Engineering Applications of Artificial Intelligence 85 (2019) 517–532

Contents lists available at ScienceDirect

Engineering Applications of Artificial Intelligence

journal homepage: www.elsevier.com/locate/engappai

Engineering applications of artificial intelligence: A bibliometric analysis of 30 years (1988–2018)☆

Amit K. Shukla [a], Manvendra Janmaijaya [a], Ajith Abraham [b,c], Pranab K. Muhuri [a,*]

[a] Department of Computer Science, South Asian University, New Delhi 110021, India
[b] Department of Computer Science, University of Pretoria, Pretoria 0002, South Africa
[c] Machine Intelligence Research Labs (MIR Labs), 3rd Street NW, P.O. Box 2259, Auburn, WA 98071, USA

ARTICLE INFO

Keywords:
Bibliometric study
Engineering applications of artificial intelligence
Scientometric mapping
Web of science
VOSviewer

ABSTRACT

The Engineering Applications of Artificial Intelligence (EAAI) is a journal of very high repute in the domain of Engineering and Computer Science. This paper gives a broad view of the publications in EAAI from 1988–2018, which are indexed in Web of Science (WoS) and Scopus. The main purpose of this research is to bring forward the prime impelling factors that bring about the EAAI publications and its citation structure. The publication and citation structure of EAAI is analyzed, which includes the distribution of publication over the years, citations per year and a bird's eye view of the citation structure. Then the co-citation analysis and over the year's trend of top keywords is given. The co-authorship networks and a geographic analysis of the sources is also provided. Further, a country-wise temporal and quantitative analysis of the publications is given along with the highly cited documents among the EAAI publications.

1. Introduction

The computer science and application community is increasing exponentially by contributing high quality research works and new findings. The authenticity of these high-quality works is approved and governed by the standardized journals. There are many well respected and influential journals who publishes such research works. Engineering Applications of Artificial Intelligence (EAAI) is one of the most prominent journal of computer science, which is published by the Elsevier. The publications in this journal can be broadly categorized in few subject areas: Artificial Intelligence, Control and system engineering, and Electrical and electronic engineering. According to the Journal Citation Report 2018 by Thomson Reuters, EAAI is one the high impact factor (IF = 3.526) journal within computer science. IFs are standard to measure the quality of the journal by evaluating a value which gives the average number of citation count of the journal referenced by other journals. EAAI has been publishing Survey papers/tutorials, Contributed papers, and Case studies or software reviews for last 30 years. Thus, in this paper, we have provided a retrospective exploration of the publications in EAAI.

Bibliometrics or sometimes referred as Scientometrics is an evaluation criterion of the research performed (Alvarez-Betancourt and Garcia-Silvente, 2014). It is one of the widely accepted quantitative and statistical analysis of the journals or the articles to generate some useful knowledgeable structures. When performed for a journal, it is basically concluding the overall growth structure, the quality of publication, the structure and citation landscape of the journal. Bibliometric analysis can also be used for identifying research strength and weakness, influencing authors in the area, best performing nations etc. Not only it is a part of library and information science, but it has been widely used in various research areas over the years (Du and Teixeira, 2012; Chen and Ho, 2015; Yataganbaba and Kurtbaş, 2016; Shukla et al., 2018; Muhuri et al., 2019). Heck and Bremser (1986) gave a first analysis where they presented the precise summary of the author and institutional contribution in the Accounting reviews journal. Over the years many authors have performed the bibliometric study of the various journals including: Naqvi (2005) on Journal of Documentation, Van Fleet et al. (2006) on Journal of Management, Chen et al. (2008) on Data & knowledge Engineering, Cobo et al. (2015) on Knowledge based systems etc. In 2017, few of the high-quality work on bibliometric study of prominent computer science journals can also be observed from the literature survey. Xu et al. (2017) presented an analysis on Transactions on Fuzzy Systems from 1994–2015, and evaluated structural and temporal analysis of the journal. On the auspicious occasion of the 40th anniversary of the European Journal of Operational Research, Laengle et al. (2017) showed the bibliometric overview of the journal since its inception in 1977. A retrospective analysis with text mining and

☆ No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to https://doi.org/10.1016/j.engappai.2019.06.010.

* Corresponding author.
E-mail address: pranabmuhuri@cs.sau.ac.in (P.K. Muhuri).

https://doi.org/10.1016/j.engappai.2019.06.010
Received 20 December 2018; Received in revised form 14 June 2019; Accepted 17 June 2019
Available online 16 July 2019
0952-1976/

bibliometric study of the Information Science Journal was presented by Yu et al. (2017) from 1968–2016. Other recent journal specific scientometric works include (Muhuri et al., 2018; Janmaijaya M et al., 2018). The bibliometric study of these significant journals is very crucial from research growth point of view. Thus, bibliometric analysis of EAAI journal is obligatory for its research participants to excel the quality of publications.

The journal of Engineering Applications of Artificial Intelligence is one of the sought-out journals in the field of the artificial intelligence (AI) and maintains a very high reputation among the research fraternity. EAAI is ranked 17 out of 61 in Web of Science (WOS)'s 'Automation & Control Systems' category, 31 out of 132 in 'Computer Science, Artificial Intelligence', 13 out of 86 in 'Engineering, Multidisciplinary' and 75 out of 260 in 'Engineering, Electrical & Electronic'. The prominence of EAAI in WoS research categories explain the large reader base it has maintained throughout the years. The popularity of EAAI publications is very evident from the fact that they attract a large number of citations. This kind of scientometric/bibliometric study is on this journal would not only benefit the research community to assess the performance of the journal but also help the young researcher to get an overall view of the AI field including sought out authors, hot areas, highly cited papers etc. It also provides an aerial view of the intrinsic structure of publication and citation distribution over the years. The major objective of this paper is to perform an extensive bibliometric analysis to explore the publication structure and growth of the journal of EAAI in last 30 years. The data of all the documents considered for this study have been retrieved from the WoS and Scopus database and the results are visualized side-by-side. This paper also presents the general bibliometric overview of the EAAI publications by taking into consideration the top cited publications, highly influential authors, institutions and countries along with their collaborations. Such analysis determines the nature of the EAAI citations and structure of the journal.

The paper is organized as follows: Section 2 includes the data source and the methodology used for the study. Section 3 shows the publications and citation structure of EAAI along with co-citations analysis of citing journals and the co-occurrence of author keywords of EAAI publications over the years. Section 4 depicts the authorship and co-authorship of the journal along with most productive and influential institutes and their bibliographic coupling. Section 5 shows the country vise analysis of EAAI publications along with a temporal analysis of top contributing countries in four phases. A conclusion is drawn in Section 6.

2. Data collection and methodology

We have performed the data collection process from the Web of Science (WoS) and Scopus repositories, which are one of the widely used database for bibliometric analysis. Although, Scopus has wider range of publishing article indexing, it suffers from few inconsistencies. On the other hand, WoS is accounted for the indexing of high-quality publications (Zavadskas et al., 2014). Majority of analysis works are performed only with WoS data (Yu et al., 2017; Merigó et al., 2015). However, we have performed the analysis on both the databases i.e. WoS and Scopus and provided the side-by-side investigation. The difference between the two databases is quite coherent. WoS has a strong coverage which goes back to 1900 while Scopus has coverage only till 1960. Scopus covers superior number of journals but with lower impact and limited to recent articles. WoS is more favored by the researchers in Scientometrics as it indexes high quality journals and recognized international conferences.

The data is extracted from 1992 till 2018 and the search query was performed on 3rd April, 2019. The query used in the search engine of WoS and Scopus was "SO = Engineering Applications of Artificial Intelligence". A total of 2960 publications were reported in the above-mentioned time span from WoS and 3104 from Scopus. The two of the most widely used indexes in computer science community have been utilized for this purpose: The Science Citation Index-Expanded (SCI-E) and the Social Science Citation Index (SSCI). The data retrieved consists of several number of tags which are: author, country, title, abstract, citation record, author affiliation etc.

A lot of performance indicators have been used in the literature for bibliographic analysis. Total Papers (TP) is the total number of publications from the source, Total Citations (TC) is the total number of citations received by the publication, Citations per Paper (CPP) is Total number of received citations count divided by Total publications, Citations Per Year (CPY) is the average citations received by a publication per year, h-index represents the research output of a resource and is equal to the number of papers (N) that have more than N citations and the number of cited publications. A graphical tool has been used to visually represent the bibliographic coupling between different countries and institutions. The co-citation graph is also presented.

3. Publication and citation structure of EAAI

The EAAI journal first started its publication in March 1988. From the WoS extraction query, the data for analysis is generated from 1992 onwards while Scopus returns data from 1988. The total number of publications graph over the years is shown in Fig. 1. In the initial four years of publication no data was available for WoS. In 1992, 48 papers were published by EAAI followed by 50, 59 and 65 publications in subsequent years. The overall growth of the journal in terms of publications has increased since 1990, however, there are minor dints in publications as compared to previous years. The years including 1996–97, 1999, 2001–02, 2005, 2014, and 2016 observed minor decline in the number of publications as compared to the respective last year. Although the annual publications were over 50 since 1993, but the publication volumes increased significantly after 2008 and is higher than 100 counts till 2018. The highest number of publications, 234 came in 2013 and around 32% of total publications (967) in EAAI are perceived in last 5 years. Till June, 2018, EAAI already published 150 papers and the trend shows that this year it will reach to new milestone.

Although there were few irregularities in the total publication trend, the citations per year growth has been exponential since 1992. The distributions of citations over the years in shown in Fig. 2, as per the WoS. EAAI has received the total of 40447 citations over these years and an average citation per year count of 1498.03. In 2018 EAAI publications received highest number of citations of 6666. A review paper on time series mining published in 2011 has received highest of 453 citations till 2018 (Fu, 2011). Here, the citation count statistics by Scopus are not provided because of the limited features of its system. It only provides the TC data of only last 10 years, which would not provide realistic statistics of the publications in the last 30 years (see Table 1).

The general citation structure by Scopus data is given in Table 2. There are 11 publications which have received more than 200 citations including (Fu, 2011; He and Wang, 2007; Leitao, 2009; Weber et al., 2012; Rashedi et al., 2011; Taormina et al., 2012; Faruk, 2010; Gokceoglu and Zorlu, 2004; Abraham et al., 2008; Yildiz, 2013; Wu and Tan, 2006). Then, there are 72 papers with more than 100 citations forming 2.31% of total publications. For more than 50 citations and more than 20 citations, we have got 306 and 967 papers, respectively. Moreover, approximately 52% of the publications have more than 10 citations with 1627 total publications. This dissimilarity in the Scopus data analysis is because of the difference in the publication sources indexed by Scopus.

