

Chapter 10

Hybrid Genetic Algorithm: An Optimization Tool

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ABSTRACT

Real coded Genetic Algorithms (GAs) are the most effective and popular techniques for solving continuous optimization problems. In the recent past, researchers used the Laplace Crossover (LX) and Power Mutation (PM) in the GA cycle (namely LX-PM) efficiently for solving both constrained and unconstrained optimization problems. In this chapter, a local search technique, namely Quadratic Approximation (QA) is discussed. QA is hybridized with LX-PM in order to improve its efficiency and efficacy. The generated hybrid system is named H-LX-PM. The supremacy of H-LX-PM over LX-PM is validated through a test bed of 22 unconstrained and 15 constrained typical benchmark problems. In the later part of this chapter, a few applications of GA in networking optimization are highlighted as the scope for future research.

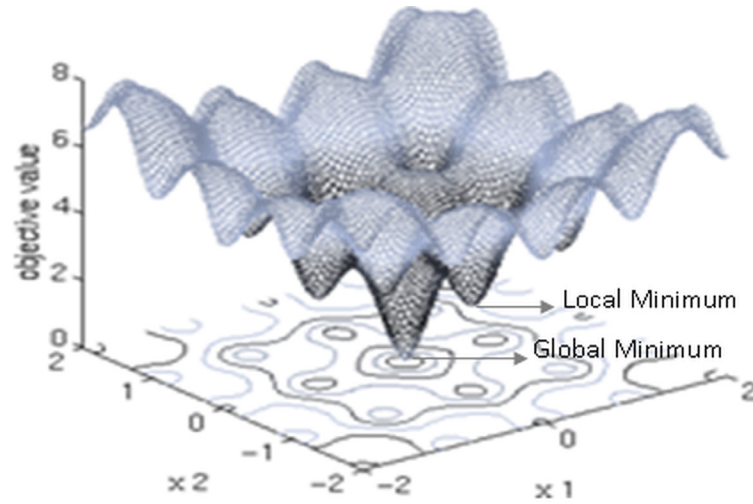
INTRODUCTION

Optimization is an art of selecting the best alternative amongst a given set of options. It is central to any problem involving decision making in many disciplines such as engineering, mathematics, statistics, economics, and computer science. Now, more than ever, it is increasingly vital to have a firm grasp of the topic due to the rapid progress in computer technology, including the development and availability of user-friendly software,

high-speed and parallel processors, and networks. Secondly, the problems, in general, arising in real life situations are highly complex and non-linear in nature. Some of them are unconstrained and some involve constraints. For such problems, it is a great challenge for the researchers to find the global optimal solution over many local optimal solutions. For example, a view of many local and single global minimum, is presented in Figure 1 for Ackley function (for $n=2$), which is a typical benchmark problem defined as

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Figure 1. Ackley Function: A 3D view for $n=2$



$$-20 * \exp(-0.02 \sqrt{\frac{1}{n} \sum_{i=1}^n x_i^2}) - \exp(\frac{1}{n} \sum_{i=1}^n \cos(2\pi x_i)) + 20 + e \quad (1)$$

To handle such highly nonlinear problems with high complexity, the traditional methods become handicapped as it is a difficult task to check the auxiliary conditions like differentiability and continuity of the function in hand. Therefore, the evolutionary methods achieved enough popularity in recent years as they do not require any auxiliary conditions to be satisfied.

Genetic Algorithm (GA) (introduced by J. Holland in 1975) is one of such evolutionary methods, which is discussed briefly in section 2. GA operators are discussed in section 3. However, using simple GA sometimes puts the simulation suffering from getting trapped in local minima and sometimes results in premature convergence. To avoid such situations, researchers frequently use the hybrid versions of the GA. A case study on quadratic approximation based hybridization is described in section 4. In the same section, the effect of hybridization to simple GA is realized

through a set of benchmark functions. Moreover, some real life applications are also presented. In section 5, some probable application areas in 'Networking optimization' are highlighted for researchers' interest. Lastly, the conclusion of the chapter is drawn in section 6.

GENETIC ALGORITHM

This section discusses the basics of Genetic Algorithm (GA). Holland is considered to be the father of GA. Later works on GA can be found in Goldberg (1989), Michalewicz (1992), Deb (1995, 2001), Mitchell (1996), Back (1996), Gen and Cheng (1997), Rajasekaran and Pai (2003) etc.

GA is based on the Darwin's principle - 'The survival of the fittest'. It works by evolving a population of individuals over a number of generations. A fitness value is assigned to each individual in the population, where the fitness computation depends upon the application. At each generation for the reproduction, individuals are selected from population according to their fitness values. Then the individuals are crossed to generate new individuals with some high crossover probability, and the new individuals are mutated with some

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