Preface

Evolutionary Computation (EC) has become an important and timely methodology of problem solving among many researchers working in the area of computational intelligence. The population based collective learning process, self adaptation and robustness are some of the key features of evolutionary algorithms when compared to other global optimization techniques. Evolutionary Computation has been widely accepted for solving several important practical applications in engineering, business, commerce, etc. As the optimization problems to be tackled in the future will be growing in terms of complexity and volume of data, we can envision a rapidly growing role of the EC over the passage of time.

Evolutionary design of intelligent systems is gaining much popularity due to its capabilities in handling several real world problems involving optimization, complexity, noisy and non-stationary environment, imprecision, uncertainty and vagueness. This edited volume is aimed to present the latest state-of-the-art methodologies in 'Engineering Evolutionary Intelligent Systems'. This book deals with the theoretical and methodological aspects, as well as various EC applications to many real world problems originating from science, technology, business or commerce. This volume comprises of 15 chapters including an introductory chapter which covers the fundamental definitions and outlines some important research challenges. These fifteen chapters are organized as follows.

In the first Chapter, *Abraham* and *Grosan* elaborate on various schemes of evolutionary design of intelligent systems. Generic hybrid evolutionary intelligent system architectures are presented with a detailed review of some of the interesting hybrid frameworks already reported in the literature.

Oh and *Pedrycz* introduce an advanced architecture of genetically optimized Hybrid Fuzzy Neural Networks (gHFNN) resulting from a synergistic usage of the genetic optimization-driven hybrid system generated by combining Fuzzy Neural Networks (FNN) with Polynomial Neural Networks (PNN). FNNs support the formation of the premise part of the rule-based structure of the gHFNN. The consequence part of the gHFNN is designed using

PNNs. The optimization of the FNN is realized with the aid of a standard back-propagation learning algorithm and genetic optimization.

In the third Chapter, *Oh* and *Pedrycz* introduce Self-Organizing Neural Networks (SONN) that is based on a genetically optimized multilayer perceptron with Polynomial Neurons (PNs) or Fuzzy Polynomial Neurons (FPNs). In the conventional SONN, an evolutionary algorithm is used to extend the main characteristics of the extended Group Method of Data Handling (GMDH) method, that utilizes the polynomial order as well as the number of node inputs fixed at the corresponding nodes (PNs or FPNs) located in each layer during the development of the network. The genetically optimized SONN (gSONN) results in a structurally optimized structure and comes with a higher level of flexibility in comparison to the one encountered in the conventional SONN.

Kim and *Park* discuss a new design methodology of the self-organizing technique which builds upon the use of evolutionary algorithms. The self-organizing network dwells on the idea of group method of data handling. The order of the polynomial, the number of input variables, and the optimal number of input variables and their selection are encoded as a chromosome. The appropriate information of each node is evolved accordingly and tuned gradually using evolutionary algorithms. The evolved network is a sophisticated and versatile architecture, which can construct models from a limited data set as well as from poorly defined complex problems.

In the fifth Chapter, *Ramanathan* and *Guan* propose the Recursive Pattern-based Hybrid Supervised (RPHS) learning algorithm that makes use of the concept of pseudo global optimal solutions to evolve a set of neural networks, each of which can solve correctly a subset of patterns. The pattern-based algorithm uses the topology of training and validation data patterns to find a set of pseudo-optima, each learning a subset of patterns.

Ramanathan and *Guan* improve the RPHP algorithm (as discussed in Chapter 5) by using a combination of genetic algorithm, weak learner and pattern distributor. The global search component is achieved by a cluster-based combinatorial optimization, whereby patterns are clustered according to the output space of the problem. A combinatorial optimization problem is therefore formed, which is solved using evolutionary algorithms. An algorithm is also proposed to use the pattern distributor to determine the optimal number of recursions and hence the optimal number of weak learners suitable for the problem at hand.

In the seventh Chapter, *Markowska-Kaczmar* proposes two methods of rule extraction referred to as REX and GEX. REX uses propositional fuzzy rules and is composed of two methods REX Michigan and REX Pitt. GEX takes an advantage of classical Boolean rules. The efficiency of REX and GEX were tested using different benchmark data sets coming from the UCI repository.

