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# Transactions on Computational Science XXI

Special Issue on Innovations  
in Nature-Inspired Computing and Applications



Springer

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# LNCS Transactions on Computational Science

Computational science, an emerging and increasingly vital field, is now widely recognized as an integral part of scientific and technical investigations, affecting researchers and practitioners in areas ranging from aerospace and automotive research to biochemistry, electronics, geosciences, mathematics, and physics. Computer systems research and the exploitation of applied research naturally complement each other. The increased complexity of many challenges in computational science demands the use of supercomputing, parallel processing, sophisticated algorithms, and advanced system software and architecture. It is therefore invaluable to have input by systems research experts in applied computational science research.

*Transactions on Computational Science* focuses on original high-quality research in the realm of computational science in parallel and distributed environments, also encompassing the underlying theoretical foundations and the applications of large-scale computation.

The journal offers practitioners and researchers the opportunity to share computational techniques and solutions in this area, to identify new issues, and to shape future directions for research, and it enables industrial users to apply leading-edge, large-scale, high-performance computational methods.

In addition to addressing various research and application issues, the journal aims to present material that is validated – crucial to the application and advancement of the research conducted in academic and industrial settings. In this spirit, the journal focuses on publications that present results and computational techniques that are verifiable.

## Scope

The scope of the journal includes, but is not limited to, the following computational methods and applications:

- Aeronautics and Aerospace
- Astrophysics
- Bioinformatics
- Climate and Weather Modeling
- Communication and Data Networks
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- High-Energy Physics
- High-Performance Computing
- Numerical and Scientific Computing
- Parallel and Distributed Computing
- Reconfigurable Hardware
- Scientific Visualization
- Supercomputing
- System-on-Chip Design and Engineering

# Editorial

The Transactions on Computational Science journal is part of the Springer series *Lecture Notes in Computer Science*, and is devoted to the gamut of computational science issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

The journal focuses on original high-quality research in the realm of computational science in parallel and distributed environments, encompassing the facilitating theoretical foundations and the applications of large-scale computations and massive data processing. Practitioners and researchers share computational techniques and solutions in the area, identify new issues, and shape future directions for research, as well as enable industrial users to apply the presented techniques.

The current volume is devoted to recent advancements in the field of nature-inspired computing and applications. The issue provides an in-depth overview of current research on neurocomputing, evolutionary algorithms, swarm intelligence, artificial immune systems, membrane computing, computing with words, artificial life, and hybrid approaches. This special issue is aimed at practitioners, researchers, and post-graduate students who are engaged in developing and applying advanced nature-inspired computational techniques from both theoretical and practical points of view. Some articles are extended versions of conference papers previously published at the Nature and Biologically Inspired Computing (NaBIC) Congress, while others are direct submissions to the special issue.

We would like to extend our sincere appreciation to Guest Editor Prof. Ajith Abraham, to all of the authors for submitting their papers to this special issue, and the associate editors and referees for their valuable work. We would like to express our gratitude to the LNCS editorial staff of Springer, who supported us at every stage of the project.

It is our hope that the fine collection of papers presented in this special issue will be a valuable resource for Transactions on Computational Science readers and will stimulate further research into the vibrant area of computational science applications.

October 2013

Marina L. Gavrilova  
C.J. Kenneth Tan

# Special Issue on Innovations in Nature-Inspired Computing and Applications

## Guest Editor's Preface

Nature-inspired computation is a general term referring to computing inspired by nature. It is an emerging interdisciplinary area in computer science and due to its success in dealing with large, complex, and dynamic problems, it has become a household name for solving real-world problems. The main idea is to mimic the complex phenomena (concepts, principles, and mechanisms) occurring in nature as computational processes in order to enhance the way computation is performed from a problem solving point of view. Some of the key paradigms falling under this umbrella are neurocomputing, evolutionary algorithms, swarm intelligence, artificial immune systems, membrane computing, computing with words, artificial life, hybrid approaches, etc. Articles were selected on the basis of fundamental ideas and concepts rather than the direct usage of well-established techniques. This special issue is aimed at practitioners, researchers, and post-graduate students who are engaged in developing and applying advanced nature-inspired computational techniques from a theoretical point of view and also to solve real-world problems. It constitutes a collection of 15 articles reflecting some of the current technological innovations in the field of nature-inspired computation and its real world applications. The papers are arranged as follows.

In the first article, Veenhuis presents a novel function optimization algorithm inspired from Wikipedia, which uses a collaborative web community of authors to improve the quality of articles. The author introduces a community optimization algorithm by mimicking a collaborative web community, which edits or improves a knowledge base. The knowledge base represents the problem to be solved and the different decision variables represent different topics contained in this knowledge base. The algorithm is tested on eight well-known benchmark problems for lower as well as higher dimensions.

