

An Analysis of Natural Computing Publication Venues

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Abstract

We present an analysis of different publication venues across the field of Natural Computing and compare these to the related fields of Machine Learning, Computational Intelligence, Artificial Intelligence, Machine Intelligence and Cybernetics. Our analysis is predominantly based upon Google Scholar Metrics h5-index. A positive correlation is found between the h5-index (2007-2011) and Impact Factors (2010), and an overall ranking of the different venues finds that a number of top conferences in the field have h5-index values equivalent, and in some cases superior to, the fields leading journals.

1 Introduction

A number of invaluable resources exist within the Natural Computing community, perhaps most notable is the Genetic Programming Bibliography actively maintained by William B Langdon [1] which also includes links to publications in the broader Evolutionary Computation literature ¹.

A ranking of Computer Science Conferences and Journals ² was published in 2008 by The Computing Research and Education Association of Australasia

¹For example, see <http://www.cs.bham.ac.uk/~wbl/biblio/ec-bibs.html>

²The ranking lists are available for journals from <http://core.edu.au/index.php/categories/journals/12> and conferences from <http://core.edu.au/index.php/categories/conference%20rankings/1>.

(CORE) [2]. In addition, the site www.cs-conference-ranking.org (which is no longer accessible) provided a useful ranking of Computer Science Conferences. A copy of this site is maintained at <http://perso.crans.org/~genest/conf.html>. A number of issues exist with these rankings, such as they are ageing rapidly, they are not actively updated, and there are differences in their methodologies and resulting rankings making them difficult to compare.

A recent addition to the resources available to researchers evaluating the impact of their publications is Google Scholar Metrics [3]. This is a useful tool to probe the impact of different publication venues (Conferences and Journals) according to citations, specifically their five year h-index (h5-index) and five year h-median (h5-median) based on the years 2007-2011. A list of the Top 100 venues (http://scholar.google.com/citations?view_op=top_venues) ranks Nature (h5-index of 295), the New England Journal of Medicine (h5-index of 274), and Science (h5-index of 265) as the Top three venues. The American Journal of Psychiatry is 100th with a h5-index of 88. Figure 1 captures the Top 40 publications on 8th May 2012. An interesting feature in the top 10 venues are the meta-sites RePEc, arXiv and the Social Science Research Network (SSRN).

In this paper we outline the impact of the different venues in the discipline of Natural Computing and compare their impact to areas of research with most commonality, including Machine Learning, Artificial Intelligence, Computational Intelligence, Machine Intelligence and Cybernetics. One striking finding is that the Google Scholar h5-index ranks a number of conferences on a par with journals in the field, and there appears to be a positive correlation between impact factors of the journals and the Google Scholar Metrics h5-index.

In the remainder of the paper we present the Google Scholar Metrics in Section 2, an analysis of the different venues for each research area in Section 3, followed by a comparative overview of the venue rankings in Section 4, before drawing some conclusions in Section 5.

2 Google Scholar Metrics

The metrics captured in this study were calculated on 1 April 2012 according to the Google Scholar Metrics information page [3]. The metric adopted for ranking is the h5-index, and in the event of matches on this value the h5-median is then employed. To explain what the h5-index and h5-median are we first need to explain how they are calculated in terms of the h-index, h-core and h-median.

Quoting from Google Scholar “*The h-index of a publication is the largest number h such that at least h articles in that publication were cited at least h times each. The h-core of a publication is a set of top cited h articles from the publication. The h-median of a publication is the median of the citation counts in its h-core.*” The h5 versions of these metrics are these metrics calculated over the last five complete calendar years (i.e., 2007-2011). When one searches on a venue the h5-index and h5-median are reported, and for each publication venue on Google Scholar Metrics one can drill down into the list of publications comprising the h5-core.

Title	h5-index	h5-median
1. Nature	295	427
2. New England Journal of Medicine	274	450
3. Science	265	388
4. RePEc	259	356
5. arXiv	256	367
6. The Lancet	205	313
7. Social Science Research Network	205	290
8. Cell	195	279
9. Proceedings of the National Academy of Sciences	189	237
10. Nature Genetics	174	268
11. Journal of Clinical Oncology	173	229
12. JAMA: The Journal of the American Medical Association	171	246
13. Physical Review Letters	162	213
14. Circulation	159	251
15. Chemical reviews	144	248
16. Blood	141	192
17. The Astrophysical Journal	140	181
18. Journal of the American College of Cardiology	139	192
19. Journal of the American Chemical Society	138	174
20. Nucleic Acids Research	135	239
21. Angewandte Chemie International Edition	133	190
22. Nature Reviews Molecular Cell Biology	128	219
23. Nature Medicine	127	191
24. Nano Letters	127	177
25. The Journal of Clinical Investigation	125	179
26. Nature Reviews Cancer	123	199
27. Nature Immunology	120	191
28. Cancer Research	120	165
29. Physical Review D	119	152
30. Chemical Society reviews	117	174
31. Neuron	117	155
32. Nature Reviews Immunology	116	198
33. Gastroenterology	116	155
34. NBER WORKING PAPER SERIES	115	177
35. Immunity	115	172
36. The Journal of Experimental Medicine	114	156
37. Nature Materials	113	202
38. Nature Reviews Genetics	113	194
39. Annals of Internal Medicine	113	180
40. Nature Biotechnology	112	200
41. Cochrane database of systematic reviews (Online)	112	156
42. Nature Reviews Neuroscience	110	175
43. BMJ	110	165
44. Advanced Materials	110	154
45. Physical Review B	110	147
46. Journal of Biological Chemistry	110	141
47. The Journal of Neuroscience	110	132

Figure 1: Google Scholar Metrics (h5-index) top publications in the English language.

It is worth highlighting at this stage that criticisms can and have been directed towards many metrics of impact such as the Impact Factor and h-index³, so the outcome of the analysis which follows should be treated with caution.

