Genetic Algorithms and Applications

Cezary Z. Janikow

Department of Mathematics and Computer Science
University of Missouri – St. Louis
janikow@radom.umsl.edu

ABSTRACT

Genetic algorithms are stochastic adaptive mechanisms simulating the natural process of adapting to the environment. Their applications use artificial environments simulating the task at hand. The information is coded and exchanged following the DNA coding and inheritance mechanisms. In recent years, the number of successfully deployed applications swelled, as the algorithms continuously evolve from pure simulative tools to algorithms bound by a common principle but implementing task-specific information. In this paper, we briefly explain what genetic algorithms are, we look at the theory and intuition behind them, and we finally explain their evolution toward such specific applications.

1 INTRODUCTION TO GENETIC ALGORITHMS

Recently, problem solving is beginning to emerge as interactions of active agents with the environment and the surrounding world rather than by isolated operations. Some of these ideas are derived from nature, where organisms both cooperate and compete for resources of the environment in the quest for a better adaptation. Such observations led to the design of algorithms which simulate these natural processes. One of the most successful such algorithms is so called genetic algorithm (GA). Genetic algorithms are adaptive search methods that simulate some of the natural processes: selection, information inheritance, random mutation, and population dynamics. The principles were first elucidated in [6], and since then the field has matured and enjoyed many successful applications. At first, GAs were most applicable to numerical parameter optimizations due to an easy mapping from the problem to representation space [2]. Today, they find more and more general applications due to better understanding of the necessary properties of the required mapping and new methodologies to process often present constraints.

1.1 Genetic algorithms at glance

A GA operates as a simulation in which a population of agents competes for survival and cooperates to achieve a better adaptation. The agents are called *chromosomes*, their high level meaningful substructures are called *genes*, and the lowest level characters are called *alleles*. Traditional genetic algorithms operate on binary bits – the alleles. The competition is stochastic, but with survival chances of an agent proportional to its current level of adaptation. This process simulates the Darwinian selection. Here, the environment is the problem at hand, and the agents are judged by their quality as potential solutions. The cooperation is achieved by merging information from few (often two) agents to produce a new one, with the hope of producing more adapted individuals (better solutions). For this objective to be fulfilled, two mechanisms are provided. First is a method that ensures that good agents have higher chances of being the donors (parents). This is achieved by the selective mechanisms which promotes survival of such individuals. Second is a mechanism aimed at selecting and merging the information in an intelligent way. This is achieved by means of cross-