IEEE Distinguished Lecture
IEEE Computational Intelligence Chapter, IEEE NZ Central Section

Date: 17 June 2016
Time: 4:10-5:30pm
Venue: CO350, Victoria University of Wellington, Kelburn Campus
Title: Evolutionary Many-Objective Optimization: Difficulties and Future Directions
Speaker: Hisao Ishibuchi (Japan), IEEE Fellow, IEEE Distinguished Lecturer

Abstract: Recently, evolutionary many-objective optimization has been the most active research area in the EMO (evolutionary multiobjective optimization) community. It was repeatedly reported that Pareto dominance-based EMO algorithms such as NSGA-II and SPEA2 did not work well on many-objective problems. When an EMO algorithm is applied to a many-objective problem, almost all individuals in a population become non-dominated with each other in an early stage of evolution (e.g., within 10 generations). In this situation, Pareto dominance-based fitness evaluation cannot generate a strong section pressure to efficiently drive the population toward the Pareto front. The current trend is the use of uniformly distributed weight vectors to search for a set of uniformly distributed non-dominated solutions (e.g., MOEA/D, NSGA-II, I-DBEA and MOEA/DD). In this talk, after brief introduction to frequently-discussed issues in many-objective optimization such as Pareto dominance-based fitness evaluation, approximation of the Pareto front and visualization of a solution set, we will discuss fair performance comparison of EMO algorithms on many-objective problems from the following viewpoints:

(1) Parameter specifications: In general, each algorithm has its own best parameter values. For fair comparison of different algorithms, it may be advisable to use the best parameter values in each algorithm. However, the same population size has always been used for performance comparison in the EMO community. This is because the comparison of solution sets of the same size is viewed as being fair comparison (whereas totally different comparison results can be obtained from a different specification of the population size). We discuss how to perform fair comparison when each EMO algorithm has a totally different best specification of the population size.

(2) Performance indicators: Hypervolume (HV) and inverted generational distance (IGD) have been frequently used for performance comparison of EMO algorithms. However, comparison results depend on the specification of a reference point for HV calculation and a reference point set for IGD calculation. Moreover, IGD is not Pareto compliant (whereas HV is Pareto compliant). These difficulties of HV and IGD are explained by simple examples and through computational experiments on many-objective test problems. A simple modification of IGD is also suggested.

(3) Test problems: DTLZ and WFG test problems have almost always been used for performance comparison in evolutionary many-objective optimization studies. However, they have very special characteristic features (as explained in this talk). For example, we can simultaneously optimize arbitrarily selected (m−1) objectives of m-objective DTLZ 1-4 and WFG 4-9 problems. The shape of their Pareto fronts is rectangular, which is the same as the shape of the distribution of uniformly distributed normalized weight vectors. Many mutated solutions are generated on a line between the current solution and the ideal point in the objective space. We clearly explain that those features make DTLZ 1-4 and WFG 4-9 very easy for weight vector-based EMO algorithms such as MOEA/D and NSGA-III even when they have many objectives.

Biography:

Prof. Hisao Ishibuchi

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Hisao Ishibuchi received the BS and MS degrees from Kyoto University in 1985 and 1987, respectively. In 1992, he received the Ph. D. degree from Osaka Prefecture University where he has been a full professor since 1999. He received a Best Paper Award from GECCO 2004, HIS-NCEI 2006, FUZZ-IEEE 2009, WAC 2010, SCIS & ISIS 2010, FUZZ-IEEE 2011 and ACIIDS 2015. He also received a 2007 JSPS Prize from Japan Society for the Promotion of Sciences. He was the Chair of the IEEE CIS Fuzzy Systems Technical Committee (2008-2009), the IEEE CIS Vice-President for Technical Activities (2010-2013), the General Chair of ICMLA 2011, the Program Chair of IEEE CEC 2010 and IES 2014, and a Program/Technical Co-Chair of FUZZ-IEEE 2006, 2011-2013, 2015 and IEEE CEC 2013-2014. Currently, he is an IEEE CIS AdCom member (2014-2016), an IEEE CIS Distinguished Lecturer (2015-2017), and the Editor-in-Chief of the IEEE Computational Intelligence Magazine (2014-2017) and the Transactions of Japan Evolutionary Computation Society (2014-2016). He is also an Associate Editor of IEEE TEVC (2007-2016), IEEE Access (2013-2016) and IEEE TCyb (2013-2016). He is an IEEE Fellow. His research interests include fuzz rule-based classifier design, evolutionary multi-objective and many-objective optimization, and evolutionary games. According to Google Scholar, the total number of citations of his publications is about 17,500 and his h-index is 58 (March 2016).