³For example, Wikipedia entries for these metrics (accessed 8 May 2012) highlight some of the criticisms [4, 5].

3 Google Scholar Metrics Analysis

We now present the results for queries of Google Scholar Metrics for a number of research areas related to Natural Computing as accessed on 8 May 2012. Some areas such as Particle Swarm Optimisation and Ant Colony Optimisation yielded no results at this time. A search on “Artificial Immune Systems” resulted in one entry, the International Conference on Artificial immune systems with a h5-index of 13 and a h5-median of 18.

3.1 Genetic Programming

A search of the term “Genetic Programming”⁴ yields a very interesting outcome (see Figure 2). Both the primary GP journal (GPEM) and the sole conference dedicated to the theme of GP (EuroGP) appear with equal h5-index values, with the journal having a slightly lower h5-median.

Publications matching <i>genetic programming</i>	Google Scholar Metrics	
	h5-index	h5-median
European Conference on Genetic Programming	15	29
Genetic Programming and Evolvable Machines	15	23

Figure 2: A ranking based on Google Scholar Metrics (h5-index) of the top publications searching on the term “Genetic Programming”.

A useful feature of Google Scholar Metrics is that it is possible to drill down into the publications which are used to generate the h5-index value for each venue (the h5-core) by clicking the hypertext link on the h5-index value itself. So for the two venues found with “Genetic Programming” each with a h5-index of 15 we see the corresponding 15 publications used to arrive at this h5-index value in Figures 3 and 4. It is also then possible to follow the link to each publication to see where its citations arise.

⁴http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=genetic+programming

European Conference on Genetic Programming – Google Scholar Metrics

http://scholar.google.com/citations?hl=en&view_op=list_hcore&venue=+v06378f5qhq.20120401

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H-index articles for European Conference on Genetic Programming			1-15
Title / Author	Cited by	Year	
A SIMD interpreter for genetic programming on GPU graphics cards WB Langdon, W Banzhaf Proceedings of the 11th European conference on Genetic programming, 73-85	82	2008	
Fast genetic programming on GPUs S Harding, W Banzhaf Proceedings of the 10th European conference on Genetic programming, 90-101	76	2007	
On the limiting distribution of program sizes in tree-based genetic programming R Poli, WB Langdon, S Dignum Proceedings of the 10th European conference on Genetic programming, 193-204	45	2007	
Population parallel GP on the G80 GPU D Robillard, V Marion-Poty, C Fontlupt Proceedings of the 11th European conference on Genetic programming, 98-109	39	2008	
Semantic building blocks in genetic programming NF McPhee, B Ohs, T Hutchison Proceedings of the 11th European conference on Genetic programming, 134-145	34	2008	
Genetic programming with fitness based on model checking CG Johnson Proceedings of the 10th European conference on Genetic programming, 114-124	32	2007	
Geometric particle swarm optimisation A Moraglio, C Di Chio, R Poli Proceedings of the 10th European conference on Genetic programming, 125-136	29	2007	
Evolution of an efficient search algorithm for the mate-in-N problem in chess A Hauptman, M Sipper Proceedings of the 10th European conference on Genetic programming, 78-89	25	2007	
Operator equalisation and bloat free GP S Dignum, R Poli Proceedings of the 11th European conference on Genetic programming, 110-121	24	2008	
Crossover, sampling, bloat and the harmful effects of size limits S Dignum, R Poli Proceedings of the 11th European conference on Genetic programming, 158-169	23	2008	
GP classification under imbalanced data sets: active sub-sampling and AUC approximation J Doucette, M Heywood Proceedings of the 11th European conference on Genetic programming, 266-277	22	2008	
Extending Operator Equalisation: Fitness Based Self Adaptive Length Distribution for Bloat Free GP S Silva, S Dignum Proceedings of the 12th European Conference on Genetic Programming, 159-170	20	2009	
Semantic Aware Crossover for Genetic Programming: The Case for Real-Valued Function Regression DU Nguyen, XH Nguyen, M O'Neill Proceedings of the 12th European Conference on Genetic Programming, 292-302	20	2009	
Self Modifying Cartesian Genetic Programming: Fibonacci, Squares, Regression and Summing S Harding, JF Miller, W Banzhaf Proceedings of the 12th European Conference on Genetic Programming, 133-144	19	2009	
A grammatical genetic programming approach to modularity in genetic algorithms E Hemberg, C Gilligan, M O'Neill, A Brabazon Proceedings of the 10th European conference on Genetic programming, 1-11	19	2007	
			1-15

Dates and citation counts are estimated and determined automatically by a computer program.
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Figure 3: The top 15 publications (in terms of Google Scholar citation counts) in the European Conference on Genetic Programming from 2007-2011.

