	CHN	Public	443	Very high	34,542
30	Chongqing U	1,163	CHN	Public	801-1000	Very high	42,413

Abbreviations: R, rank; J, journal; QSR, Quacquarelli Symonds World University Ranking; QSRO, Quacquarelli Symonds World University Research Output.

These results indisputably show the great impact that the scientific community of China is having on fuzzy research and vice versa. China is the country

with the largest number of papers citing the selected journals. If we take into account the top 30 countries citing these journals, 28 of every 100 cites come from

China. This is especially relevant as China started the research on fuzzy theory in the 1970s, but it was not until 1986 that a substantial increment of fuzzy research is observed in the country; for a detailed evolution of fuzzy research in China see [28,29].

In general, a total of 56 different countries were displayed in the top 30 individual journal results. Europe has the largest number of top countries citing the selected journals with 27, followed by Asia with 16, America with 7, Africa 4 and Oceania 2. However, when analyzing the number of publications citing the selected journals, all the countries located in Asia generated 245,553 papers, which is a 103% more than the papers published by the countries located in Europe: 106,370. America has a total of 61,233 papers citing the selected journals, Oceania 10,972, and Africa 3,573. Table 26 gathers information about the top 30 countries citing the selected journals. Figure 3 displays the distribution of top citing countries and the total amount of papers citing the selected journals. For the detailed structure of the countries citing each of the selected journals please see Table 28.

Table 26.

Top 30 Countries Citing Fuzzy Research Journals

R	Country	CT	R	Country	CT
1	P.R. China	115,759	16	Japan	7,485
2	USA	37,601	17	Germany	7,145
3	Taiwan	25,567	18	Brazil	5,927
4	Iran	25,291	19	Saudi Arabia	5,547
5	Spain	25,081	20	Belgium	4,402
6	India	24,203	21	Greece	4,265
7	UK	19,857	22	Singapore	4,074
8	Turkey	14,052	23	Mexico	3,861
9	Canada	13,709	24	Czech Republic	3,370
10	South Korea	11,914	25	Pakistan	3,305
11	Australia	10,959	26	Netherlands	2,177
12	France	10,819	27	Egypt	2,174
13	Italy	10,504	28	Portugal	1,820
14	Poland	8,114	29	Serbia	1,673
15	Malaysia	7,634	30	Romania	1,661

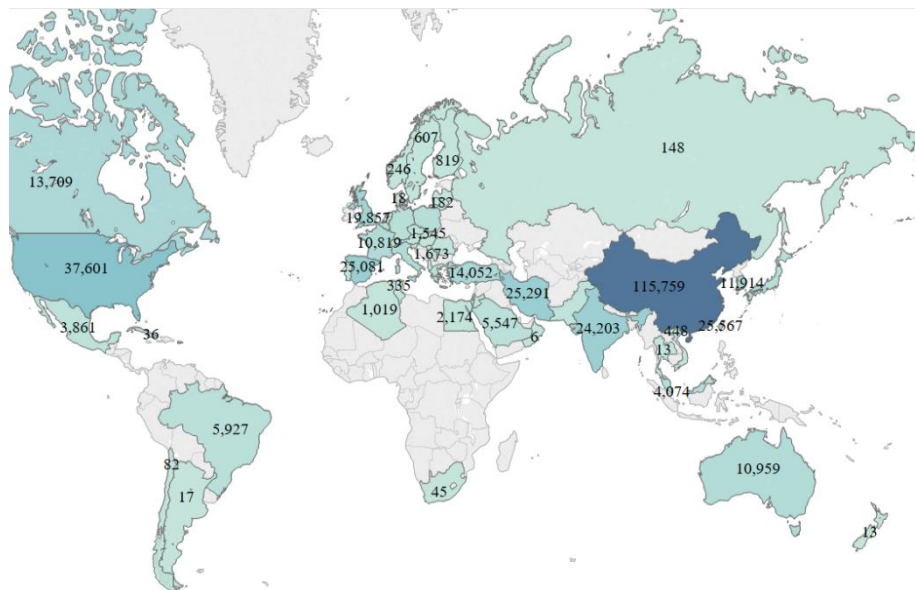


Figure 3. Distribution of the Top 30 Countries Citing Fuzzy Research Journals

Table 27.