In Table 3, we have ranked the top 25 journals from WoS and Scopus that have documents citing EAAI publications. The top citing journals according to WoS and Scopus are EAAI (1062) and Lecture Notes in Computer Science (1580), respectively. On analysis of WoS, it is found that apart from EAAI, journals like Expert Systems with Applications, Applied Soft Computing, Neurocomputing, Information Sciences, and International Journal of Advanced Manufacturing Technology have cited EAAI frequently with 862, 669, 394, 376, and 370

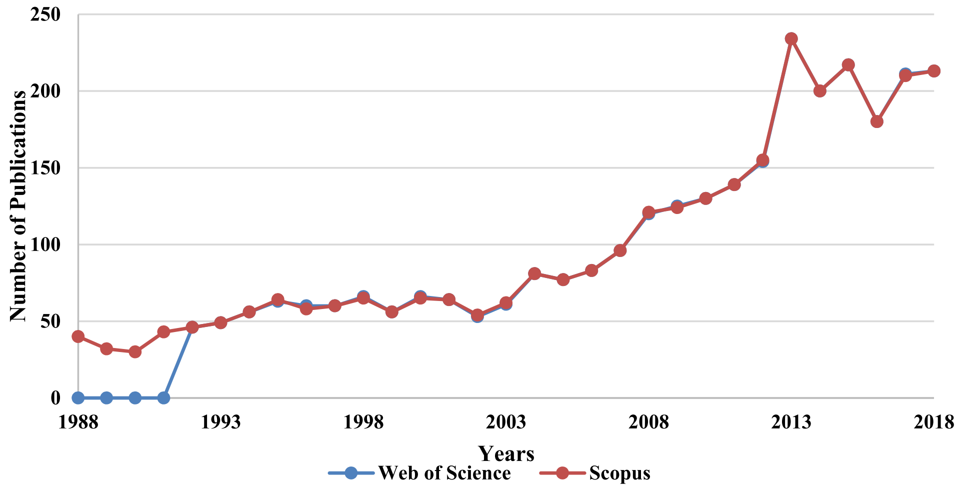

Fig. 1. Distribution of publication over the years.

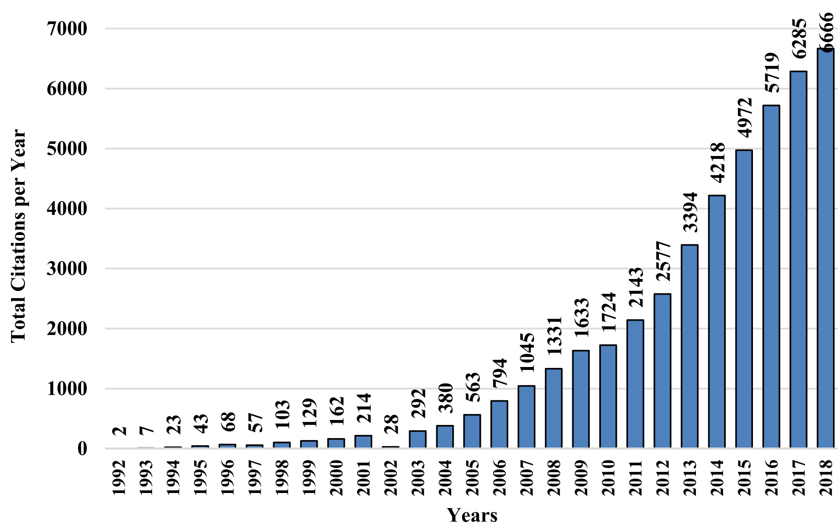

Fig. 2. Distribution of citations over the year (1992–2018).

times, respectively. They are followed by Mathematical Problems in Engineering (292), Neural Computing Applications (290), IEEE Access (275), International Journal of Production Research (261), etc. The higher IF journals like IEEE Transactions on Fuzzy Systems has also cited EAAI 125 times over these years.

The analysis of Scopus data is as follows: Journals like Engineering Applications of Artificial intelligence, Expert Systems with Applications, Applied Soft Computing Journal, Advances in Intelligent Systems and Computing, and Neurocomputing have cited EAAI frequently with 1368, 965, 770, 494 and 433 times, respectively. They are followed by Information Sciences (418), International Journal of Advanced Manufacturing Technology (409), Studies in Computational Intelligence (401), Neural Computing and Applications (376), etc.

Co-citation analysis between the various computer science journals with the results extracted from WoS is given in Fig. 3. Co-citations analysis takes number of citations into the consideration and counts the total number of times an article from a journal is cited in the other journal. In Fig. 3, Engineering Applications of Artificial Intelligence is centered in the middle with the largest node representing that most of the citations has come from it. Other major nodes which have cited articles from EAAI, are also prominent in the figure which are: Expert Systems and Applications, Lecture Notes in Computer Science, IEEE Transactions on Neural Networks, Fuzzy Sets and Systems, and European Journal of Operational Research Etc.

Furthermore, the co-citation analysis results extracted from Scopus between the various journals is represented in Fig. 4. Again, Engineering Applications of Artificial Intelligence is the most prominent journal in terms of highest citation counts. Other significant journals are Neurocomputing, IEEE transactions on Fuzzy Systems, European Journal of Operational research etc.

Furthermore, we have compiled the list of topmost 40 papers from WoS and Scopus, with respective authors, year of publication, TC, and CPY in EAAI. Table 4 enlists the data from WoS while Table 5 shows the results from Scopus data. In the results from WoS dataset, the paper published in 2011 by Fu (2011) has received highest number of citations of 453. It has the average per year citation rate of 56.63. The paper on engineering design problem with the help of particle swarm optimization (PSO) by He and Wang (2007) has received the second highest citation count of 340. It is followed by survey paper on Agent-based distributed manufacturing control by Leitao (2009) with 329 citations. The most recent paper to make it into top 40 most cited papers was published in 2014 by Kuila and Jana (2014). In case of Scopus data analysis, as in Table 5, the paper by Fu (2011) still remains at the top with TC of 615 and citations per year of 76.9. It is followed by Leitao (2009), He and Wang (2007), Dharia and Adeli (2003), and Weber et al. (2012) with citations per year of 44.4 (TC = 444), 35.3 (TC = 424), 20.3 (TC = 325), and 44.7 (TC = 313), respectively.

The visual representation of the used keywords in WoS used since 1992 is shown in Fig. 5 with the help of VOSviewer

Table 1
General citation structure in EAAI with WoS data (1992–2018).

Year	≥200	≥100	≥50	≥20	≥10	≥5	≥1	0	TP	TC	CPP
2018	0	0	0	2	9	26	132	81	213	435	2.04
2017	0	0	1	9	27	73	179	32	211	1056	5.00
2016	0	0	2	15	55	109	173	7	180	1553	8.63
2015	0	0	4	36	96	159	212	5	217	2603	12.00
2014	0	1	7	56	117	159	195	5	200	3174	15.87
2013	0	5	13	69	139	191	228	6	234	4149	17.73
2012	1	3	15	46	96	130	152	2	154	3288	21.35
2011	1	4	10	47	89	122	136	3	139	3269	23.52
2010	0	1	13	50	94	114	129	1	130	2917	22.44
2009	1	4	16	61	89	106	122	3	125	3389	27.11
2008	0	4	11	47	79	102	119	1	120	2726	22.72
2007	1	4	13	44	71	85	95	1	96	2767	28.82
2006	0	2	10	33	52	67	83	0	83	1781	21.46
2005	0	0	11	39	55	69	77	0	77	1954	25.38
2004	0	2	10	37	58	70	79	2	81	2033	25.10
2003	2	4	16	35	43	49	61	0	61	2180	35.74
2002	0	0	4	19	32	37	51	2	53	949	17.91
2001	0	0	8	23	41	53	62	2	64	1417	22.14
2000	0	2	6	20	38	46	59	7	66	1298	19.67
1999	0	0	3	8	25	38	50	6	56	720	12.86
1998	0	0	0	10	22	39	62	4	66	591	8.95
1997	0	0	1	7	16	28	55	5	60	517	8.62
1996	0	0	3	13	22	35	51	9	60	765	12.75
1995	0	1	2	5	15	28	51	12	63	526	8.35
1994	0	0	0	1	8	25	49	7	56	271	4.84
1993	0	0	0	1	8	16	38	11	49	229	4.67
1992	0	0	0	2	7	13	37	9	46	218	4.74
Total	6	37	179	735	1403	1989	2737	223	2960		
%	0.19	1.19	5.79	23.64	45.32	64.49	89.49	8.50			

Table 2
General citation structure in EAAI with Scopus Data (1988–2018).

Year	≥200	≥100	≥50	≥20	≥10	≥5	≥1	0	TP	TC	CPP
2018	0	0	0	6	14	39	153	60	213	62	0.30
2017	0	0	3	12	42	95	195	15	210	1421	7.89
2016	0	0	3	24	75	123	175	5	180	2000	9.22
2015	0	1	8	50	110	177	216	1	217	3229	16.15
2014	0	2	13	77	131	171	196	4	200	3907	16.70
2013	0	5	27	90	164	201	232	2	234	5372	34.66
2012	2	6	23	65	110	142	155	0	155	4293	30.88
2011	2	5	16	70	104	131	138	1	139	4328	33.29
2010	1	4	25	65	102	122	129	1	130	3868	31.19
2009	2	7	26	74	96	114	122	2	124	4548	37.59
2008	0	6	24	61	92	111	121	0	121	3815	39.74
2007	1	7	21	56	78	89	95	1	96	3617	43.58
2006	0	2	14	39	63	77	82	1	83	2414	31.35
2005	0	4	18	46	62	75	77	0	77	2840	35.06
2004	0	6	14	45	65	74	79	2	81	2661	42.92
2003	2	7	21	39	46	52	62	0	62	2982	55.22
2002	0	1	7	24	33	40	52	2	54	1196	18.69
2001	0	2	15	29	50	57	62	2	64	1946	29.94
2000	1	3	10	26	43	51	59	6	65	1757	31.38
1999	0	0	3	14	28	44	51	5	56	892	13.72
1998	0	0	2	16	29	43	64	1	65	827	13.78
1997	0	1	2	10	18	35	56	4	60	714	12.31
1996	0	1	7	16	28	33	54	4	58	1055	16.48
1995	0	1	3	8	17	35	57	7	64	685	12.23
1994	0	0	0	3	11	28	52	4	56	337	6.88
1993	0	0	0	4	11	18	37	12	49	291	6.33
1992	0	0	0	3	8	17	39	7	46	255	5.93
1991	0	1	1	1	5	13	31	12	43	244	8.13
1990	0	0	0	0	1	5	19	11	30	61	1.91
1989	0	0	0	0	3	4	17	15	32	77	1.93
1988	0	0	0	0	2	8	24	16	40	101	2.52
Total	11	72	306	967	1627	2185	2748	143	3104		
%	0.35	2.31	9.85	31.15	52.41	70.39	88.53	4.60			

(van Eck and Waltman, 2010). It is easily accessible open source software developed for visualizing the bibliometric maps. This tool shows the bibliometric coupling between the nodes which represents the subject area and the link between them represents the collaboration between the research keywords. From these figures, we can conclude that the topics of neural networks, genetic algorithm, artificial intelligence, data mining, multi-objective optimization etc. are still used as a major research area in EAAI since its inception.

