

Chapter 8

Parallel Multi–Criterion Genetic Algorithms: Review and Comprehensive Study

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ABSTRACT

The objective of this paper is to study the existing and current research on parallel multi-objective genetic algorithms (PMOGAs) through an intensive experiment. Many early efforts on parallelizing multi-objective genetic algorithms were introduced to reduce the processing time needed to reach an acceptable solution of them with various examples. Further, the authors tried to identify some of the issues that have not yet been studied systematically under the umbrella of parallel multi-objective genetic algorithms. Finally, some of the potential application of parallel multi objective genetic algorithm is discussed.

1. INTRODUCTION

Real world search and optimization problems logically involve many objectives (Coello, C. A. 2000). Different solutions may produce trade-offs (conflicting scenario) among different objectives. A solution that is best (in a better sense with respect to one objective requires a compromise in other objectives) this prohibits one to choose a solution which is optimal with respect to one objective. Simultaneous optimization of these objectives can capture multiple Pareto- optimal solutions (Coello, C. A. 1999).

The capability of a Genetic Algorithm (GAs) to find a series of optimal solutions in a single simulation run makes it a distinctive candidate in solving multi-objective optimization problem. Over the years large numbers of multi-objective genetic algorithms (MOGAs) have been published (Coello, C. A. 2001;

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Coello, C. A. 2000; Deb K. 2001; Fonseca & Fleming 1993; Zitzler et.al. 2003). One of the major issues in MOGAs is computationally very expensive in most of the practical application, as instead of searching for a single optimal solution, one generally needs to find the whole front of Pareto optimal solution. For that reason parallelizing MOGA is an important topic of interest in this paper.

In the multi-objective case a set of non-dominated solutions is sought rather than a single optimum (Deb. K. et.al., 1999; Coello et.al. 2002). This generates a possibility of multiple processors search for different solutions, rather than to follow an identical goal. We discussed several models in the parlance of parallel multi-objective genetic algorithm like parallel GA (Alba, E., & Tomasdni 2002; Zitzler et.al. 2003).

The remainder of this paper is organized as follows. In Section 2 a short review on multi-objective genetic algorithms are discussed. Section 3 discusses different parallel multi-objective genetic algorithms. Section 4 presents the experimental study on different PMOGAs by taking different popular and benchmark test functions. Section 5 discusses different issues related with PMOGAs. Finally, conclusions are given in Section 6.

2. MULTI-OBJECTIVES GENETIC ALGORITHMS

Multi-objective optimization methods are based on the idea of finding optimal solutions to problems having multiple objectives (Coello, C. A. 1999; Coello, C. A. 2000; Zydallis 2003). Hence, for this type of problems the user is never satisfied by finding one solution that is optimized with respect to a single criterion. The principle of a multi-criteria optimization procedure is different from that of a single criterion optimization. In a single criterion the main objective is to find a globally optimal solution. However, in a multi-criteria optimization problem, there is more than one objective function, each of which may have a different individual optimal solution. The objective functions are said to be conflicting if there exists an adequate distinction in the optimal solutions corresponding to different objectives, this presents a set of optimal solutions, instead of one optimal solution known as Pareto-optimal solutions (Coello, C. A. 2001 & 2006; Deb 1999; Schaffer 1985; Veldhuizen & Lamont 2000)

A multi-objective problem can be defined having x objectives (say f_i , $i = 1, 2, \dots, x$ and $x > 1$). Any two solutions S^1 and S^2 (having 'm' decision variables, each) can have one, two possibilities -one dominates the other or none dominates the other'. Solution S^1 is said to dominate the other solution, S^2 , if the following conditions are true:

1. The solution S^1 is not worse than S^2 in all objectives, or $f_i(S^1) \geq f_i(S^2)$ for all $i = 1, 2, \dots, x$;
2. The solution S^1 is strictly better than S^2 in at least one objective, or $f_i(S^1) > f_i(S^2)$ for at least one i , $i = 1, 2, 3, \dots, x$.

If any of the above conditions is violated, the solution S^1 does not dominate the solution S^2 . If S^1 dominates the solution, S^2 , then we can also say that S^2 is dominated by S^1 , or is non-dominated by S^2 , or simply between the two solutions, S^1 is the non-dominated solution.

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