In depth citation analysis per university and journal

R	University	ASC	C&S	ESA	FODM	FSS	IASC	IEEE TFS	IF	IJAR	IJCIS	IJFS	IJGS	IJIS	IJITDM	IJUFKS	IrJFS	IS	JIFS	JMVLSC	KBS	Kyb	SC	Total
1	U Granada	263	38	504	72	764		488	117	479	95		158	466	92	265	17	792	80	106	262		358	5,416
2	Sichuan U	233		418	112	453		283	103	164	67	25	116	207	85	131		493	102	9	272		89	3,362
3	Northeastern U	237		453		532	9	703	41			25	51	98	23			715	53		135		99	3,174
4	Harbin Inst Tech	216		562		470		698	37			26	67		22			733	42		174		72	3,119
5	Cent S U	283		395	67	330	18	262	95	78	73	74	80	154	65	91		468	125		227		127	3,012
6	Southeast U	181		483	54	382		419	66	140	39	19	127	170	43	102		510	72		179			2,986
7	U Tehran	428	21	1045		488	18			72	26						32	449	70		148	33	86	2,940
8	Huazhong U Sci Tech	351	23	737		252	7	285	54						24			676			198	31	89	2,727
9	City U Hong Kong	179	25	549		386		465		70			61	110	30	53		576			136		72	2,712
10	Hong Kong Polytech U	232	21	811		388		291		71				63	31			464			152		76	2,600
11	Tsinghua U		36	514	70	258		281	49	73	29		60	96	22	88		499	50		148		96	2,369
12	Dalian U Tech	328		443		339		292	44	74	39							536			129		75	2,299
13	U Alberta	167			20	535		414		159			95	106		71		483	41		116		81	2,288
14	Shanghai Jiao Tong U	199	27	591	25	294		316	38	70				76	27			479			144			2,286
15	Polish Acad Sci		23			577		344		205			96	155		97		548		12		31	95	2,183
16	Natl Taiwan U Sci Tech	213	95	657		394		252				25		66	23			352						2,077
17	Nanyang Tech U	218		436		276		318										456			124		109	1,937
18	Xi An Jiao Tong U	201		473					60	95	24		78	82		60		399			186		71	1,729
19	Zhejiang U	213		568			13	234	34									516			148			1,726
20	Natl Chiao Tung U		29	538		418		242				20			40			393						1,680
21	Beihang U	221		466	36			258	73							55		390	41				69	1,609
22	Tongji U	191		431	23					75	30		54	83				391	53		153		104	1,588
23	Amirkabir U Tech	350	32	574		255	10									55	12		44			32	74	1,438
24	U Malaya	328		748					39												218		65	1,398
25	Natl Cheng Kung U			586		424	7	267				20				76								1,380
26	Wuhan U	179		363			7		73		28	37						443			123		86	1,339
27	U Elect Sci Tech China							265	55	77	30	20	70		66	58		517	42		137			1,337
28	Xidian U	227							65								12	616	43		130		117	1,210
29	Tianjin U	155		331	36				49						35	61		386			124			1,177
30	Chongqing U	198		419			9		41									368			128			1,163

Table 28.