Table 3
Journals citing EAAI.

	Web of Science		Scopus	
	Journal name	TP	Journal name	TP
1	Engineering Applications of Artificial Intelligence	1062	Lecture Notes in Computer Science including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	1580
2	Expert Systems with Applications	862	Engineering Applications of Artificial Intelligence	1368
3	Applied Soft Computing	669	Expert Systems with Applications	965
4	Neurocomputing	394	Applied Soft Computing Journal	770
5	Information Sciences	376	Advances in Intelligent Systems and Computing	494
6	International Journal of Advanced Manufacturing Technology	370	Neurocomputing	433
7	Mathematical Problems in Engineering	292	Information Sciences	418
8	Neural Computing Applications	290	International Journal of Advanced Manufacturing Technology	409
9	IEEE Access	275	Studies in Computational Intelligence	401
10	International Journal of Production Research	261	Neural Computing and Applications	376
11	Knowledge Based Systems	244	IFAC Proceedings Volumes IFAC Papers online	319
12	Soft Computing	230	Soft Computing	308
13	Computers Industrial Engineering	227	Mathematical Problems in Engineering	306
14	Sensors	217	International Journal of Production Research	296
15	Journal of Intelligent Fuzzy Systems	197	Applied Mechanics and Materials	284
16	Journal of Intelligent Manufacturing	187	Knowledge Based Systems	274
17	Energy	166	IEEE Access	269
18	Applied Intelligence	165	Computers and Industrial Engineering	251
19	Computers Chemical Engineering	158	Journal of Intelligent and Fuzzy Systems	217
20	International Journal of Electrical Power Energy Systems	145	Sensors Switzerland	212
21	Energies	141	Journal of Intelligent Manufacturing	212
22	ISA Transactions	129	IEEE International Conference on Fuzzy Systems	187
23	Mechanical Systems and Signal Processing	128	Advanced Materials Research	179
24	Industrial Engineering Chemistry Research	127	Computers and Chemical Engineering	156
25	IEEE Transactions on Fuzzy Systems	125	Proceedings of The World Congress on Intelligent Control and Automation WCICA	128

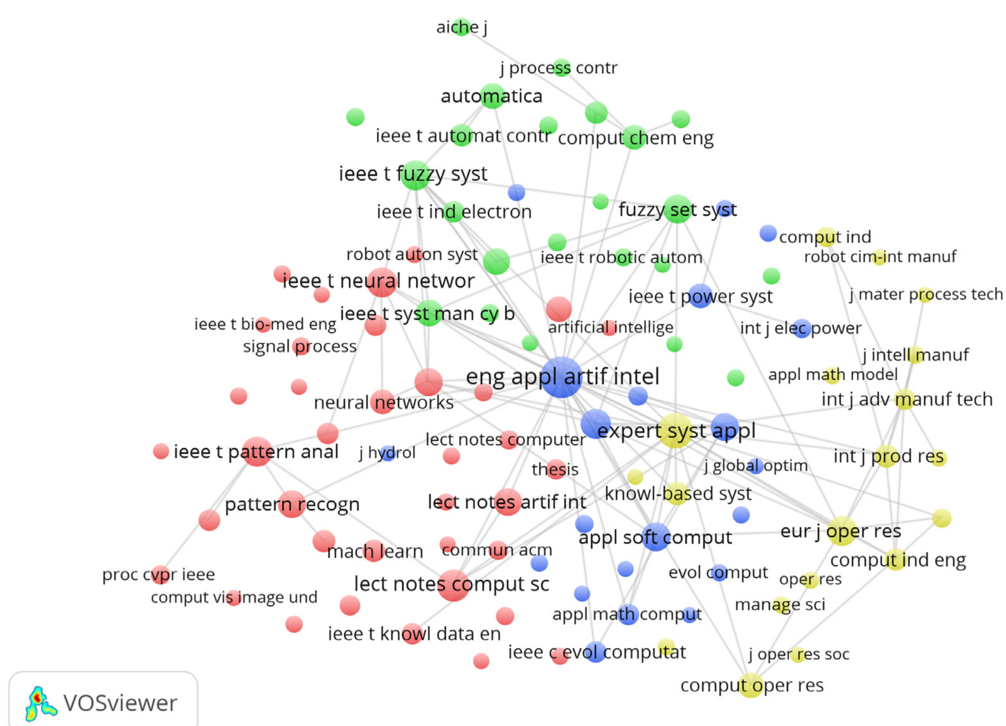

Fig. 3. Co-citation analysis of journals from WoS.

Fig. 6 shows the visualization of keywords extracted from Scopus dataset. Apart from the same frequently used keywords from the authors in WoS result, there are other prominent keywords such as: fuzzy logic, fuzzy systems, fault diagnosis etc.

Fig. 7 shows the trend of using the keywords in last 7 years from 2011–18 to analyze the area of research targeted by the researchers in recent times. There are few keywords which are prominent such as: particle swarm optimization, multi-objective optimization, machine learning, genetic algorithm, neural networks etc. The more precise listing of the keywords over the years and temporal analysis from WoS is shown in Table A.1 and Table A.2 in Appendix. Table A.1 shows the overall trend of the use of keywords and also the latest 7 years pattern from 2011–2018. The major keywords in top 5 are neural network (neural networks), genetic algorithm (genetic algorithms), fuzzy logic, artificial intelligence with total occurrences of 243, 210, 81, and 64, respectively. If we see the same table for the last 7 years pattern, genetic algorithms and neural networks are still in top 5 with 40 and 35 occurrences. However, particle swarm optimization, machine

Table 4
Top 40 most cited papers in EAAI as extracted from WoS.

Rank	Title	Authors	TC	Publication year	CPY
1	A review on time series data mining (Fu, 2011)	Fu Tak-chung	453	2011	56.63
2	An effective co-evolutionary particle swarm optimization for constrained engineering design problems (He and Wang, 2007)	He Qie; Wang, Ling	340	2007	28.33
3	Agent-based distributed manufacturing control: A state-of-the-art survey (Leitao, 2009)	Leitao Paulo	329	2009	32.90
4	Artificial neural networks and support vector machines with genetic algorithm for bearing fault detection (Samanta et al., 2003)	Samanta B; Al-Balushi, KR; Al-Araimi, SA	251	2003	15.69
5	Overview on Bayesian networks applications for dependability, risk analysis and maintenance areas (Weber et al., 2012)	Weber P; Medina-Oliva, G; Simon, C; Iung, B	223	2012	31.86
6	Auto ID systems and intelligent manufacturing control (McFarlane et al., 2003)	McFarlane D; Sarma, S; Chirn, JL; Wong, CY; Ashton, K	204	2003	12.75
7	Filter modeling using gravitational search algorithm (Rashedi et al., 2011)	Rashedi Esmat; Nezamabadi-pour, Hossien; Saryazdi, Saeid	192	2011	24.00
8	Artificial neural network simulation of hourly groundwater levels in a coastal aquifer system of the Venice lagoon (Taormina et al., 2012)	Taormina Riccardo; Chau, Kwok-wing; Sethi, Rajandrea	189	2012	27.00
9	A hybrid neural network and ARIMA model for water quality time series prediction (Faruk, 2010)	Faruk Durdu Oemer	170	2010	18.89
10	A fuzzy model to predict the uniaxial compressive strength and the modulus of elasticity of a problematic rock (Gokceoglu and Zorlu, 2004)	Gokceoglu C; Zorlu, K	166	2004	11.07
11	Design of fractional-order (Abraham et al., 2008)	Biswas Arijit; Das, Swagatam; Abraham, Ajith; Dasgupta, Sambarta	156	2009	15.60
12	Comparison of evolutionary-based optimization algorithms for structural design optimization (Yildiz, 2013)	Yildiz Ali R	148	2013	24.67
13	Genetic learning and performance evaluation of interval type-2 fuzzy logic controllers (Wu and Tan, 2006)	Wu Dongrui; Tan, Woei Wan	148	2006	11.38
14	Application of interactive genetic algorithm to fashion design (Kim and Cho, 2000)	Kim HS; Cho, SB	145	2000	7.63
15	A survey on applications of the harmony search algorithm (Manjarres et al., 2013)	Manjarres D; Landa-Torres, I; Gil-Lopez, S; Del Ser, J; Bilbao, M. N; Salcedo-Sanz, S; Geem, Z. W	144	2013	24.00
16	A combined neural-wavelet model for prediction of Ligvanchai watershed precipitation (Nourani et al., 2009)	Nourani Vahid; Alami, Mohammad T; Aminfar, Mohammad H	139	2009	13.90
17	AdaBoost with SVM-based component classifiers (Li et al., 2008)	Li Xuchun; Wang, Lei; Sung, Eric	137	2008	12.45
18	Blended biogeography-based optimization for constrained optimization (Ma and Simon, 2011)	Ma Haiping; Simon, Dan	135	2011	16.88
19	Energy efficient clustering and routing algorithms for wireless sensor networks: Particle swarm optimization approach (Kuila and Jana, 2014)	Kuila Pratyay; Jana, Prasanta K	133	2014	26.60
20	Combining a neural network with a genetic algorithm for process parameter optimization (Cook et al., 2000)	Cook DF; Ragsdale, CT; Major, RL	125	2000	6.58
21	Genetic algorithm-based multi-objective optimization of cutting parameters in turning processes (Sardinas et al., 2006)	Sardinas RQ; Santana, MR; Brindis, EA	122	2006	9.38
22	An integrated multi-criteria decision analysis and inexact mixed integer linear programming approach for solid waste management (Cheng et al., 2003)	Cheng S; Chan, CW; Huang, GH	117	2003	7.31
23	Machine-learning paradigms for selecting ecologically significant input variables (Muttil and Chau, 2007)	Muttil Nitin; Chau, Kwok-Wing	115	2007	9.58
24	Multi-agent model predictive control for transportation networks: Serial versus parallel schemes (Negenborn et al., 2008)	Negenborn R. R; De Schutter, B; Hellendoorn, J	113	2008	10.27
25	Neural network model for rapid forecasting of freeway link travel time (Dharia and Adeli, 2003)	Dharia A; Adeli, H	110	2003	6.88
26	Forecasting the behavior of an elderly using wireless sensors data in a smart home (Suryadevara et al., 2013)	Suryadevara N. K; Mukhopadhyay, S. C; Wang, R; Rayudu, R. K	109	2013	18.17
27	Neural network and neuro-fuzzy assessments for scour depth around bridge piers (Bateni et al., 2007)	Bateni S. M; Borghei, S. M; Jeng, D. -S	108	2007	9.00
28	Multi-objective optimization of two stage thermoelectric cooler using a modified teaching–learning-based optimization algorithm (Rao and Patel, 2013)	Rao R. Venkata; Patel, Vivek	106	2013	17.67
29	State of the art of smart homes (De Silva et al., 2012)	De Silva Liyanage C; Morikawa, Chamin; Petra, Iskandar M	106	2012	15.14
30	Parameter optimization of modern machining processes using teaching–learning-based optimization algorithm (Rao and Kalyankar, 2013)	Rao R. Venkata; Kalyankar, V. D	105	2013	17.50
31	Optimizing feedforward artificial neural network architecture (Benardos and Vosniakos, 2007)	Benardos P. G; Vosniakos, G. -C	104	2007	8.67
32	An efficient hybrid algorithm based on modified imperialist competitive algorithm and K-means for data clustering (Niknam et al., 2011)	Niknam Taher; Fard, Elahe Taherian; Pourjafarian, Narges; Rousta, Alireza	103	2011	12.88
33	Hand gesture recognition using a neural network shape fitting technique (Stergiopoulou and Papamarkos, 2009)	Stergiopoulou E; Papamarkos, N	103	2009	10.30
34	Recognition of facial expressions using Gabor wavelets and learning vector quantization (Bashyal and Venayagamoorthy, 2008)	Bashyal Shishir; Venayagamoorthy, Ganesh K	103	2008	9.36
35	A hybrid genetic algorithm for the multi-depot vehicle routing problem (Ho et al., 2008)	Ho William; Ho, George T. S; Ji, Ping; Lau, Henry C. W	103	2008	9.36