Tushar and *Pratihar* deals with Takagi and Sugeno Fuzzy Logic Controllers (FLC) by focusing on their design process. This development by

clustering the data based on their similarity among themselves and then cluster-wise regression analysis is carried out, to determine the response equations for the consequent part of the rules. The performance of the developed cluster-wise linear regression approach; cluster-wise Takagi and Sugeno model of FLC with linear membership functions and cluster-wise Takagi and Sugeno model of FLC with nonlinear membership functions are illustrated using two practical problems.

In the ninth Chapter, *Prosperi* and *Ulivi* propose fuzzy relational models for genotypic drug resistance analysis in Human Immunodeficiency Virus type 1 (HIV-1). Fuzzy logic is introduced to model high-level medical language, viral and pharmacological dynamics. Fuzzy evolutionary algorithms and fuzzy evaluation functions are proposed to mine resistance rules, to improve computational performance and to select relevant features.

Azzini and *Tettamanzi* present an approach to the joint optimization of neural network structure and weights, using backpropagation algorithm as a specialized decoder, and defining a simultaneous evolution of architecture and weights of neural networks.

In the eleventh Chapter, *Dempsey et al.* present grammatical genetic programming to generate radial basis function networks. Authors tested the hybrid algorithm considering several benchmark classification problems reporting on encouraging performance obtained there.

In the sequel *Cha et al.* propose neural-genetic model to wave-induced liquefaction, which provides a better prediction of liquefaction potential. The wave-induced seabed liquefaction problem is one of the most critical issues for analyzing and designing marine structures such as caissons, oil platforms and harbors. In the past, various investigations into wave-induced seabed liquefaction have been carried out including numerical models, analytical solutions and some laboratory experiments. However, most previous numerical studies are based on solving complicated partial differential equations. The neural-genetic simulation results illustrate the applicability of the hybrid technique for the accurate prediction of wave-induced liquefaction depth, which can also provide coastal engineers with alternative tools to analyze the stability of marine sediments.

In the thirteenth Chapter, *Quintero* and *Pierre* propose a multi-population Memetic Algorithm (MA) with migration and elitism to solve the problem of assigning cells to switches as a design step of large-scale mobile networks. Being well-known in the literature to be an NP-hard combinatorial optimization problem, this task requires the recourse to heuristic methods, which can practically lead to good feasible solutions, not necessarily optimal, the objective being rather to reduce the convergence time toward these solutions. Computational results reported on an extensive suite of extensive tests confirm the efficiency and the effectiveness of MA to provide good solutions in comparison with other heuristics well-known in the literature, especially those for large-scale cellular mobile networks.

Alba and *Dorronsoro* solve the Capacitated Vehicle Routing Problem (CVRP) of 160 instances using a Cellular genetic algorithm (cGA) hybridized with a problem customized recombination operation, an advanced mutation operator integrating three mutation methods, and an inclusion of two well-known local search algorithms formulated for routing problems.

In the last Chapter, *Achtnig* investigates the use of Particle Swarm Optimization (PSO) in dealing with optimization problems of very high dimension. It has been found that PSO with some of the concepts originating from evolutionary algorithms, such as a mutation operator, can in many cases significantly improve the performance of the PSO. Further improvements have been reported with the addition of a random constriction coefficient.

We are very much grateful to all the authors of this volume for sharing their expertise and presenting their recent research findings. Our thanks go to the referees for their outstanding service and a wealth of critical yet highly constructive comments. The Editors would like to thank Dr. Thomas Ditzinger (Springer Engineering In house Editor, Studies in Computational Intelligence Series), Professor Janusz Kacprzyk (Editor-in-Chief, Springer Studies in Computational Intelligence Series) and Ms. Heather King (Editorial Assistant, Springer Verlag, Heidelberg) for the editorial assistance and excellent collaboration during the development of this volume.

We hope that the reader will share our excitement and find the volume '*Engineering Evolutionary Intelligent Systems*' both useful and inspiring.

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