In depth citation analysis per country and journal

R	Country	ASC	C&S	ESA	FODM	FSS	IASC	IEEE TFS	IF	IJAR	IJCIS	IJFS	IJGS	IJIS	IJTDM	IJUFKS	IrJFS	IS	JIFS	JMVLSC	KBS	Kyb	SC	TG
1	P.R. China	10,073	780	20,478	1,179	13,486	355	12,302	2,798	3,611	1,400	1,040	2,581	3,396	1,112	2,598	326	23,119	2,547	274	7,537	849	3,918	115,759
2	USA	2,189	677	7,410	141	5,079	182	2,756	655	1,457	189	83	1,417	1,482	396	1,045	23	8,109	490	91	2,104	782	844	37,601
3	Taiwan	1,809	304	6,627	114	4,583	50	2,967	131	509	82	348	279	525	263	489	9	4,426	233	19	1,178	127	495	25,567
4	Iran	3,577	183	6,424	145	3,719	69	1,410	202	595	167	139	230	374	145	418	294	4,069	753	162	955	292	969	25,291
5	Spain	1,690	344	4,494	187	3,536	50	1,877	506	1,491	288	94	596	1,366	246	1,037	44	3,920	272	219	1,332	297	1,195	25,081
6	India	3,655	180	5,512	142	3,352	46	1,715	369	480	172	169	404	349	77	328	124	4,461	479	68	1,091	198	832	24,203
7	UK	1,456	438	4,159	78	2,274	41	1,734	413	946	153	63	587	784	141	391	15	3,261	263	52	1,366	551	691	19,857
8	Turkey	1,564	127	3,899	83	2,090	46	710	91	264	176	57	189	312	124	246	92	2,304	398	96	586	215	383	14,052
9	Canada	927	149	2,418	66	2,245	76	1,417	274	658	75	40	395	500	84	300	8	2,652	169	52	691	186	327	13,709
10	South Korea	699	104	3,171	29	1,871	63	1,272	204	202	46	59	142	207	53	129	39	2,496	180	24	616	48	260	11,914
11	Australia	913	168	2,405	40	1,192	26	1,162	200	308	82	45	181	293	80	228	6	2,277	124	29	748	129	323	10,959
12	France	629	128	1,664	25	1,874	23	1,014	273	755	60	27	385	464	46	300	7	1,978	72	29	482	284	300	10,819
13	Italy	619	125	1,824	51	1,809	21	782	203	658	68	22	254	548	49	346	24	1,982	88	44	459	96	432	10,504
14	Poland	516	186	1,052	43	1,552	16	746	123	507	35	17	222	371	50	239	7	1,561	103	44	327	153	244	8,114
15	Malaysia	1,177	51	2,397	40	653	21	367	114	131	77	42	57	102	64	78	21	1,204	138		545	75	280	7,634
16	Japan	407	115	997	26	1,477	34	732	100	294	43	17	232	237	67	166		1,701	118	46	389	56	231	7,485
17	Germany	366	174	1,315	21	1,228	28	526	109	365	42	12	220	242	51	181	6	1,468	61	24	363	139	204	7,145
18	Brazil	633	54	1,615	22	689	10	491	113	216	36	8	71	116	44	97		1,082	52	34	316	80	148	5,927
19	Saudi Arabia	520		935	52	632	13	510	170	142	60	36	192	144	50	94	33	1,141	129	58	316	70	250	5,547
20	Belgium	213	47	728	17	870		319	71	300	46		165	246	34	210		700	40	20	179	73	124	4,402
21	Greece	358	32	1,045	11	692	9	385	65	143	18			117	33	62	10	712	68	19	271	62	153	4,265
22	Singapore	353		913		518	16	568	57		18	25		97	24	67		879	38		341		160	4,074
23	Mexico	551		1,022		374	46	458	43		37	16	60	86				755	71		165		177	3,861
24	Czech Republic		39		28	938		207	40	271			252	149		179	18	679	50	69	104		347	3,370
25	Pakistan	356		590	22	412	10	176	93		23	54	57	69	30		56	754	178	23	230		172	3,305
26	Netherlands		55	729			9		74	178			110	146	20	49		522			210	75		2,177
27	Egypt	317		524		500	9					13					14	479	49		132	47	90	2,174
28	Portugal	265	30	749					66				63		76			386	33		152			1,820
29	Serbia	254		640	17	482				97	17	11				80	15		37	23				1,673
30	Romania	187			11	518		165				11					36	436	58	55			184	1,661

5. Conclusion

This work presents a bibliometric analysis focused on universities and countries of 22 highly oriented fuzzy research scientific journals. The study presents 88,845 total papers from 196 different universities and 427,701 studies from 56 different countries in which the 22 selected fuzzy-oriented journals are highly cited. A distribution of the results of both universities and countries clearly highlights Asia, specifically the People's Republic of China as the most citing region of fuzzy research with 115,759 as a country, followed by the USA with 37,601 and Taiwan with a total of 25,567 papers. The institution with the largest number of citations of these 22 journals is the University of Granada in Spain, followed by Sichuan University in China and Northeastern University in the USA. The present work presents 22 tables structuring the individual results of each of the selected journals and the aggregated results for the top 30 countries and institutions.

Diverse statistical information has been presented for the selected journals, e.g., the total number of citations (TC) the total number of papers published (TP), the total number of papers citing the journal (TPC), the journal h-index (H), the most recent 2017 impact factor (IF) available, the 2017 5 year impact factor (5YIF), the most cited paper of the journal (MCP) and the citation structure, and in the case of individual and collective results, the total number of papers by institution (UT) and total number of citations by country (CT), and for the universities' top ranking, the Quacquarelli Symonds World University Ranking (QSR), the Quacquarelli Symonds World University Research Output (QSRO) and the number of students per institution.

An objective search methodology is proposed, based on the search for the publication name for each of the 22 selected journals in "name of publication" in the WoS. The selection of the journals is based on previous studies on fuzzy research bibliometrics using certain statistics such as the fuzzy h-index and percentages of fuzzy papers published in the journals. The selection of the database responds to the need for a robust and wide scientific database that comprises peer-evaluated research journals. Some search filters are also proposed to focus the research on articles, letters, reviews and notes. Finally, a manual discrimination of the results was performed, first in the category of in-

stitutions in order to avoid university systems and focusing on the core individual results and second on countries, to update the counts of currently non-existing countries to their actual geo-politic territories.

Along with the natural results of compiling and representing large amounts of data in convenient tables and figures, this study offers additional implications including a visualization of the conformation or association of research groups and possible synergies between researchers, leading institutions that explore fuzzy techniques and new opportunities for applications in emerging research countries. Future research is needed as there are limitations for this study; first to broaden the scope on both the databases for the research of these study topics, e.g., in Scopus or Google Scholar, and the 22 selected journals, and second to find connecting trends with other topics such as authors, research areas, other journals and a selection of diverse timespans to generate a wider picture of the citing scope on the rapidly growing field of fuzzy research [30–32].

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