(*continued on next page*)

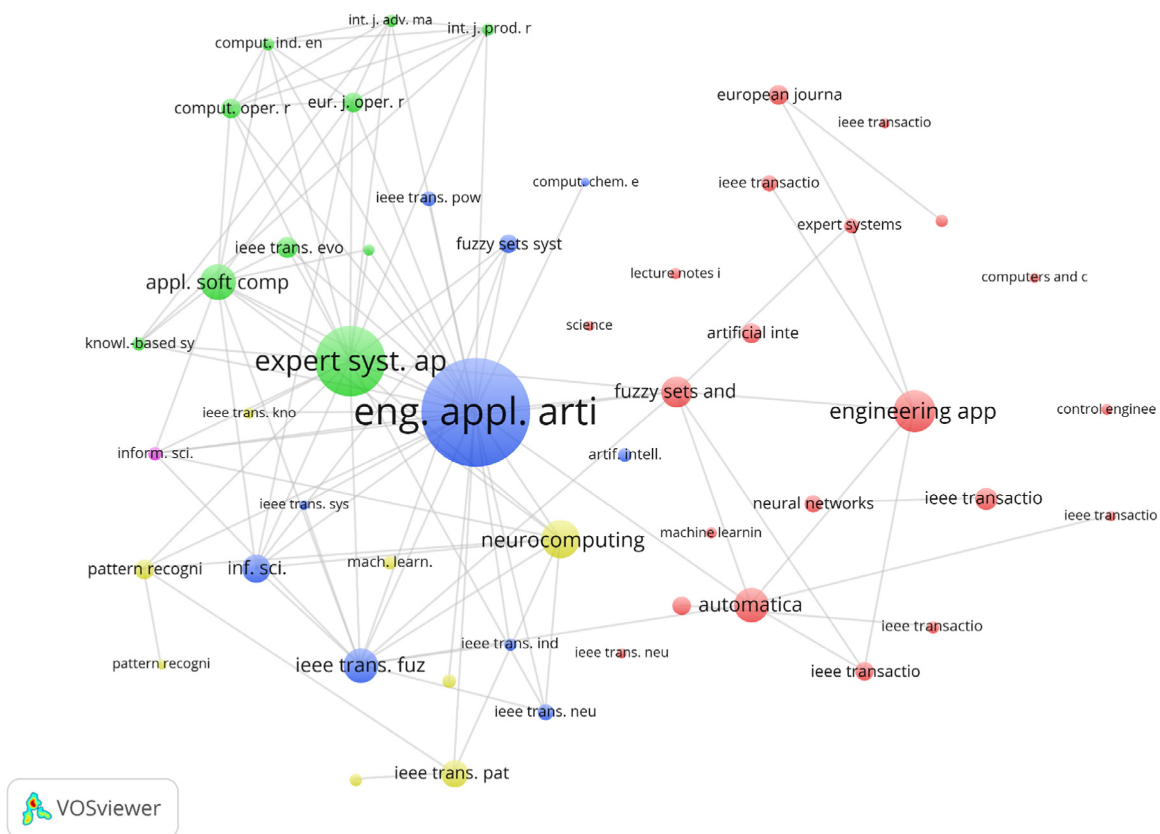

Fig. 4. Co-citation analysis of journals from Scopus.

Table 4 (*continued*).

Rank	Title	Authors	TC	Publication year	CPY
36	Evolving the neural network model for forecasting air pollution time series (Niska et al., 2004)	Niska H; Hiltunen, T; Karppinen, A; Ruuskanen, J; Kolehmainen, M	103	2004	6.87
37	A Syntactic Pattern-Recognition approach for process monitoring and fault-diagnosis (Rengaswamy and Venkatasubramanian, 1995)	Rengaswamy R; Venkatasubramanian, V	100	1995	4.17
38	A comparative study of population-based optimization algorithms for downstream river flow forecasting by a hybrid neural network model (Chen et al., 2015)	Chen X. Y; Chau, K. W; Busari, A. O	98	2015	24.50
39	Simulation based fuzzy TOPSIS approach for group multi-criteria supplier selection problem (Zouggari and Benyoucef, 2012)	Zouggari Akram; Benyoucef, Lyes	98	2012	14.00
40	A novel fractional order fuzzy PID controller and its optimal time domain tuning based on integral performance indices (Das et al., 2012)	Das Saptarshi; Pan, Indranil; Das, Shantanu; Gupta, Amitava	98	2012	14.00

learning, and data mining has entered the major keywords spot with 41, 31, and 26 occurrence, respectively. Moreover, from Table A.2, which shows the occurrences of keywords during last two decades, we can conclude that during 2001–10 most of the major keywords used in overall time span have been same. Quite interestingly, during 1992–2000, few keywords like fault diagnosis and knowledge systems were major keywords with 24 occurrences each.

To see the keyword trend over last 30 years from Scopus, Table A.3 shows the most common keywords in EAAI used by the authors. Few of the most widely used keywords are: Neural Network, Genetic Algorithm, Fuzzy Logic, Artificial Intelligence etc.

4. Authorship and co-authorship

The authors are the major backbone of any publishing journal. Table 6 shown below lists the top 15 most productive and significant authors contributing to EAAI, as per WoS extracted results. Table 7 lists the same output mined from Scopus. In both the Tables, Chan tops the list of most productive authors with 20 publications in WoS and 19 publications in Scopus, having TC of 483 in WoS and TC of 652 in Scopus. Apart from Chan, there are seven other authors which are common in both the Tables but with different rankings due to the inconsistency in indexing by the two indexers. These authors are Huang, Abraham, Papamarkos, Passino, Venkatasubramanian, Bourbakis, Chatterjee, Salcedo, Venayagamoorthy and Pedrycz.

In WoS, 13 authors have published at least 10 papers. Chan tops the list with 20 publications and 483 total citations. Huang and Abraham rank at 2nd and 3rd spot with 15 and 12 publications. They are followed by Papamarkos (12), Pedrycz (12), and Salcedo-Sanz (12) with 345, 214 and 235 citations, respectively. It is worth noticing that despite being at 12th and 13th positions, authors Chau and Wang have the CPP of 63.3 and 63.1 with publications count of 10 for both. In Scopus, every author in the top 15 list have more than 11 publications. The highest CPP is attained by Wang (66.4) with TP of 15 and TC of 996. He is followed by Venkatasubramanian (56.58) and Abraham (44.33) in terms of CPP.

Now, we present the topmost 25 institutions that are sorted on the basis of total publications and compiled the results in Table 8. Other performance metric including TC, CPP and h-index is also mentioned. Table 8 is based on the results extracted from WoS only since the Scopus

Table 5
Top 40 most cited papers in EAAI as extracted from Scopus.

