Fundamenta Informaticae 35 (1998)
IOS Press

Preface

Evolutionary algorithms have received considerable attention regarding their potential as optimization techniques for complex real-world problems. These techniques, based on the important principle of "survival of the fittest," model some natural phenomena of genetic and phenotypic inheritance and Darwinian strife for survival; they also constitute an interesting category of modern heuristic search. They constitute a class of adaptive algorithms with operations based on probabilistic methods for creating and maintaining individuals in a population of solutions, and through a process of variation and selection, finding a near-optimum solution.

Evolutionary techniques have been successfully applied to variety of difficult problems. These include numerical optimization, machine learning, optimal control, cognitive modeling, classic operation research problems (traveling salesman problem, knapsack problems, transportation problems, assignment problems, bin packing, scheduling, partitioning, etc.), engineering design, system integration, iterated games, robotics, signal processing, and many others.

This special issue provides fourteen articles written on various topics connected with evolutionary techniques. The volume starts with a paper by Fogel, who provides an evidence that "evolutionary computation ideas" emerged earlier than commonly accepted. The paper reviews one early contribution to evolutionary computation (from 1967), which employed self-adaptation, co-evolution, and assessed the utility of recombination in various settings.

The following paper by Esquivel, Leiva, and Gallard overviews one of the main operators of any evolutionary algorithm: selection. The authors discuss several selection operators that have been proposed in the past and indicate the their interactions with other operators (like crossover or mutation).

The third paper by Eiben and Schippers concerns the widely known notions of exploration and exploitation in evolutionary search. A close look on these notions, however, reveals that widely known as they might be, they are not well understood. The authors present a survey of related papers and research questions that inspire further investigations.

Bäck in his paper discusses self-adaptation issues in evolutionary computation. This is one of the most important and promising areas of research in evolutionary computation, as it has a potential of adjusting the algorithm to the problem while solving the problem.

The paper by Rudolph presents a survey on evolutionary computation theory. In particular, convergence of evolutionary algorithms modeled by Markov processes is considered. The

paper provides a clear classification of research areas and the corresponding results, including recent theoretical investigations on obtaining convergence rates rather than abstract results on convergence in probability.

The paper by Murthy, Bhandari, and Pal introduces a concept of ϵ-optimal stopping time for genetic algorithms and considers two approaches (pessimistic and optimistic) to find it (genetic algorithms, considered in this paper, assume elitist model of selection). The authors provide also the optimal mutation probability in the context of of the worst case analysis.

There are many applications of evolutionary techniques. The paper by Khouja, Michalewicz, and Vijayaragavan investigates the usefulness of an evolutionary algorithm for solving this economic lot and delivery scheduling problem. The problem is to find a "just-in-time" schedule in which one production run of each component and a subsequent delivery of these components to the assembly facility occur in each cycle. The objective is to find the best sequence and cycle duration that minimizes the average cost per unit time of transportation, inventory at both the supplier and the assembly facility, and setup costs at the supplier.

The paper by Sebag, Schoenauer, and Peyral addresses an interesting issue of "evolutionary memory". It seems that memorizing the best and worst past individuals might be beneficial: e.g., the memory may bias the the mutation operator, guiding the generation of new offspring. The paper discusses also the possible roles of memory in evolutionary algorithms, depending on whether the fitness landscape changes or not.

Giordana and Lo Bello examine the applications of evolutionary algorithms for machine learning tasks. This is a challenging area of research as it is still uncertain whether evolutionary techniques are useful for various learning problems. The authors concentrate on one particular task of learning classification programs from examples, and, in this context, discuss the potential behind evolutionary methods.

The paper by Angeline gives a historical perspective on one particular branch of evolutionary computation: genetic programming, as it is known today. The progression from the earliest computational attempts at program evolution through the diversity of methods that define the current state-of-the-art is fully discussed.

Ant systems, introduced quite recently, constitute another example of a population-based optimization system, where artificial ants collectively solve an optimization problem by some cooperative effort. The paper by Boryczka addresses different strategies (models) used in connection with ant systems and provides some experimental results on traveling salesman problem.

One of the strengths of evolutionary algorithms is based on the easiness of their parallelization. The paper by Seredynski overviews existing models and new tendencies concerning parallel and distributed evolutionary computation. The paper discusses also ways to explore parallelism in evolutionary algorithms as well as different forms of control its execution.

One of the most exciting developments related to evolutionary computation is DNA computing, which, apart from serving as a connection between computers and living systems, aims at massively parallel computations. The paper by Deaton, Garzon, Rose, Franceschetti, and Stevens reviews the current state of DNA computing that has developed since 1994.

Finally, the volume ends with an overview of open issues by one of the pioneers of the field, Ken DeJong: he summarizes the recent trends, and carefully enlights the promising directions for fruitful research in evolutionary computation.

We feel that this volume might be of assistance to many researchers and practitioners involved in solving complex real-life problems. We hope that it may also help many individuals who are currently just 'interested' in evolutionary techniques; the included papers, apart from providing a broad overview of possibilities of applying these techniques to a real-life problems, report on theoretical aspects of evolutionary algorithms.

October 1998

A. E. Eiben and Zbigniew Michalewicz