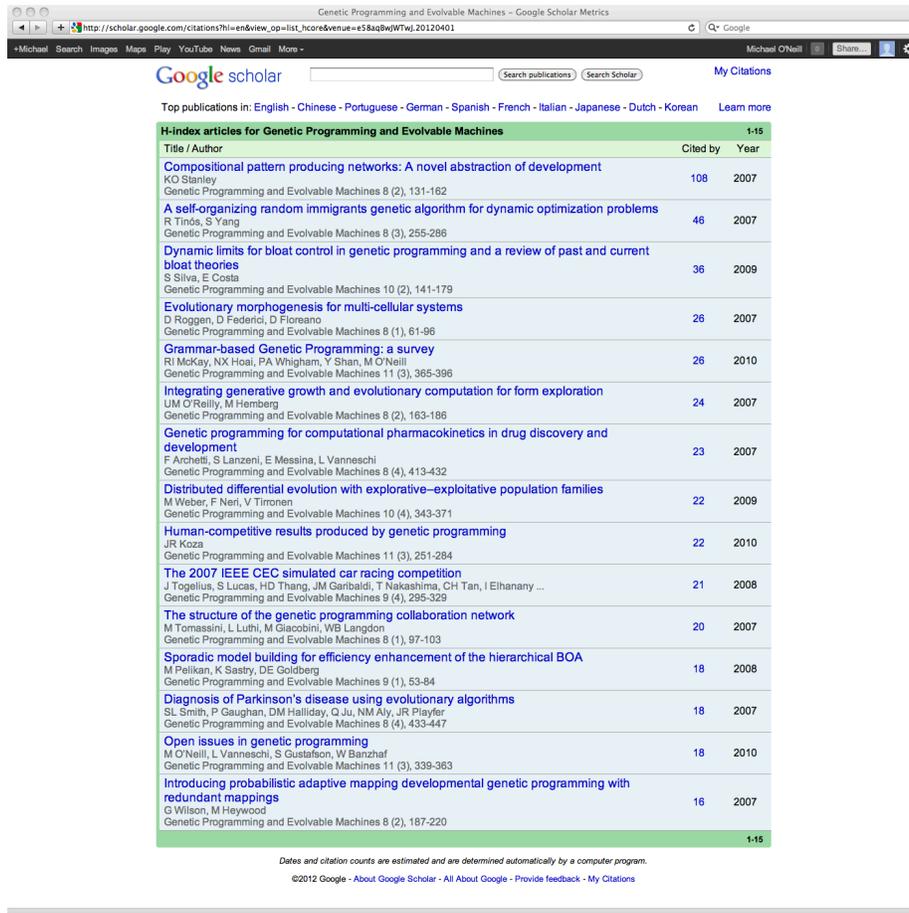


Figure 4: The top 15 publications (in terms of Google Scholar citation counts) in the Genetic Programming and Evolvable Machines journal from 2007-2011.

3.2 Evolutionary Computation

A search of the term “Evolutionary Computation”⁵ yields the results in Figure 5. Unsurprisingly top of the pile is the IEEE Transactions on Evolutionary Computation. What is very interesting is the relative superior ranking of the IEEE Congress on Evolutionary Computation (CEC) to the other primary field journal (Evolutionary Computation published by MIT Press), and also the fact that the other large conference (ACM Genetic and Evolutionary Computation Conference GECCO) has the same h5-index as the Evolutionary Computation journal.

Publications matching <i>evolutionary computation</i>	Google Scholar Metrics	
	h5-index	h5-median
IEEE Transactions on Evolutionary Computation	41	66
IEEE Congress on Evolutionary Computation, CEC	29	40
Evolutionary Computation	20	35
Annual Conference on Genetic and Evolutionary Computation	20	25
European Conference on Evolutionary Computation, Machine Learning and Data Mining in Bioinformatics	10	17
International Conference on Applications of evolutionary computation	7	9
<i>Annual Conference Companion on Genetic and Evolutionary Computation</i>	5	9

Figure 5: A ranking based on Google Scholar Metrics (h5-index) of the top publications searching on the term “Evolutionary Computation”.

3.3 Neural Networks

Searching for the term “Neural Networks”⁶ we find the results presented in Figure 6. In this case the top two entries are journals, namely the IEEE Transactions on Neural Networks and Neural Networks published by Elsevier, with the International Joint Conference on Neural Networks coming in third.

3.4 Natural Computing

Figure 7 presents the results of a search of the term “Natural Computing”⁷. Not surprisingly the Natural Computing journal published by Springer appears at the top of the ranking. What is surprising, and a trend which will emerge throughout the analysis presented here, is that the International Conference on Natural Computation (ICNC) appears with the same h5-index value as the fields journal albeit with a lower h5-median.

⁵http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=evolutionary+computation

⁶http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=neural+networks

⁷http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=natural+computing

Publications matching <i>neural networks</i>	Google Scholar Metrics	
	h5-index	h5-median
IEEE Transactions on Neural Networks	42	58
Neural Networks	34	45
International Joint Conference on Neural Networks	19	30
International Conference on Artificial neural networks	13	19
International Symposium on Neural Networks: Advances in Neural Networks	10	13
International work Conference on Artificial neural networks	10	12
International Conference on Neural Networks and Signal Processing	8	13
International Workshop on Cellular Neural Networks and Their Applications	8	9
International Symposium on Neural Networks	7	10
Optical Memory & Neural Networks	5	9
International Conference on Advances in neural networks	4	4

Figure 6: A ranking based on Google Scholar Metrics (h5-index) of the top publications searching on the term “Neural Networks”.

Publications matching <i>natural computing</i>	Google Scholar Metrics	
	h5-index	h5-median
Natural Computing	17	28
International Conference on Natural Computation	17	18
International Conference on Adaptive and Natural Computing Algorithms	12	13
New Mathematics and Natural Computation (NMNC)	10	14
International Conference on Computational Intelligence and Natural Computing, CINC	5	7

Figure 7: A ranking based on Google Scholar Metrics (h5-index) of the top publications searching on the term “Natural Computing”.

3.5 Machine Learning

Figure 8 shows the results of the search of the term “Machine Learning”⁸. Here we see the Annual International Conference on Machine Learning sandwiched between two of the fields journals (The Journal of Machine Learning Research and Machine Learning) with a considerably higher h5-index than Machine Learning.

3.6 Artificial Intelligence

A search of the term “Artificial Intelligence”⁹ yields a familiar trend at this stage with the National Conference on Artificial Intelligence emerging top of the pile ahead of the journals Artificial intelligence and the Journal of Artificial Intelligence Research.

⁸http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=machine+learning

⁹http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=artificial+intelligence

Publications matching <i>machine learning</i>	Google Scholar Metrics	
	h5-index	h5-median
The Journal of Machine Learning Research	51	71
Annual International Conference on Machine Learning	45	65
Machine Learning	28	53
European Conference on Machine learning and knowledge discovery in databases	22	31
International Conference on Machine Learning and Cybernetics	14	19
International Conference on Machine Learning and Data Mining in Pattern Recognition	11	21
International Conference on Machine Learning and Applications	11	16
European Conference on Evolutionary Computation, Machine Learning and Data Mining in Bioinformatics	10	17
IEEE International Workshop on Machine Learning for Signal Processing	10	13

Figure 8: A ranking based on Google Scholar Metrics (h5-index) of the top publications searching on the term “Machine Learning”.