Rank	Title	Authors	TC	Publication year	CPY
1	A review on time series data mining (Fu, 2011)	Fu, T.-C.	615	2011	76.9
2	Agent-based distributed manufacturing control: A state-of-the-art survey (Leitao, 2009)	Leitato, P.	444	2009	44.4
3	An effective co-evolutionary particle swarm optimization for constrained engineering design problems (He and Wang, 2007)	He, Q.; Wang, L.	424	2007	35.3
4	Neural network model for rapid forecasting of freeway link travel time (Dharia and Adeli, 2003)	Dharia, A.; Adeli, H.	325	2003	20.3
5	Overview on Bayesian networks applications for dependability, risk analysis and maintenance areas (Weber et al., 2012)	Weber, P.; Medina-Oliva, G.; Simon, C.; Iung, B.	313	2012	44.7
6	Real-time batch process supervision by integrated knowledge-based systems and multivariate statistical methods (Ündey et al., 2003)	Ündey, C.; Tatara, E.; Çınar, A.	298	2003	18.6
7	Filter modeling using gravitational search algorithm (Rashedi et al., 2011)	Rashedi, E.; Nezamabadi-Pour, H.; Saryazdi, S.	263	2011	32.9
8	A hybrid neural network and ARIMA model for water quality time series prediction (Faruk, 2010)	Faruk, D.	237	2010	26.3
9	Design of fractional-order PID controllers with an improved differential evolution (Abraham et al., 2008)	Biswas, A.; Das, S.; Abraham, A.; Dasgupta, S.	218	2009	21.8
10	Artificial neural network simulation of hourly groundwater levels in a coastal aquifer system of the Venice lagoon (Taormina et al., 2012)	Taormina, R.; Chau, K.-W.; Sethi, R.	209	2012	29.9
11	Closed-loop fault diagnosis based on a nonlinear process model and automatic fuzzy rule generation (Ballé and Fuessel, 2000)	Ballé, P.; Fuessel, D.	208	2000	10.9
12	Hybrid knowledge representation in a blackboard KBS for liquid retaining structure design (Chau and Albermani, 2004)	Chau, K.W.; Albermani, F.	194	2004	12.9
13	AdaBoost with SVM-based component classifiers (Li et al., 2008)	Li, X.; Wang, L.; Sung, E.	192	2008	17.5
14	A survey on applications of the harmony search algorithm (Manjarres et al., 2013)	Manjarres, D.; Landa-Torres, I.; Gil-Lopez, S.; Del Ser, J.; Bilbao, M.N.; Salcedo-Sanz, S.; Geem, Z.W.	190	2013	31.7
15	Genetic learning and performance evaluation of interval type-2 fuzzy logic controllers (Wu and Tan, 2006)	Wu, Dongrui; Wan Tan, Woei	185	2006	14.2
16	Energy efficient clustering and routing algorithms for wireless sensor networks: Particle swarm optimization approach (Kuila and Jana, 2014)	Kuila, P.; Jana, P.K.	183	2014	36.6
17	Blended biogeography-based optimization for constrained optimization (Ma and Simon, 2011)	Ma, H.; Simon, D.	169	2011	21.1
18	Roboskeleton: An architecture for coordinating robot soccer agents (Camacho et al., 2006)	Camacho, D.; FernÃ¡ndez, F.; Rodelgo, M.A.	168	2006	12.9
19	Comparison of evolutionary-based optimization algorithms for structural design optimization (Yildiz, 2013)	Yildiz, A.R.	167	2013	27.8
20	A hybrid genetic algorithm for the multi-depot vehicle routing problem (Ho et al., 2008)	Ho, W.; Ho, G.T.S.; Ji, P.; Lau, H.C.W.	160	2008	14.5
21	Multi-agent model predictive control for transportation networks: Serial versus parallel schemes (Negenborn et al., 2008)	Negenborn, R.R.; De Schutter, B.; Hellendoorn, J.	159	2008	14.5
22	A combined neural-wavelet model for prediction of Ligvanchai watershed precipitation (Nourani et al., 2009)	Nourani, V.; Alami, M.T.; Aminfar, M.H.	152	2009	15.2
23	State of the art of smart homes (De Silva et al., 2012)	De Silva, L.C.; Morikawa, C.; Petra, I.M.	150	2012	21.4
24	A novel neuro-estimator and its application to parameter estimation in a remotely piloted vehicle (Menhaj and Salmasi, 2000)	Menhaj, M.B.; Rajaei Salmasi, F.	150	2000	7.9
25	Strip-packing using hybrid genetic approach (Yeung and Tang, 2004)	Yeung, L.H.W.; Tang, W.K.S.	146	2004	9.7
26	Mathematical modeling and optimization strategies (genetic algorithm and knowledge base) applied to the continuous casting of steel (Muttil and Chau, 2007)	Santos, C.A.; Spim, J.A.; Garcia, A.	144	2003	9.0
27	UML 2.0 and agents: How to build agent-based systems with the new UML standard (Bauer and Odell, 2005)	Bauer, B.; Odell, J.	143	2005	10.2
28	Parameter optimization of modern machining processes using teaching–learning-based optimization algorithm (Rao and Kalyankar, 2013)	Venkata Rao, R.; Kalyankar, V.D.	142	2013	23.7
29	Multi-objective optimization of two stage thermoelectric cooler using a modified teaching–learning-based optimization algorithm (Rao and Patel, 2013)	Venkata Rao, R.; Patel, V.	140	2013	23.3
30	Recognition of facial expressions using Gabor wavelets and learning vector quantization (Bashyal and Venayagamoorthy, 2008)	Bashyal, S.; Venayagamoorthy, G.K.	139	2008	12.6
31	A novel fractional order fuzzy PID controller and its optimal time domain tuning based on integral performance indices (Das et al., 2012)	Das, S.; Pan, I.; Das, S.; Gupta, A.	136	2012	19.4
32	Artificial intelligence for monitoring and supervisory control of process systems (Uraikul et al., 2007)	Uraikul, V.; Chan, C.W.; Tontiwachwuthikul, P.	136	2007	11.3
33	Hand gesture recognition using a neural network shape fitting technique (Stergiopoulou and Papamarkos, 2009)	Stergiopoulou, E.; Papamarkos, N.	134	2009	13.4
34	Model-based design indexing and index learning in engineering design (Bhatta and Goel, 1996)	Bhatta, S.R.; Goel, A.K.	134	1996	5.8
35	Ant colony intelligence in multi-agent dynamic manufacturing scheduling (Xiang and Lee, 2008)	Xiang, W.; Lee, H.P.	133	2008	12.1
36	Forecasting the behavior of an elderly using wireless sensors data in a smart home (Suryadevara et al., 2013)	Suryadevara, N.K.; Mukhopadhyay, S.C.; Wang, R.; Rayudu, R.K.	132	2013	22.0
37	Optimizing feedforward artificial neural network architecture (Benardos and Vosniakos, 2007)	Benardos, P.G.; Vosniakos, G.-C.	132	2007	11.0
38	Non-fragile output feedback H∞ vehicle suspension control using genetic algorithm (Du et al., 2003)	Du, H.; Lam, J.; Sze, K.Y.	132	2003	8.3
39	An efficient hybrid algorithm based on modified imperialist competitive algorithm and K-means for data clustering (Niknam et al., 2011)	Niknama, T.; Fard, E.T.; Pourjafarian, N.; Rousta, A.	129	2011	16.1
40	Design and analysis of fuzzy schedulers using fuzzy Lyapunov synthesis (Margaliot and Langholz, 2001)	Margaliot, M.; Langholz, G.	128	2001	7.1

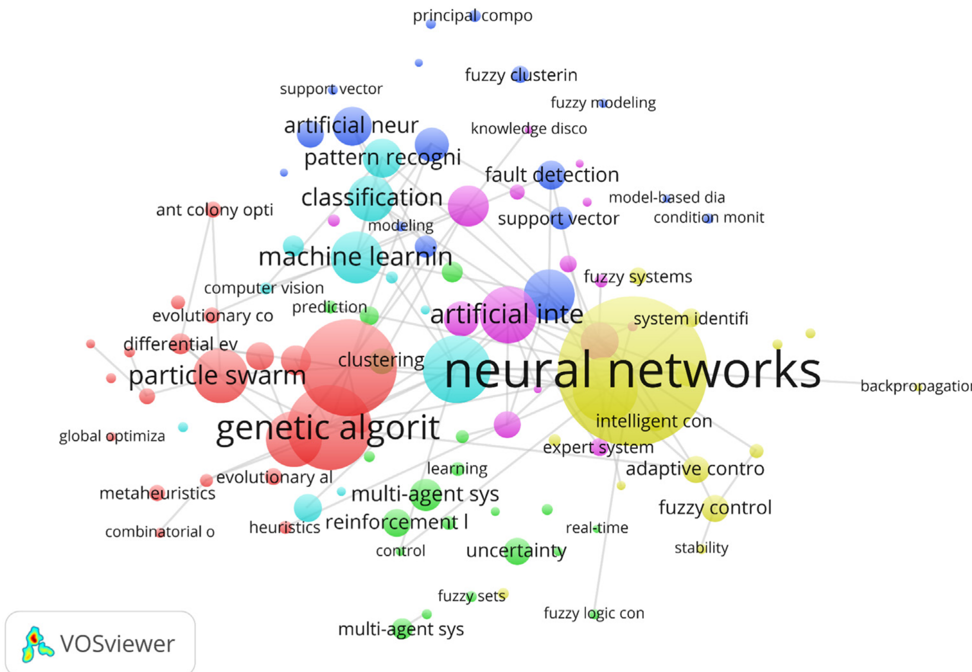

Fig. 5. Co-occurrence of author keywords of publications in EAAI from WoS (1992–2018).

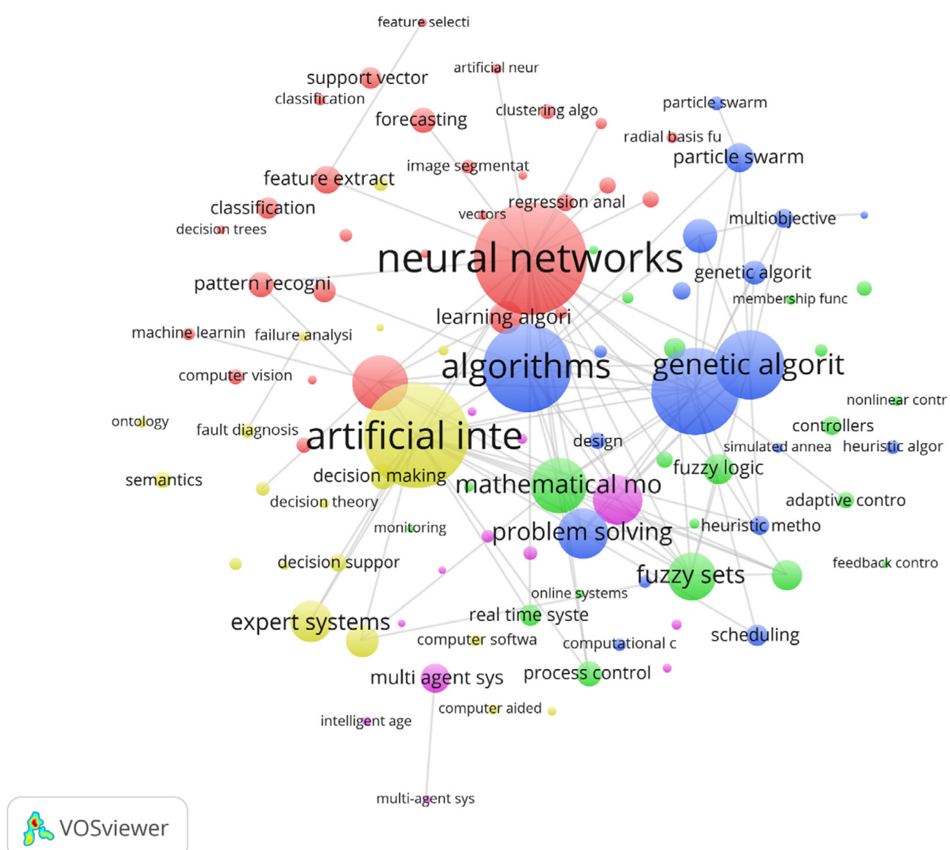

Fig. 6. Co-occurrence of author keywords of publications in EAAI, from Scopus (1988–2018).

