ELSEVIER International Journal of Approximate Reasoning 31 (2002) 155–156
INTERNATIONAL JOURNAL OF APPROXIMATE REASONING
www.elsevier.com/locate/ijar

Editorial

Synergies between evolutionary computation and probabilistic graphical models

Evolutionary computation and probabilistic graphical models have been two of the most lively research topics in artificial intelligence during the 1990s. However, with a few exceptions, each topic has been treated and developed separately. Recently, there has been an attempt to leverage the advances of one field into the other.

This special issue is focused on cross-fertilization aspects between probabilistic graphical models and evolutionary computation. The six papers included in the number cover two types of synergies between both paradigms.

On the one hand probabilistic graphical models are used to develop a new paradigm for evolutionary computation, named estimation of distribution algorithms (EDAs) [1]. This new class of algorithms generalizes genetic algorithms by replacing the crossover and mutation operators with the learning and sampling from the probability distribution of the best individuals of the population at each iteration of the algorithm. Working in such a way, the relationships between the variables involved in the problem domain are explicitly and effectively captured and exploited. On the other hand a recently proposed metaheuristic named ant colony optimization is used to learn Bayesian network structures from data.

The paper by Mühlenbein and Mahnig presents a theory of population based optimization methods using approximations of search distributions. The authors prove the convergence of the search distributions to the global optima when the search distribution is a Boltzman distribution at each step and the size of the population is large enough. Also the relation between these optimization methods and those used in statistical physics is discussed. An application of the proposed method to the bipartitioning of large graphs is presented.

Baluja's paper demonstrates how a priori knowledge of parameter dependencies, even incomplete knowledge, can be incorporated to efficiently obtain

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PII: S0888-613X(02)00118-4

accurate models that account for parameter interdependencies. The incorporation of the a priori knowledge is achieved by effectively putting priors on the network structures. Empirical evidence of the accuracy of the proposed approach is also presented.

Pelikan, Sastry and Goldberg's paper discusses the Bayesian optimization algorithm, which uses Bayesian networks to model promising solutions and to sample new candidate solutions. In this paper the applicability of the methods for learning Bayesian networks in the context of genetic and evolutionary search is analyzed, concluding that the presented algorithm yields robust, efficient and accurate search.

The paper by Bosman and Thierens proposes a new algorithm for evolutionary multiobjective optimization by learning and using probabilistic mixture distributions. A specialized diversity preserving selection operator is used in order to improve and maintain the diversity of the population. With experimental results in two different problem domains the authors verify the effectiveness of the approach.

De Campos, Fernández-Luna, Gámez and Puerta's paper presents an adaptation of a recently introduced metaheuristic named ant colony optimization to the problem of learning Bayesian networks from data by means of a score + search approach. These authors present some experimental work with three different domains.

Finally, the paper by González, Lozano and Larrañaga presents a theoretical study of the behaviour in linear and quadratic functions of the univariate marginal distribution algorithm for continuous domains with tournament selection. The modelization is done for a tournament selection analyzing its behaviour in linear and quadratic functions.

Reference

[1] P. Larrañaga, J.A. Lozano (Eds.), Estimation of Distribution Algorithms. A New Tool for Evolutionary Computation, Kluwer Academic Publishers, 2001.

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