Top 20 publications matching <i>artificial intelligence</i>	Google Scholar Metrics	
	h5-index	h5-median
National Conference on Artificial intelligence	42	59
Artificial Intelligence	38	62
Journal of Artificial Intelligence Research	37	64
Engineering Applications of Artificial Intelligence	31	44
Artificial Intelligence in Medicine	24	30
FRONTIERS IN ARTIFICIAL INTELLIGENCE AND APPLICATIONS	23	31
International Conference on Logic for programming, artificial intelligence, and reasoning	17	26
AAAI Conference on Artificial Intelligence	16	20
Annals of Mathematics and Artificial Intelligence	15	25
IEEE International Conference on Tools with Artificial Intelligence	15	22
Applied Artificial Intelligence	14	21
ACIS International Conference on Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing	14	17
INTERNATIONAL JOURNAL OF PATTERN RECOGNITION AND ARTIFICIAL INTELLIGENCE	13	20
Annual German Conference on Advances in artificial intelligence	13	19
Artificial Intelligence for Engineering Design, Analysis and Manufacturing	12	26
Artificial Intelligence Review	11	29
Conference on Artificial Intelligence in Medicine	10	15
artificial intelligence Mexican International Conference on Advances in artificial intelligence	9	11
Transactions of the Japanese Society for Artificial Intelligence	8	16
International Conference on Modeling Decisions for Artificial Intelligence	8	11

Figure 9: A ranking based on Google Scholar Metrics (h5-index) of the top publications searching on the term “Artificial Intelligence”.

3.7 Computational Intelligence

Results of a search of the term “Computational Intelligence”¹⁰ is presented in Figure 10 with the IEEE Computational Intelligence Magazine ranking first. Interestingly the seven year old IEEE Conference on Computational Intelligence and Games ranks 3rd, and above the journal Computational Intelligence in its 28th year of existence.

¹⁰http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=computational+intelligence

Top 20 publications matching <i>computational intelligence</i>	Google Scholar Metrics	
	h5-index	h5-median
IEEE Computational Intelligence Magazine	22	39
Computational Intelligence and Neuroscience	20	37
IEEE Conference on Computational Intelligence and Games	17	26
Computational Intelligence	12	21
IEEE Symposium on Computational Intelligence and Data Mining	12	20
IEEE Symposium on Foundations of Computational Intelligence	12	17
International Conference on Computational Intelligence and Security (CIS)	11	16
International Conference on Conference on Computational Intelligence and Multimedia Applications	11	16
IEEE International Symposium on Computational Intelligence in Robotics and Automation (CIRA)	10	11
International Conference on Computational Intelligence and Security Workshops	9	11
Pacific-Asia Workshop on Computational Intelligence and Industrial Application	7	14
IEEE International Conference on Computational Intelligence for Measurement Systems and Applications, CIMSA	7	9
International Symposium on Computational Intelligence and Design	7	9
International Symposium on Computational Intelligence and Intelligent Informatics	7	9
International Conference on Computational Intelligence for Modelling, Control and Automation	7	7
International Conference on Computational Intelligence and Software Engineering, CISE	6	10
International Conference on Computational Intelligence, Communication Systems and Networks	6	7
IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology	5	8
International Conference on Artificial Intelligence and Computational Intelligence, AICI	5	8
International Conference on Computational Intelligence and Natural Computing, CINC	5	7

Figure 10: A ranking based on Google Scholar Metrics (h5-index) of the top publications searching on the term “Computational Intelligence”.

3.8 Machine Intelligence

A search with the term “Machine Intelligence”¹¹ yields one additional publication in addition to those already captured, the IEEE Transactions on Pattern Analysis and Machine Intelligence with a h5-index of 85 and h5-median of 140 the highest of these values recorded in this study. Of particular note here is that this h5-index value of 85 is very close to a value of 88 which would place this journal inside the Top 100 English language venues.

3.9 Soft Computing

Searching for “Soft Computing”¹² results in the data presented in Figure 11 with the two journals (Applied Soft Computing and Soft Computing) appearing top of the list.

¹¹http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=machine+intelligence

¹²http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=soft+computing

Publications matching <i>soft computing</i>	Google Scholar Metrics	
	h5-index	h5-median
Applied Soft Computing	41	54
Soft Computing-A Fusion of Foundations, Methodologies and Applications	26	45
International Conference on Soft computing as transdisciplinary science and technology	7	10
International Conference of Soft Computing and Pattern Recognition	6	7
International Workshop on Soft Computing Applications	4	8

Figure 11: A ranking based on Google Scholar Metrics (h5-index) of the top publications searching on the term “Soft Computing”.

3.10 Miscellaneous

Of notable interest to the author (as it is known that these journals publish studies on Natural Computing) neither the Information Science or Systems, Man and Cybernetics journals were captured in any of the above Google Scholar Metric queries, also the Parallel Problem Solving from Nature (PPSN) and Advances in Neural Information Processing (NIPS) conferences were also absent. A separate search for each of these is presented here.

Figure 12 presents the results of a search for the term “Systems Man and Cybernetics”¹³. The IEEE transactions of this name is broken into three parts, with part B ranked above part C, which is ranked in turn above part A. This is the same ordering which one would obtain if ranked based upon these journals published impact factors (2.699, 2.105, and 2.093 respectively for parts B, C and A) .