results were inconsistent. Centre National De La Recherche Scientifique CNRS institution from France has published maximum number of 105 publications and received 1814 citations. Other than CNRS, there are other institutions from France that made it to the top 25 lists such as: Universite Lille Nord De France Comue (40), Universite De Toulouse (34), Universite Federale Toulouse Midi Pyrenees Comue (25) and Universite De Valenciennes Et Du Hainaut Cambresis (26). There are two Indian institutions in the list, Indian Institute of Technology IIT (44) at 3rd position and Jadavpur University (25) at 17th position. Two other Asian institutions from Singapore and Hong Kong make it

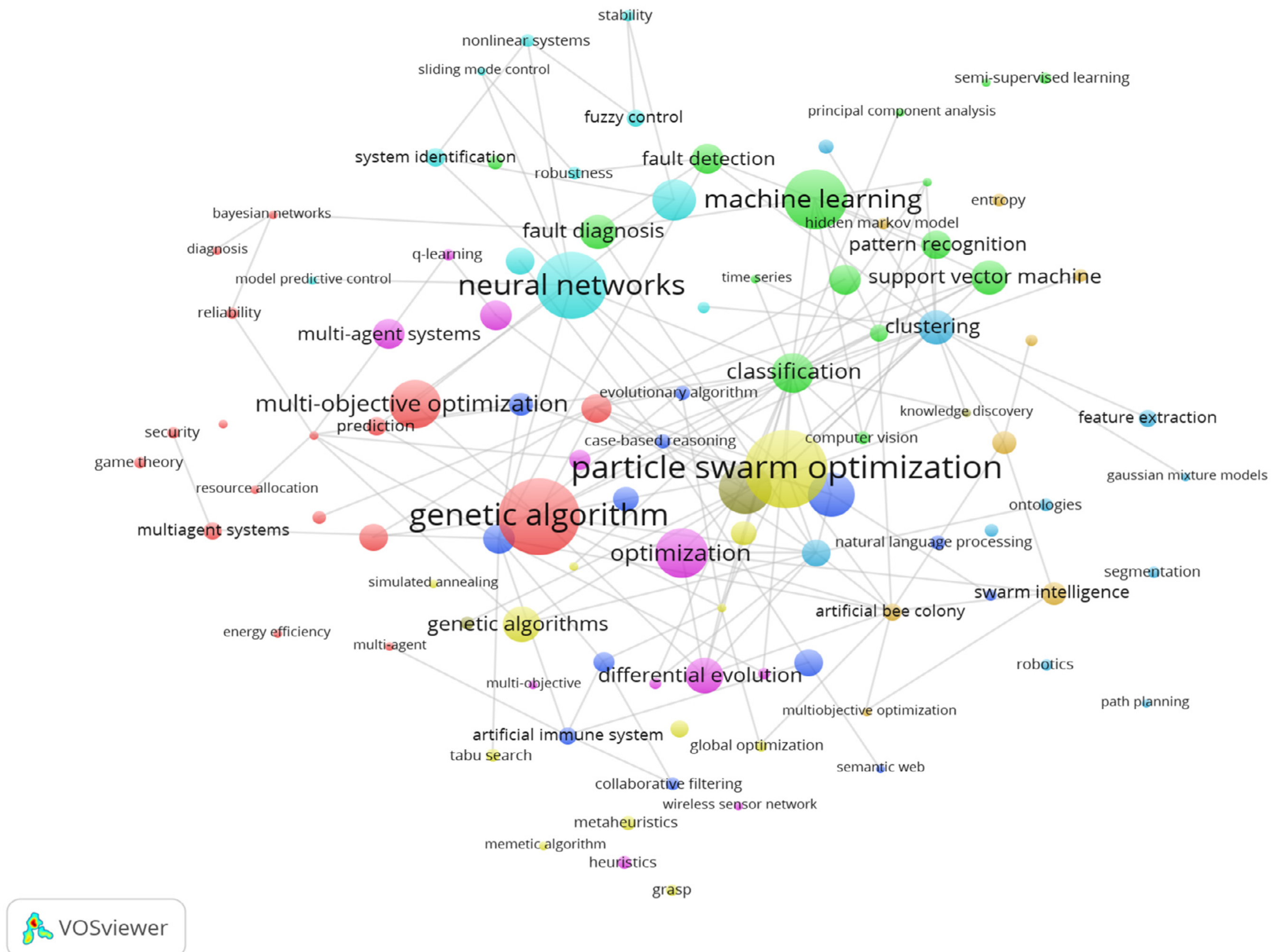

Fig. 7. Co-occurrence of author keywords of publications in EAAI (2011–2018).

Table 6
Most productive and influential authors in EAAI as extracted from WoS.

Rank	Author name	TP	TC	CPP
1	Chan CW	20	483	24.15
2	Huang GH	15	344	22.93
3	Abraham A	12	386	32.17
4	Papamarkos N	12	345	28.75
5	Pedrycz W	12	214	17.83
6	Salcedo-Sanz S	12	235	19.58
7	Chatterjee A	11	117	10.64
8	Passino KM	11	106	9.64
9	Venayagamoorthy GK	11	278	25.27
10	Venkatasubramanian V	11	464	42.18
11	Botti V	10	105	10.50
12	Chau KW	10	633	63.30
13	Wang L	10	631	63.10
14	Babuska R	9	121	13.44
15	Li YP	9	167	18.56

Table 7
Most productive and influential authors in EAAI as extracted from Scopus.

Rank	Author name	TP	TC	CPP
1	Chan CW	19	652	34.32
2	Chen Y	16	158	9.88
3	Wang L	15	996	66.40
4	Zhang Y	15	262	17.47
5	Huang GH	14	450	32.14
6	Liu Y	13	162	12.46
7	Abraham A	12	532	44.33
8	Adeli H	12	396	33.00
9	Li C	12	330	27.50
10	Li Z	12	222	18.50
11	Papamarkos N	12	466	38.83
12	Pedrycz W	12	266	22.17
13	Salcedo-Sanz S	12	313	26.08
14	Venkatasubramanian V	12	679	56.58
15	Venayagamoorthy GK	11	373	33.91

to the top 5 list which are Nanyang Technological University (47), and Hongkong Polytechnic University (41), respectively.

An interesting thing to notice about China is that despite being the highest contributor of publications, only two institutes Shanghai Jiao Tong University (29) and Chinese Academy of Sciences (23) make it to the top 25 list. This implies that lot of other institutions are also contributing to the total publication count of EAAI from China

Fig. 8 shows the bibliographic coupling between the institutions. Bibliographic coupling forms a link between the papers citing the same publications. It can also be defined as the common association between any two identities. In this case, these identities are the institutions. From the figure, it can be seen that on the left bottom side a cluster of pink color is formed of the group of institutions from France which often collaborate with each other. Similarly, we can see the coupling between the four major institutions in the world such as: Nanyang Technological University (Singapore), National University of Singapore (Singapore), Indian Institute of Technology IIT (India), and Delft University of Technology (Netherlands). These all form a cluster with blue

Table 8
Most productive and influential institutions.

Rank	Organization	TP	TC	CPP	H-index
1	Centre National De La Recherche Scientifique CNRS	105	1814	17.28	21
2	Nanyang Technological University	47	789	16.79	15
3	Indian Institute of Technology System IIT System	44	997	22.66	19
4	Hong Kong Polytechnic University	41	1650	40.24	19
5	Universite Lille Nord De France Comue	40	629	15.73	15
6	Universitat Politecnica De Valencia	37	467	12.62	13
7	National University of Singapore	36	848	23.56	17
8	Universite De Toulouse	34	351	10.32	11
9	State University System of Florida	32	458	14.31	12
10	Delft University of Technology	31	399	12.87	12
11	Shanghai Jiao Tong University	29	457	15.76	13
12	University of Regina	29	638	22.00	12
13	Islamic Azad University	28	466	16.64	12
14	City University of Hong Kong	26	422	16.23	13
15	Universite De Valenciennes Et Du Hainaut Cambresis	26	505	19.42	13
16	Universite Federale Toulouse Midi Pyrenees Comue	25	270	10.80	10
17	Jadavpur University	24	644	26.83	13
18	Purdue University	24	572	23.83	13
19	University of Sheffield	24	288	12.00	10
20	Chinese Academy of Sciences	23	239	10.39	9
21	Fondation I Site ULNE	23	380	16.52	11
22	Universite De Lille	23	318	13.83	10
23	Amirkabir University of Technology	22	539	24.50	12
24	University of Alberta	22	440	20.00	11
25	University of Hong Kong	22	550	25.00	13

Table 9
Most productive countries in EAAI as extracted from WoS.

S. No.	Country	TP	TC	CPP
1	Peoples R China	450	7856	17.46
2	USA	398	6081	15.28
3	Spain	262	3471	13.25
4	France	242	3807	15.73
5	England	181	2832	15.65
6	Iran	177	3262	18.43
7	Canada	161	2336	14.51
8	India	159	3372	21.21
9	Taiwan	120	1867	15.56
10	Turkey	85	2212	26.02
11	Germany	82	1122	13.68
12	Singapore	79	1601	20.27
13	Italy	76	1135	14.93
14	Brazil	74	846	11.43
15	South Korea	72	1015	14.10

Table 10
Most productive countries in EAAI as extracted from Scopus.

