

Indian paper crosses 5000+ citations mark

For the first time, a paper having all Indian authors has received 5000+ citations. According to the Web of Science Core Collection database, as on 9 February 2015, there are only 541 papers among the more than 50 million records in the database from 1945 to 2015, which have received more than 5000 citations. Now an Indian paper is also in this league. The paper¹ has been published by researchers from the Indian Institute of Technology (IIT), Kanpur. It discusses multiobjective evolutionary algorithms (EAs) that use nondominated sorting and sharing and its criticisms mainly for their: (1) $O(MN^3)$ computational complexity (where M is the number of objectives and N is the population size); (2) nonelitism approach and (3) the need for specifying a sharing parameter. The paper suggests a nondominated sorting-based multiobjective EA (MOEA), called nondominated sorting genetic algorithm II (NSGA-II), which alleviates all the above three difficulties. Table 1 gives the citations received by the paper according to various citation databases.

According to *Web of Science*, the paper has received 6500 citations and according to Web of Science Core Collection database, on the basis of which we made the analysis, the paper has received 5637 citations. The paper did not receive any citation in its publishing year. It started receiving citations from next year, i.e. 2003. Till 2014, the paper has received citations at an average rate of 465.83. Since 2009, the paper has been receiving more than 500 citations per year and has received more than 4000 citations during the period 2009–2014.

Table 1. Citations according to database/source*

Source	Citations
<i>Web of Science</i>	6,500
<i>Scopus</i> **	9,058
<i>CrossRef</i> **	4,121
<i>Google Scholar</i>	13,529

*As on 9 February 2015.

**Metrics according to journal website.

The high citations reflect the significance of this important work. Among numerous multi-objective optimization algorithms, the elitist NSGA-II is one of the most popular methods due to its simplicity, effectiveness and minimum involvement of the user². This algorithm was born as a result of numerous experiments and outstanding teamwork of the then Kanpur Genetic Algorithm Laboratory (KanGAL) team (in early 2000) under the expert guidance of Deb. After a number of experiments conducted in KanGAL, it was established that on one hand NSGA-II performed better than any other existing MOEA in all test functions and on the other hand several remarkable results were obtained on application of NSGA-II to engineering design problems with a multi-objective flavour³. As described in the article¹, on nine different difficult test problems NSGA-II was able to maintain a better spread of solutions compared to two other elitist MOEAs-Pareto-archived evolution strategy (PAES) and strength-Pareto EA (SPEA). NSGA-II has been immensely successful and popular. Simplicity, effectiveness, modularity and low number of user-defined parameters, are the main factors determining the popularity of NSGA-II among multi-objective optimization methods⁴.

The paper has received most citations from the People's Republic of China (PRC) (1308 citations), which is nearly 25% of the total citations received by it so far. The paper has been cited by Indian authors 459 times. In all, 85 countries have cited the paper. But PRC, USA and India have together contributed to more than 2000 citations.

From India, the paper has been cited 191 times by IITs and 59 times by Jadavpur University. Among international universities, Xidian University, China has cited the paper the maximum number of times (97), followed by National University of Singapore (95).

Two thousand one hundred and eighty-two journals have cited the article so far. The journal *Lecture Notes in Computer Science* has cited the paper maximum

number of times (385 citations), followed by *IEEE Congress on Evolutionary Computation*. The top 5 citing journals have contributed to more than 1000 citations or approximately 20% of all the citations.

According to the Web of Science Core Collection database, the next most highly cited paper (5447 citations) from India is by Agostinelli *et al.*⁵, but this is a mega-authorship paper with 127 authors from 14 countries. There are five more papers that have received over 3000 citations, but all these are again mostly 'review of particle physics' papers authored by Particle Data Group with a large number of authors from several countries including India. If we were to consider the next leading paper in the league of the IIT Kanpur paper with all Indian authors from Indian institutions, the second most highly cited Indian paper is by Desiraju⁶ with 2942 citations.

In 2012, we had looked at champion works⁷, i.e. papers that have received 1000+ citations. It was found that there were 36 papers from India with 1000+ citations. This has now grown to 54 with the exceptional paper from IIT Kanpur having all Indian authors topping the list with most citations.

1. Deb, K. *et al.*, *IEEE Trans. Evol. Comput.*, 2002, 6(2), 182–197.
2. Ghiasi, H. *et al.*, *Eng. Opt.*, 2011, 43, 39–59.
3. http://www.iitk.ac.in/kangal/deb_research_shtml
4. Deb, K, Proceedings of the 10th Annual Conference on Genetic and Evolutionary Computation (GECCO'08), 12–16 July, Atlanta, Georgia, USA, 2008, pp. 633–640.
5. Agostinelli, S. *et al.*, *Nucl. Instrum. Methods Phys. Res. Sect. A*, 2003, 506(3), 250–303.
6. Desiraju, G. R., *Angew. Chem.-Inter. Ed. Engl.*, 1995, 34(21), 2311–2327.
7. Mahesh, G., *Curr. Sci.*, 2012, 103, 1260–1261.

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