Preface

Social insects – ants, termites, wasps, and bees – live in almost every land habitat on Earth. Over the last one hundred million years of evolution they have conquered an enormous variety of ecological niches in the soil and vegetation. Undoubtedly, their social organization, in particular the genetically evolved commitment of each individual to the survival of the colony, is a key factor underpinning their success. Moreover, these insect societies exhibit the fascinating property that the activities of the individuals, as well as of the society as a whole, are not regulated by any explicit form of centralized control. Evolutionary forces have generated individuals that combine a total commitment to the society together with specific communication and action skills that give rise to the generation of complex patterns and behaviors at the global level.

Among the social insects, ants may be considered the most successful family. There are about 9,000 different species, each with a different set of specialized characteristics that enable them to live in vast numbers, and virtually everywhere. The observation and study of ants and ant societies have long since attracted the attention of the professional entomologist and the layman alike, but in recent years, the ant model of organization and interaction has also captured the interest of the computer scientist and engineer. Ant societies feature, among other things, autonomy of the individual, fully distributed control, fault-tolerance, direct and environment-mediated communication, emergence of complex behaviors with respect to the repertoire of the single ant, collective and cooperative strategies, and self-organization. The simultaneous presence of these unique characteristics have made ant societies an attractive and inspiring model for building new algorithms and new multi-agent systems.

In the last 10–15 years ant societies have provided the impetus for a growing body of scientific work, mostly in the fields of robotics, operations research, and telecommunications. The different simulations and implementations described in this research go under the general name of *ant algorithms*. Researchers from all over the world and possessing different scientific backgrounds have made significant progress concerning both implementation and theoretical aspects, within this novel research framework. Their contributions have given the field a solid basis and have shown how the "ant way", when carefully engineered, can result in successful applications to many real-world problems. Much as in the fields of genetic algorithms and neural networks, to take two examples, nature seems to offer us a valuable source of ideas for the design of new systems and algorithms.

A particularly successful research direction in ant algorithms, known as *ant colony optimization (ACO)*, is dedicated to their application to discrete optimization problems. Ant colony optimization has been applied successfully to a large number of difficult combinatorial problems such as the traveling salesman problem, the quadratic assignment problem and scheduling problems, as well as to routing in telecommunication networks. Ant colony optimization algorithms

have all been inspired by a specific foraging behavior of colonies of Argentine ants (*Iridomyrmex humilis*) that, as also observed in the laboratory, are able to find if not the shortest, at least a very good path connecting the colony's nest with a source of food. The elements playing an essential role in this ant foraging behavior were thoroughly reverse-engineered and put to work to solve problems of combinatorial optimization in *Ant System*, the algorithm described in the doctoral thesis of Marco Dorigo, at the beginning of the 1990s. This first application stimulated the interest of other researchers around the world to design algorithms for several important optimization and network problems getting inspiration from the same ant foraging behavior, and from Ant System in particular. Recently, in 1998, the ant colony optimization metaheuristic was defined, providing a common framework for describing this important class of ant algorithms.

The growing interest in ant colony optimization algorithms and, more generally, in ant algorithms, led, in 1998, to the organization of *ANTS'98 – From Ant Colonies to Artificial Ants*, the first international workshop on ant algorithms and ant colony optimization, held in Brussels, Belgium, which saw the participation of more than 50 researchers from around the world. On that occasion, a selection of the best papers presented at the workshop were published as a special issue of the *Future Generation Computer Systems* (Vol. 16, No. 8, 2000). The success of the workshop incited us to repeat the experience two years later: ANTS 2000 saw the participation of more than 70 participants and the 41 extended abstracts presented as talks or posters at the workshop were collected in a booklet distributed to participants. Also on that occasion, a selection of the best papers were published as a journal special issue (*IEEE Transactions on Evolutionary Computation*, Vol. 6, No. 4, 2002). Today the "ant algorithms community" continues to grow and we can see the field beginning to show encouraging signs of maturity, even if there is still a long way to go before reaching a deep and solid understanding concerning theoretical foundations and the design of effective implementations.

This volume contains the proceedings of *ANTS 2002 – From Ant Colonies to Artificial Ants: Third International Workshop on Ant Algorithms*, held in Brussels, Belgium, on September 12–14, 2002. These proceedings contain 36 contributions: 17 full papers and 11 short papers presented at the workshop as talks, and 8 extended abstracts presented as posters. These papers were selected out of a total of 52 submissions after a careful review process involving at least two referees for each paper.

We are very grateful to the members of the international program committee for their detailed reviews and for being available for additional comments and opinions, when needed. We hope that readers will agree that the quality of the papers collected in this volume reflects a new maturity in the field of ant algorithms, as well as a strong commitment to high standards of review.

The papers contributing to these proceedings are from authors coming from more than 20 different countries. We thank them, as well as all those contributing

to the organization of the workshop, in particular, IRIDIA and the ULB for providing rooms and logistic support.

Finally, we would like to thank our sponsors, the company *AntOptima* (`www.antoptima.com`), and the EC funded Research and Training Network *Metaheuristics Network* (`www.metaheuristics.org`), who financially supported the workshop.

We hope that these proceedings will provide an insightful and comprehensive starting point for the scientist entering the field of ant algorithms, as well as a valuable reference to the latest developments for the experienced practitioner in the field.

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