Publications matching <i>systems man and cybernetics</i>	Google Scholar Metrics	
	h5-index	h5-median
IEEE Transactions On Systems, Man And Cybernetics Part B, Cybernetics	44	68
IEEE Transactions on Systems, Man, and Cybernetics Part C, Applications and Reviews	37	63
IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans	35	48
IEEE International Conference on Systems, Man and Cybernetics	17	23
WSEAS International Conference on Computational intelligence, man-machine systems and cybernetics	4	8

Figure 12: A ranking based on Google Scholar Metrics (h5-index) of the top publications searching on the term “Systems Man and Cybernetics”.

A search of the term “Information Science”¹⁴ found the Elsevier published journal (Information Science) with the second highest h5-index value (56) of all venues in this analysis (h5-median of 84). The top 15 publications in Information Science are presented in Figure 13, four of which could be classed as Natural Computing (including Genetic Algorithm, Patricle Swarm, Coopera-

¹³http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=systems+man+and+cyanbernetics

¹⁴http://scholar.google.com/citations?hl=en&view_op=search_venues&vq=information+science

tive Coevolution and Gravitational Search). Searching for “Parallel Problem Solving From Nature” we find the event has a h5-index of 16 and h5-median of 25. A search for “Neural Information Processing” yielded two results, Advances in Neural Information Processing Systems (NIPS) with a h5-index of 33 and h5-median of 57, and also the International Conference on Neural Information Processing with values of 5 and 9 for h5-index and h5-median respectively. Other notable absences are the conferences Foundations of Genetic Algorithms (FOGA) and Genetic Programming Theory and Practice (GPTP). Neither FOGA or GPTP produce any results under Google Scholar Metrics at this time.

H-index articles for Information Sciences			
Title / Author	Cited by	Year	
Rudiments of rough sets Z Pawlak, A Skowron Information Sciences 177 (1), 3-27	763	2007	
Rough sets: Some extensions Z Pawlak, A Skowron Information Sciences 177 (1), 28-40	423	2007	
Rough sets and Boolean reasoning Z Pawlak, A Skowron Information Sciences 177 (1), 41-73	344	2007	
Is there a need for fuzzy logic? LA Zadeh Information Sciences 178 (13), 2751-2779	289	2008	
Advances in type-2 fuzzy sets and systems JM Mendel Information Sciences 177 (1), 84-110	194	2007	
Topological approaches to covering rough sets W Zhu Information Sciences 177 (6), 1499-1508	177	2007	
Soft sets and soft groups H Aktas, N Cagman Information Sciences 177 (13), 2728-2735	149	2007	
A new similarity measure for collaborative filtering to alleviate the new user cold-starting problem HJ Ahn Information Sciences 178 (1), 37-51	142	2008	
Intuitionistic preference relations and their application in group decision making Z Xu Information Sciences 177 (11), 2363-2379	135	2007	
A hybrid genetic algorithm and bacterial foraging approach for global optimization DH Kim, A Abraham, JH Cho Information Sciences 177 (18), 3918-3937	135	2007	
Using the analytic network process (ANP) in a SWOT analysis-A case study for a textile firm Yüksel, M Dagdeviren Information Sciences: an International Journal 177 (16), 3364-3382	128	2007	
Large scale evolutionary optimization using cooperative coevolution Z Yang, K Tang, X Yao Information Sciences 178 (15), 2985-2999	115	2008	
Multi-Objective Particle Swarm Optimization with time variant inertia and acceleration coefficients PK Tripathi, S Bandyopadhyay, SK Pal Information Sciences 177 (22), 5033-5049	108	2007	
An interactive method for fuzzy multiple attribute group decision making ZS Xu, J Chen Information Sciences 177 (1), 248-263	106	2007	
GSA: A Gravitational Search Algorithm E Rashedi, H Nezamabadi-pour, S Saryyedi Information Sciences 179 (13), 2232-2248	105	2009	

Figure 13: The top 15 publications (in terms of Google Scholar citation counts) in the Information Science journal from 2007-2011.

4 Overview of Venue rankings

A relative ranking of each venues impact according to its Google Scholar h5-index (and then h5-median when a tie exists on h5-index) is presented in Figure 14. Where available, the impact factor of each journal as published on their website (8 May 2012) is presented alongside their h5-index and h5-median values, although this is not used for ranking here.