The diffusion of innovation theory explains how new ideas are disseminated among social system members. Sampaio et al. in the second article propose the use of evolutionary algorithms for the simulation of innovation diffusion within organizations. To overcome some of the problems inherent in the conventional evolutionary algorithm a probabilistic approach is also incorporated.

In the sequel, Jha et al. evaluate the performance of a robot by empowering it with a decision-making capability, which uses synthetic emotions. The authors attempted to make the robot perform high-profile tasks rather than menial ones so as to increase its utility.

Biogeography-based optimization is a population-based algorithm that is inspired by biogeography, which describes the immigration and emigration of species between habitats. Goel et al. in the fourth article present a land cover

feature extraction technique based on the extended species abundance model of biogeography and the algorithm has been successfully tested on two different multi-spectral satellite image datasets.

In the fifth paper, Madureira et al. describe the developing issues for ant-colony system-based optimization tools to support decision-making processes and solve the problem of generating a sequence of jobs that minimizes the total weighted tardiness for a set of jobs to be processed in a single machine.

Many real-world optimization problems present themselves in a multi-objective setting (where each of the objectives portrays different aspects of the problem). Ganesan et al. in the sixth article propose the weighted sum scalarization approach using differential evolution, chaotic differential evolution, and gravitational search algorithms to generate the approximate Pareto frontier.

In the sequel, Dutta et al. present a real-coded multi-objective genetic algorithm based  $K$ -clustering method, where a genetic algorithm is exploited to search for suitable clusters and centers of clusters so that intra-cluster distance and inter-cluster distances are simultaneously optimized. The authors attempted to simultaneously tackle dimensionality reduction and optimization of objectives using the multi-objective genetic algorithm.

The scheduling problem is considered to be an NP-complete combinatorial optimization problem and during the past few decades, researchers have used different meta-heuristics to solve such complex problems. However, most of these meta-heuristic techniques require extensive parameter tuning, which is again a very hard and time-consuming task to perform. Periera et al. in the eighth article propose a case-based reasoning module to solve the parameter-tuning problem in a multi-agent scheduling system.

Díaz-Parra and Ruiz-Vanoye in the ninth paper propose a vertical transfer algorithm for solving the school bus routing problem. The vertical transfer algorithm uses the clusterization population pre-selection operator, tournament selection, crossover-k operator, and an intelligent mutation operator.

In the tenth paper, Saha et al. propose craziness-based particle swarm optimization for designing digital Infinite Impulse Response (IIR) filters. Experimental results illustrate that apart from gaining better control on cognitive and social components of the conventional particle swarm optimization algorithm, the craziness-based particle swarm optimization offers better performance.

The prisoner's dilemma game has emerged as the most promising mathematical metaphor for studying cooperation. Wang et al. conduct simulations with four different types of neighbourhood structures, and agents update their strategies by probabilistically imitating the strategies of better performing neighbours. During the evolution each agent can modify its own strategy and/or personal feature via a particle swarm optimization approach in order to improve the utility.

Polášek and Uhlár in the twelfth paper propose a method for extracting, identifying, and visualizing topics, code tiers, users, and authors in software projects. The methodology can extract topics and visualize them in 3D graphs and then



developers within and outside the teams can receive and utilize visualized information from the code and apply it to their projects.

Navrat and Sabo present an approach, inspired by honey bees, that allows exploring the World Wide Web by extracting keywords relevant to current news stories. Honey bees cooperate together to select random keywords and carry them from one article to another, landing only on the articles relevant to the keyword.

In the fourteenth article, Raeesi and Kobti introduce the Variable Neighborhood Search (VNS) metaheuristic. VNS is hybridized with Differential Evolution (DE) incorporating explorative evolutionary operators and sub-populations to improve the population diversity. The algorithms are then validated on classical job shop scheduling problems.

In the final paper, Snasel et al. illustrate a growing self-organizing grid method for knowledge discovery and visualization for the analysis of emergency call-taking information systems and their data characteristics. To handle the massive data, the growing grid algorithm is implemented in a parallel environment using compute unified device architecture. Experimental results illustrate that the proposed method is very efficient.

I would like to thank our peer-reviewers for their diligent work and timely efforts. We are also grateful to the Editor-in-Chief of Springer's LNCS Transactions on Computational Science, Prof. Marina Gavrilova, University of Calgary, Canada, for her continued support and for the opportunity to organize this special issue. We hope that the readers will enjoy reading this special issue and find it useful.

**Acknowledgments:** This work was also performed within the framework of the IT4 Innovations Centre of Excellence project, reg. no. CZ.1.05/1.1.00/02.0070 by operational programme 'Research and Development for Innovations' funded by the Structural Funds of the European Union and state budget of the Czech Republic, EU.

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