S. No.	Country	TP	TC	CPP
1	USA	446	8800	19.73
2	Peoples R China	419	7690	18.35
3	UK	286	4950	17.31
4	Spain	264	4591	17.39
5	France	242	5137	21.23
6	Iran	177	4172	23.57
7	Canada	174	3360	19.31
8	India	166	4441	26.75
9	Taiwan	121	2535	20.95
10	Hong Kong	92	3108	33.78
11	Germany	90	1794	19.93
12	Singapore	87	2186	25.13
13	Turkey	87	2912	33.47
14	Italy	78	1530	19.62
15	Brazil	76	1151	15.14

color on the top right side. The more solid link between the nodes represents the more number of collaboration between the institutions.

5. Country analysis of EAAI publications

In this section, we have provided the analysis from perspective of a country. Since, EAAI is one of the most sought out journal in computer science community and publishes the content related to most demanding topics, it has been targeted by many number of researchers from several countries. Top 15 Country wise analysis in terms of TP, TC, and CPP is shown in Tables 9 and 10, results extracted from WoS and Scopus, respectively. The ordering is based on the total number of publications by each country.

Table 9 tabulates the countries on the basis of data from WoS, Peoples R China is ranked on the topmost position with 450 papers and 7856 citations. Peoples R China is closely followed by USA with 398 papers and 6081 citations. It is followed by Spain (262), France (242), England (181), and Iran (177). It is worth mentioning that, developing countries like Iran, India, Taiwan and Turkey have made it to the top 10 countries to contribute in the EAAI journal with 177, 159, 120, and 85 publications, respectively. This clearly gives an impression on the quality of world class research done in the developing nations. Turkey shows the highest CPP of 26.02 with 85 papers and 2212 citations.

In the Scopus data, USA (indexed as United States in Scopus) counts the highest of 446 TP with 8800 TC. It is followed by China (TP = 419, TC = 7690) and United Kingdom (TP = 286, TC = 4950). CPP is highest for Hong Kong with value of 33.78 having only 92 publication and 3108 total citations. Turkey and India are next in terms of the CPP with the value of 33.47 and 26.75, respectively. Interestingly, the results extracted from WoS and Scopus compiled in Tables 9 and 10, respectively, are dissimilar. Such differences in TC can be accounted for the differing set of journals indexed in the two databases. For the inconsistency in the TP, let us consider the case of United Kingdom which in WoS is considered as England, North Ireland and Scotland separately.

Fig. 9 shows the clear distribution of publications in the form of bibliographic coupling from various countries in EAAI journal. These coupling are extracted from the WoS data. For visualization, we have used the VOSviewer where nodes represent the countries and the link between them shows the collaboration between them. Nodes with USA and China are more prominent and form a cluster with other countries such as: England, Iran, Singapore, Turkey etc. It represents that these set of countries in that cluster have more joined work with each other. Similarly, France, Canada, Poland, Germany etc. form another cluster.

The bibliographic coupling of the 25 most productive countries /territories in EAAI as extracted from Scopus is compiled in Fig. 10.

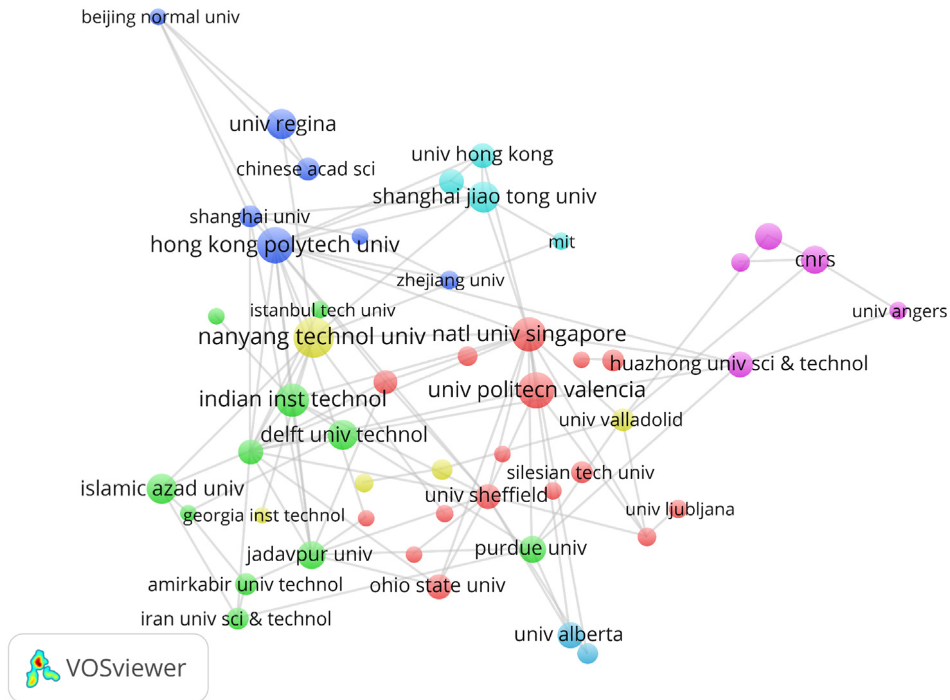

Fig. 8. Bibliographic coupling of institutions.

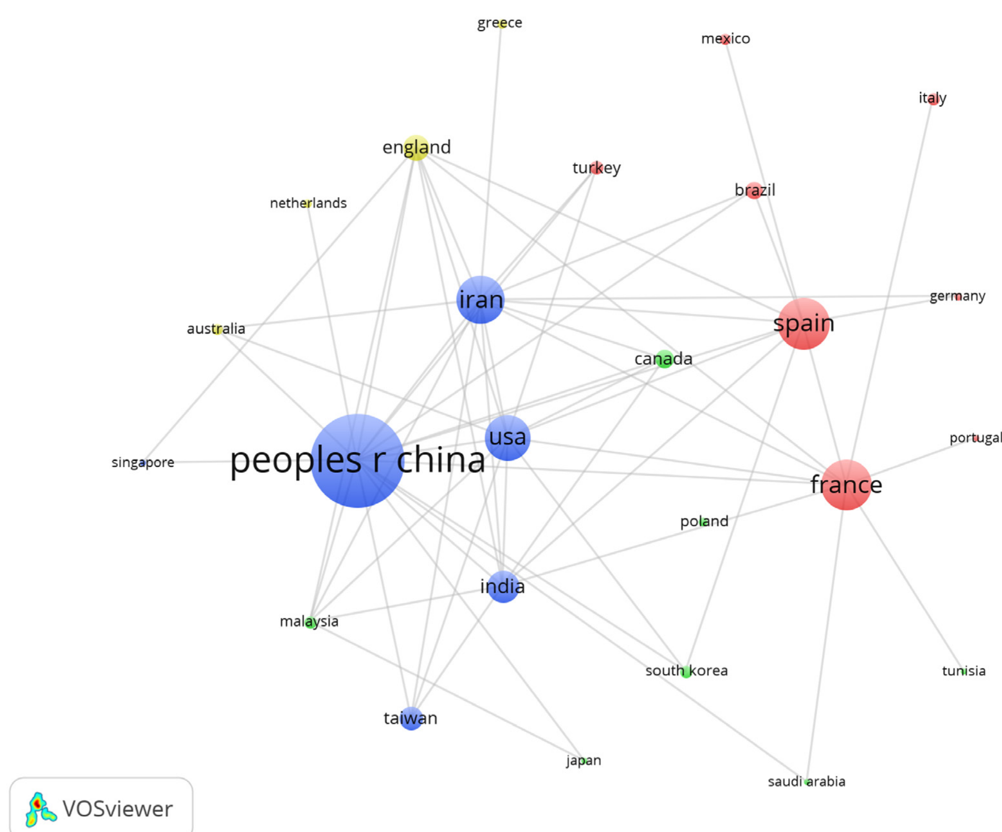

Fig. 9. Bibliographic Coupling of the 25 most productive countries/territories in EAAI (1992–2018) as extracted from WoS.

There is prominent collaborative work among United States and United Kingdom as can be seen in the bottom right part of the figure. China forms another major cluster. In one of the other clusters representing the collaboration is from countries Spain and France.

Table 11 shows the temporal analysis of the productive and influential countries in four times span: 1992–97, 1998–2004, 2005–2010, and 2011–18. In each time span, top 5 countries are ranked by the total number of publications. USA had dominated the first 3 time spans with 93, 103, and 79 total publications. Moreover, h-index is highest for USA

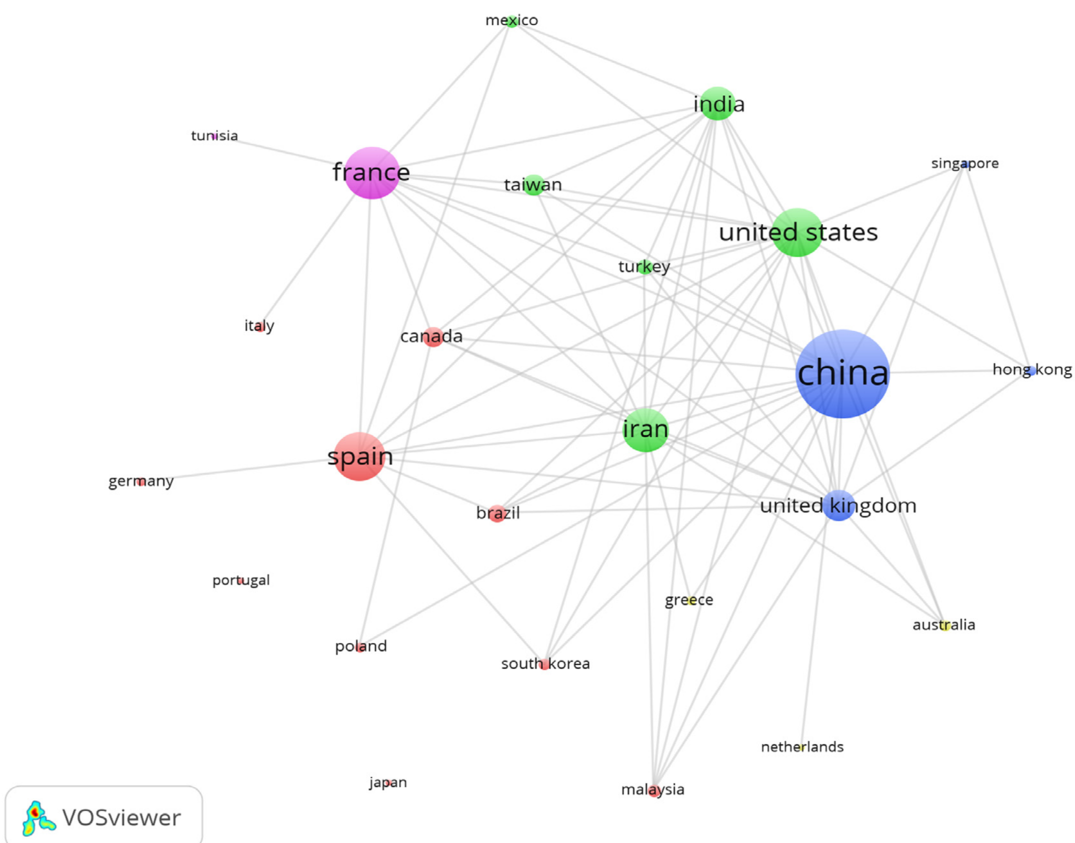

Fig. 10. Bibliographic Coupling of the 25 most productive countries/territories in EAAI (1988–2018) as extracted from Scopus.