Rank	Top Publications matching <i>NC, EC, GP, CI, AI, ML, SC</i>	Google Scholar Metrics		Journal Website
		h5-index	h5-median	
1	Machine Intelligence	85	140	4.38
2	IEEE Transactions on Pattern Analysis and Machine Intelligence	66	84	2.833
3	The Journal of Machine Learning Research	51	71	2.79
4	Annual International Conference on Machine Learning	45	65	
5	IEEE Transactions On Systems, Man And Cybernetics Part B: Cybernetics	44	68	2.699
6	National Conference on Artificial Intelligence	42	59	
7	IEEE Transactions on Neural Networks	42	58	2.623
8	IEEE Transactions on Evolutionary Computation	41	66	4.423
9	Applied Soft Computing	41	54	2.084
10	Artificial Intelligence	38	62	2.511
11	Journal of Artificial Intelligence Research	37	64	1.988
12	IEEE Transactions on Systems, Man, and Cybernetics Part C: Applications and Reviews	37	63	2.105
13	IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans	35	48	2.093
14	Neural Networks	34	45	1.995
15	Advances in Neural Information Processing Systems	33	57	
16	Engineering Applications of Artificial Intelligence	31	44	1.344
17	IEEE Congress on Evolutionary Computation (CEC)	29	40	
18	Machine Learning	28	53	1.967
19	Soft Computing-A Fusion of Foundations, Methodologies and Applications	26	45	1.512
20	Artificial Intelligence in Medicine	24	30	1.568
21	Frontiers in Artificial Intelligence and Applications	23	31	
22	IEEE Computational Intelligence Magazine	22	39	2.905
23	European Conference on Machine Learning and knowledge discovery in databases	22	31	
24	Computational Intelligence and Neuroscience	20	37	
25	Evolutionary Computation (MIT Press)	20	35	2.630
26	Annual Conference on Genetic and Evolutionary Computation (ACM GECCO)	20	25	
27	International Joint Conference on Neural Networks	19	20	
28	Natural Computing	17	28	
29	IEEE Conference on Computational Intelligence and Games (CGI)	17	26	
29	International Conference on Logic for programming, artificial intelligence, and reasoning	17	26	
30	IEEE International Conference on Systems, Man and Cybernetics	17	23	
31	International Conference on Natural Computation	17	18	
32	Parallel Problem Solving From Nature (PPSN)	16	25	
33	AAAI Conference on Artificial Intelligence	16	20	
34	European Conference on Genetic Programming (EuroGP)	15	29	
35	Annals of Mathematics and Artificial Intelligence	15	25	0.43
36	Genetic Programming and Evolvable Machines	15	23	1.167
37	IEEE International Conference on Tools with Artificial Intelligence	15	22	
38	Applied Artificial Intelligence	14	21	0.563
39	International Conference on Machine Learning and Cybernetics	14	19	
40	ACIS International Conference on Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing	14	17	
41	International Journal of Pattern Recognition and Artificial Intelligence	13	20	0.660
42	Annual German Conference on Advances in artificial intelligence	13	19	
42	International Conference on Artificial neural networks	13	19	
43	International Conference on Artificial Immune Systems	13	18	
44	Artificial Intelligence for Engineering Design, Analysis and Manufacturing	12	26	0.64
45	Computational Intelligence	12	21	
46	IEEE Symposium on Computational Intelligence and Data Mining	12	20	
47	IEEE Symposium on Foundations of Computational Intelligence	12	17	
48	International Conference on Adaptive and Natural Computing Algorithms	12	13	
49	Artificial Intelligence Review	11	29	0.429
50	International Conference on Machine Learning and Data Mining in Pattern Recognition	11	21	
51	International Conference on Computational Intelligence and Security (CSI)	11	16	
51	International Conference on Conference on Computational Intelligence and Multimedia Applications	11	16	
52	International Conference on Machine Learning and Applications	11	16	
53	European Conference on Evolutionary Computation, Machine Learning and Data Mining in Biomedicine	10	17	
54	Conference on Artificial Intelligence in Medicine	10	15	
55	New Mathematics and Natural Computation (NMNC)	10	14	
56	IEEE International Workshop on Machine Learning for Signal Processing	10	13	
56	International Symposium on Neural Networks: Advances in Neural Networks	10	13	
57	International work Conference on Artificial neural networks	10	12	
58	IEEE International Symposium on Computational Intelligence in Robotics and Automation (CIRA)	10	11	
59	International Conference on Computational Intelligence and Security Workshops	9	11	
59	artificial intelligence Mexican International Conference on Advances in artificial intelligence	9	11	
60	Transactions of the Japanese Society for Artificial Intelligence	8	16	
61	International Conference on Neural Networks and Signal Processing	8	13	
62	International Conference on Modeling Decisions for Artificial Intelligence	8	11	
63	International Workshop on Cellular Neural Networks and Their Applications	8	9	
64	Pacific-Asia Workshop on Computational Intelligence and Industrial Application	7	14	
65	International Conference on Soft computing as transdisciplinary science and technology	7	10	
65	International Symposium on Neural Networks	7	10	
66	International Conference on Application of evolutionary computation	7	9	
66	IEEE International Conference on Computational Intelligence for Measurement Systems and Application, CMSA	7	9	
66	International Symposium on Computational Intelligence and Design	7	9	
66	International Symposium on Computational Intelligence and Intelligent Informatics	7	9	
67	International Conference on Computational Intelligence for Modelling, Control and Automation	7	7	
68	International Conference on Computational Intelligence and Software Engineering, CSE	6	10	
69	International Conference on Computational Intelligence, Communication Systems and Networks	6	7	
69	International Conference of Soft Computing and Pattern Recognition	6	7	
70	Annual Conference Companion on Genetic and Evolutionary Computation	5	9	
70	Optical Memory & Neural Networks	5	9	
70	International Conference on Neural Information Processing	5	9	
71	IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology	5	8	
71	International Conference on Artificial Intelligence and Computational Intelligence, AICI	5	8	
72	International Conference on Computational Intelligence and Natural Computing, CINC	5	7	
73	International Workshop on Soft Computing Applications	4	8	
73	WSEAS International Conference on Computational intelligence, man-machine systems and cybernetics	4	8	
74	International Conference on Advances in neural networks	4	4	

Figure 14: A ranking based on Google Scholar Metrics (h5-index) of the top publications in Natural Computing, Evolutionary Computation, Genetic Programming, Computational Intelligence, Artificial Intelligence, Machine Intelligence, Soft Computing and Machine Learning. The impact factor of each journal is also provided (where available from the journals own webpage).

A ranking of the journals based on their h5-index is presented in Figure 15. A correlation analysis of journals h5-index and h5-median has a coefficient of 0.97 showing strong positive correlation between these metrics (see Figure 16). If we were then to rank the journals based on their published impact factors (where available) we see a new ranking in Figure 18. A correlation analysis of impact factors and h5-index values is presented in Figure 17. Using linear regression analysis we see a positive correlation between these metrics, and with a correlation coefficient of 0.80 this is reasonably strong. Some unusual cases worth highlighting are the *IEEE Transactions on Evolutionary Computation*, the *Evolutionary Computation* journal, and the *IEEE Computational Intelligence Magazine* each of which have an impact factor than their h5-index values would suggest.

It is interesting that our findings are consistent with an earlier 2008 study of Computer Science venues, which manually calculated their own *Google Scholar Impact metric* (based on average citations per publication in a venue over a period including 2000 to 2003) [6]. Comparing our findings to this earlier study using data from 10 years ago, the top 26 publications in our field would be a close fit to A* ranked journals in Computer Science (this includes the ACM GECCO and IEEE CEC conferences). GECCO and CEC also appeared in the top A category of the 2008 Australian conference ranking study, and the Australian Research Council consider these A ranked journals as equivalent to the A* and A ranked journals [2].

It is also interesting to extract the conference rankings based on their h5-index, and this is presented in Figure 19.

Rank(h5)	Top Journals matching <i>NC, EC, GP, CI, AI, ML, SC</i>	Google Scholar Metrics		Journal Website
		h5-index	h5-median	Impact Factor
1	IEEE Transactions on Pattern Analysis and Machine Intelligence	85	140	4.38
2	Information Sciences	56	84	2.833
3	The Journal of Machine Learning Research	51	71	2.79
4	IEEE Transactions On Systems, Man And Cybernetics Part B, Cybernetics	44	68	2.699
5	IEEE Transactions on Neural Networks	42	58	2.633
6	IEEE Transactions on Evolutionary Computation	41	66	4.403
7	Applied Soft Computing	41	54	2.084
8	Artificial Intelligence	38	62	2.511
9	Journal of Artificial Intelligence Research	37	64	1.98
10	IEEE Transactions on Systems, Man, and Cybernetics Part C, Applications and Reviews	37	63	2.105
11	IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans	35	48	2.093
12	Neural Networks	34	45	1.955
13	Engineering Applications of Artificial Intelligence	31	44	1.344
14	Machine Learning	28	53	1.967
15	Soft Computing-A Fusion of Foundations, Methodologies and Applications	26	45	1.512
16	Artificial Intelligence in Medicine	24	30	1.568
17	IEEE Computational Intelligence Magazine	22	39	2.905
18	Evolutionary Computation (MIT Press)	20	35	2.630
19	Annals of Mathematics and Artificial Intelligence	15	25	0.43
20	Genetic Programming and Evolvable Machines	15	23	1.167
21	Applied Artificial Intelligence	14	21	0.563
22	International Journal of Pattern Recognition and Artificial Intelligence	13	20	0.660
23	Artificial Intelligence for Engineering Design, Analysis and Manufacturing	12	26	0.64
24	Artificial Intelligence Review	11	29	0.429

Figure 15: A ranking based on Google Scholar Metrics h5-index of the top journals publications in Natural Computing, Evolutionary Computation, Genetic Programming, Computational Intelligence, Artificial Intelligence, Machine Intelligence, Soft Computing and Machine Learning.

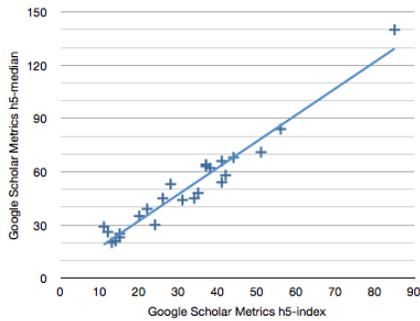


Figure 16: A scatter plot of Google Scholar Metrics h5-index and h5-median values. Using linear regression analysis there is a strong positive correlation between these two metrics with a correlation coefficient of 0.97.

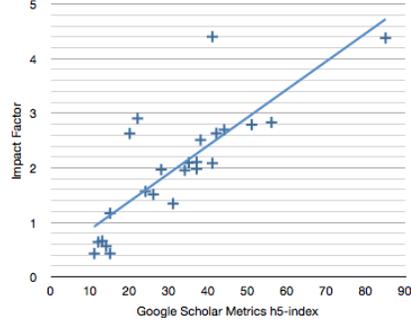


Figure 17: A scatter plot of Impact Factors versus Google Scholar Metrics h5-index values. Using linear regression analysis there is a positive correlation between Impact Factor and h5-index, with a correlation coefficient of 0.80 indicating this correlation is reasonably strong.

Rank (IF)	h5-index Ranking	Top Journals matching <i>NC, EC, GP, CI, AI, ML, SC</i>	Google Scholar Metrics		Journal Website
			h5-index	h5-median	Impact Factor
1	1	IEEE Transactions on Pattern Analysis and Machine Intelligence	85	140	4.38
2	6	IEEE Transactions on Evolutionary Computation	41	66	4.403
3	17	IEEE Computational Intelligence Magazine	22	39	2.905
4	2	Information Sciences	56	84	2.833
5	3	The Journal of Machine Learning Research	51	71	2.79
6	4	IEEE Transactions On Systems, Man And Cybernetics Part B, Cybernetics	44	68	2.699
7	5	IEEE Transactions on Neural Networks	42	58	2.633
8	18	Evolutionary Computation (MIT Press)	20	35	2.630
9	8	Artificial Intelligence	38	62	2.511
10	10	IEEE Transactions on Systems, Man, and Cybernetics Part C, Applications and Reviews	37	63	2.105
11	11	IEEE Transactions on Systems, Man and Cybernetics, Part A: Systems and Humans	35	48	2.093
12	7	Applied Soft Computing	41	54	2.084
13	9	Journal of Artificial Intelligence Research	37	64	1.98
14	14	Machine Learning	28	53	1.967
15	12	Neural Networks	34	45	1.955
16	16	Artificial Intelligence in Medicine	24	30	1.588
17	15	Soft Computing-A Fusion of Foundations, Methodologies and Applications	26	45	1.512
18	13	Engineering Applications of Artificial Intelligence	31	44	1.344
19	20	Genetic Programming and Evolvable Machines	15	23	1.167
20	22	International Journal of Pattern Recognition and Artificial Intelligence	13	20	0.660
21	23	Artificial Intelligence for Engineering Design, Analysis and Manufacturing	12	26	0.64
22	21	Applied Artificial Intelligence	14	21	0.563
23	19	Annals of Mathematics and Artificial Intelligence	15	25	0.43
24	24	Artificial Intelligence Review	11	29	0.429

Figure 18: The top journals ranked on Impact Factor in Natural Computing, Evolutionary Computation, Genetic Programming, Computational Intelligence, Artificial Intelligence, Machine Intelligence, Soft Computing and Machine Learning. The original h5-index ranking is retained in the first column as a point of comparison.