Table 11
Most productive and influential countries in four different stages.

Years	Country/Territory	TP	TC	CPP	H-index
1992–1997	USA	93	749	8.05	15
	England	38	206	5.42	8
	Canada	29	219	7.55	5
	Hong Kong	18	107	5.94	5
	China	18	219	12.16	9
1998–2004	USA	103	1939	18.83	24
	England	41	794	19.37	15
	China	40	973	24.33	19
	Canada	37	683	18.46	15
	Singapore	29	568	19.58	16
2005–2010	USA	79	1852	23.44	25
	China	71	2259	31.82	29
	Spain	70	1340	19.14	22
	France	68	1493	21.96	23
	Canada	44	905	20.56	17
2011–2018	China	327	4643	14.20	31
	Spain	161	1756	10.91	20
	France	154	2014	13.08	22
	USA	151	1810	11.99	22
	Iran	147	2393	16.27	27

in only first two time span and it is less then China in the third time span of 2005–10, despite USA being the highest publisher in the third time span. Interestingly, China dominates the time span of 2011–18, with 327 publications and also the highest citations count of 4643. This trend of China in all four time span shows its incredible growth in the research paper publications in EAAI. In the last 7 years, one developing country Iran has shown a remarkable growth and reached the top 5 spot in publications count.

6. Conclusion

This paper explores the 30 years of EAAI publications as indexed by WoS and Scopus. Various bibliometric and statistical techniques are used to unearth the trends followed and certain characteristics of the publications. The citation history and publication structure is analyzed. Over the years, EAAI has gained tremendous repute in the research community. EAAI published maximum publications (234) in the year 2013. The journal attracted maximum citations in the year 2018 with 6666 citations. The journal has 6 and 11 papers with more than 200 citations over the years with respect to the WoS and Scopus, respectively. The most productive and influential authors of EAAI are Chan, Huang, Abraham, Papamarkos and Pedrycz as reported by WoS. According to Scopus, most influential authors are Chan, Chen, Wang, Zhang, and Huang. Central National De La Recherche Scientifique of France published maximum papers. USA stands as the most productive country according to both the database. Since its inception, EAAI has played a pioneer role in shaping the academic research and is truly discovering the trends in artificial intelligence.

Acknowledgments

Authors are thankful to the anonymous reviewers for their valuable comments which have helped them a lot in improving the paper significantly. First author thankfully acknowledges the INSPIRE fellowship received from the Department of Science and Technology, Government of India. Second author is grateful to the South Asian University, New Delhi, India for the financial support in the form of a Ph.D. fellowship.

Appendix

(see Tables A.1–A.3).

Table A.1
Most common keywords in EAAI during 1992–2018 and 2011–2018 from WoS.

1992–2018				2011–2018			
Rank	Keyword	Occurrence	Total link strength	Rank	Keyword	Occurrence	Total link strength
1	neural networks	171	98	1	particle swarm optimization	41	30
2	genetic algorithm	110	72	2	genetic algorithm	40	27
3	genetic algorithms	100	65	3	neural networks	35	20
4	fuzzy logic	81	70	4	machine learning	31	18
5	neural network	72	45	5	data mining	26	17
6	artificial intelligence	64	47	6	optimization	26	16
7	optimization	63	51	7	multi-objective optimization	25	13
8	particle swarm optimization	59	39	8	feature selection	23	13
9	fault diagnosis	58	55	9	neural network	22	12
10	machine learning	50	35	10	classification	21	19
11	artificial neural networks	45	25	11	differential evolution	19	15
12	classification	45	38	12	genetic algorithms	19	10
13	expert systems	45	37	13	clustering	18	11
14	data mining	41	26	14	fault diagnosis	18	11
15	pattern recognition	41	30	15	support vector machine	18	11
16	case-based reasoning	39	16	16	artificial intelligence	16	8
17	feature selection	36	25	17	fault detection	16	11
18	multi-agent systems	35	7	18	multi-agent systems	16	4
19	multi-objective optimization	34	20	19	reinforcement learning	16	5
20	evolutionary algorithms	32	22	20	support vector machines	16	10
21	fault detection	32	31	21	artificial neural networks	15	10
22	knowledge-based systems	32	26	22	pattern recognition	15	10
23	scheduling	32	22	23	ant colony optimization	14	11
24	fuzzy control	31	12	24	ontology	14	2
25	adaptive control	30	19	25	simulation	14	8
26	clustering	28	18	26	uncertainty	14	5
27	process control	28	30	27	evolutionary algorithms	13	7
28	reinforcement learning	28	10	28	fuzzy logic	13	5
29	simulation	27	22	29	genetic programming	12	8
30	support vector machines	27	19	30	gravitational search algorithm	12	6
31	support vector machine	26	14	31	swarm intelligence	12	8
32	multi-agent system	25	7	32	evolutionary computation	11	9
33	simulated annealing	25	24	33	multi-agent system	11	0
34	uncertainty	25	14	34	wireless sensor networks	11	8
35	feature extraction	24	14	35	prediction	10	11
36	artificial neural network	23	6	36	system identification	10	5
37	differential evolution	23	21	37	artificial bee colony	9	10
38	intelligent control	23	14	38	artificial immune system	9	3
39	system identification	23	17	39	artificial neural network	9	5
40	genetic programming	22	11	40	feature extraction	9	2

Table A.2
Most common keywords in EAAI during 2001–2010 and 1992–2000 from WoS.

2001–2010				1992–2000			
Rank	Keyword	Occurrence	Total link strength	Rank	Keyword	Occurrence	Total link strength
1	neural networks	59	28	1	neural networks	77	62
2	genetic algorithm	58	36	2	expert systems	38	42
3	genetic algorithms	58	40	3	fuzzy logic	34	43
4	neural network	39	27	4	artificial intelligence	28	46
5	fuzzy logic	34	29	5	fault diagnosis	24	41
6	optimization	23	23	6	knowledge-based systems	24	39
7	artificial intelligence	20	13	7	genetic algorithms	23	21
8	scheduling	20	12	8	case-based reasoning	18	17
9	artificial neural networks	19	12	9	expert system	18	21
10	multi-agent systems	19	3	10	process control	17	22
11	particle swarm optimization	18	13	11	fuzzy control	15	14
12	evolutionary algorithms	17	13	12	optimization	14	19
13	fault diagnosis	16	13	13	genetic algorithm	12	13
14	simulated annealing	16	17	14	intelligent control	12	15
15	adaptive control	15	8	15	knowledge representation	12	15
16	machine learning	15	12	16	artificial neural networks	11	3
17	pattern recognition	15	14	17	neural network	11	9
18	classification	14	13	18	pattern recognition	11	11
19	data mining	14	6	19	classification	10	6
20	multi-agent system	14	7	20	knowledge acquisition	10	7
21	artificial neural network	13	3	21	fuzzy systems	9	12
22	case-based reasoning	13	2	22	knowledge engineering	9	20
23	fault detection	11	12	23	adaptive control	8	14
24	feature selection	11	12	24	image processing	8	11

(*continued on next page*)

Table A.2 (*continued*).

2001–2010				1992–2000			
Rank	Keyword	Occurrence	Total link strength	Rank	Keyword	Occurrence	Total link strength
25	fuzzy systems	11	6	25	knowledge-based system	7	3
26	evolutionary algorithm	10	4	26	obstacle avoidance	7	3
27	fuzzy clustering	10	3	27	computer vision	6	5
28	genetic programming	10	6	28	diagnosis	6	10
29	reinforcement learning	10	2	29	feature extraction	6	5
30	simulation	10	8	30	software engineering	6	12
31	support vector machines	10	8	31	system identification	6	8
32	feature extraction	9	9	32	autonomous vehicles	5	2
33	multi-objective optimization	9	8	33	backpropagation	5	5
34	identification	8	6	34	conceptual design	5	3
35	knowledge-based systems	8	2	35	decision trees	5	6
36	metaheuristics	8	4	36	design	5	3
37	multiobjective optimization	8	6	37	fault detection	5	8
38	process control	8	8	38	knowledge bases	5	4
39	support vector machine	8	3	39	learning	5	7
40	uncertainty	8	7	40	logic programming	5	3

Table A.3
Most common keywords in EAAI during 1988–2018 from Scopus.

1992–2018			
Rank	Keyword	Occurrence	Total link strength
1	neural networks	159	663
2	genetic algorithm	107	450
3	genetic algorithms	91	351
4	fuzzy logic	71	298
5	neural network	71	312
6	artificial intelligence	64	284
7	optimization	62	271
8	particle swarm optimization	62	254
9	fault diagnosis	52	225
10	machine learning	52	212
11	classification	46	202
12	expert systems	46	209
13	pattern recognition	44	196
14	artificial neural networks	42	180
15	data mining	40	175
16	feature selection	37	166
17	multi-agent systems	36	161
18	multi-objective optimization	35	142
19	case-based reasoning	33	125
20	scheduling	33	142
21	fuzzy control	32	122
22	knowledge-based systems	32	134
23	evolutionary algorithms	31	137
24	adaptive control	30	128
25	clustering	29	126
26	fault detection	29	130
27	reinforcement learning	29	108
28	expert system	28	113
29	process control	28	124
30	simulation	27	113
31	support vector machine	27	108
32	uncertainty	27	117
33	support vector machines	26	99
34	multi-agent system	25	100
35	differential evolution	24	111
36	intelligent control	24	109
37	simulated annealing	24	100
38	feature extraction	23	97
39	system identification	23	98
40	artificial neural network	22	100

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