Rank	Top Conferences matching NC, EC, GP, CI, AI, ML	Google Scholar Metrics		
		h5-index	h5-median	
1	1	Annual International Conference on Machine Learning	45	65
2	2	National Conference on Artificial Intelligence	42	59
3	3	Advances in Neural Information Processing Systems	33	57
4	4	IEEE Congress on Evolutionary Computation (CEC)	29	40
5	5	European Conference on Machine learning and knowledge discovery in databases	22	31
6	6	Annual Conference on Genetic and Evolutionary Computation (ACM GECCO)	20	25
7	7	International Joint Conference on Neural Networks	19	30
8	8=	IEEE Conference on Computational Intelligence and Games (CIIG)	17	26
9	8=	International Conference on Logic for programming, artificial intelligence, and reasoning	17	26
10	9	IEEE International Conference on Systems, Man and Cybernetics	17	23
11	10	International Conference on Natural Computing	17	18
12	11	Parallel Problem Solving From Nature (PPSN)	16	25
13	12	AAAI Conference on Artificial Intelligence	16	20
14	13	European Conference on Genetic Programming (EuroGP)	15	29
15	14	IEEE International Conference on Tools with Artificial Intelligence	15	22
16	15	International Conference on Machine Learning and Cybernetics	14	19
17	16	ACIS International Conference on Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing	14	17
18	17=	Annual German Conference on Advances in artificial intelligence	13	19
19	17=	International Conference on Artificial neural networks	13	19
20	18	International Conference on Artificial Immune Systems	13	18
21	19	IEEE Symposium on Computational Intelligence and Data Mining	12	20
22	20	IEEE Symposium on Foundations of Computational Intelligence	12	17
23	21	International Conference on Adaptive and Natural Computing Algorithms	12	13
24	22	International Conference on Machine Learning and Data Mining in Pattern Recognition	11	21
25	23=	International Conference on Computational Intelligence and Security (CIS)	11	16
26	23=	International Conference on Conference on Computational Intelligence and Multimedia Applications	11	16
27	23=	International Conference on Machine Learning and Applications	11	16
28	24	European Conference on Evolutionary Computation, Machine Learning and Data Mining in Bioinformatics	10	17
29	25	Conference on Artificial Intelligence in Medicine	10	15
30	26=	IEEE International Workshop on Machine Learning for Signal Processing	10	13
31	26=	International Symposium on Neural Networks: Advances in Neural Networks	10	13
32	27	International work Conference on Artificial neural networks	10	12
33	28	IEEE International Symposium on Computational Intelligence in Robotics and Automation (CIRA)	10	11
34	29=	International Conference on Computational Intelligence and Security Workshops	9	11
35	29=	artificial intelligence Mexican International Conference on Advances in artificial intelligence	9	11
36	30	International Conference on Neural Networks and Signal Processing	8	13
37	31	International Conference on Modeling Decisions for Artificial Intelligence	8	11
38	32	International Workshop on Cellular Neural Networks and Their Applications	8	9
39	33	Pacific-Asia Workshop on Computational Intelligence and Industrial Application	7	14
40	34=	International Conference on Soft computing as transdisciplinary science and technology	7	10
41	34=	International Symposium on Neural Networks	7	10
42	35=	International Conference on Applications of evolutionary computation	7	9
43	35=	IEEE International Conference on Computational Intelligence for Measurement Systems and Applications, CIMSA	7	9
44	35=	International Symposium on Computational Intelligence and Design	7	9
45	35=	International Symposium on Computational Intelligence and Intelligent Informatics	7	9
46	36	International Conference on Computational Intelligence for Modelling, Control and Automation	7	7
47	37	International Conference on Computational Intelligence and Software Engineering, CISE	6	10
48	38=	International Conference on Computational Intelligence, Communication Systems and Networks	6	7
49	38=	International Conference of Soft Computing and Pattern Recognition	6	7
50	39=	Annual Conference Companion on Genetic and Evolutionary Computation	5	9
51	39=	International Conference on Neural Information Processing	5	9
52	40=	IEEE Symposium on Computational Intelligence in Bioinformatics and Computational Biology	5	8
53	40=	International Conference on Artificial Intelligence and Computational Intelligence, AICI	5	8
54	41	International Conference on Computational Intelligence and Natural Computing, CINC	5	7
55	42=	International Workshop on Soft Computing Applications	4	8
56	42=	WSEAS International Conference on Computational intelligence, man-machine systems and cybernetics	4	8
57	43	International Conference on Advances in neural networks	4	4

Figure 19: The top conferences ranked on h5-index in Natural Computing, Evolutionary Computation, Genetic Programming, Computational Intelligence, Artificial Intelligence, Machine Intelligence, Soft Computing and Machine Learning.

5 Conclusions

Analysing the impact of different conference and journal publication venues in the field of natural computing and related fields of computational intelligence, artificial intelligence, machine intelligence, machine learning and cybernetics reveals two interesting findings:

1. There is a positive correlation between Impact Factors (2010) and Google Scholar Metrics h5-index (2007-2011).
2. The top conference venues have h5-index values similar to, and in some cases superior to, high quality journals in these fields.

An overall ranking of the various venues is presented in Figure 14. Based on our analysis it is clear that publication in the top conference venues is of great importance in these fields, having similar impact to publication in journals. In times of multi-disciplinary research conveying this message to our collaborators and colleagues in other disciplines can be a challenge, and hopefully studies such as this will help to convey this important message. Given the ease of use of Google Scholar Metrics it will be interesting to see how these trends evolve over time.

A webpage containing the searches adopted in this study is available at UCD's Natural Computing Research & Applications Group [7].

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