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Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Marina L. Gavrilova C.J. Kenneth Tan
Cong-Vinh Phan (Eds.)

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Special Issue on Advances in Autonomic Computing:
Formal Engineering Methods
for Nature-Inspired Computing Systems

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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
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- Compilers and Operating Systems
- Computer Graphics
- Computational Biology
- Computational Chemistry
- Computational Finance and Econometrics
- Computational Fluid Dynamics
- Computational Geometry

- Computational Number Theory
- Computational Physics
- Data Storage and Information Retrieval
- Data Mining and Data Warehousing
- Grid Computing
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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 techniques presented.

The current volume is devoted to recent advancements in autonomic computing with special focus on formal engineering methods for nature-inspired computing systems and is edited by Phan Cong-Vinh. It is comprised of seven papers providing an in-depth overview of the area and comprehensive evaluation of state-of-the-art methodologies for autonomic computing.

We would like to extend our sincere appreciation to the special issue guest editor, Phan Cong-Vinh, for his diligence in preparing this special issue. We would also like to thank all of the authors for submitting their papers to the 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, in particular Alfred Hofmann, Ursula Barth, and Anna Kramer, who supported us at every stage of the project.

It is our hope that the fine collection of papers presented in this 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.

November 2011

Marina L. Gavrilova
C.J. Kenneth Tan

Advances in Autonomic Computing: Formal Engineering Methods for Nature-Inspired Computing Systems Guest Editor's Preface

This special issue, with papers contributed by prominent researchers from academia and industry, contains reference material for researchers, scientists, professionals, and students in computer science and computer engineering as well as developers and practitioners in computing and networking systems design, providing them with state-of-the-art research findings and future opportunities and trends. These contributions include some recent advances in autonomic computing reflected in the seven papers that we chose to invite for this special issue. In particular, the special issue covers various problems on formal engineering methods for nature-inspired computing systems.

The first paper, by Arun Prakash, Zoltan Theisz, and Ranganai Chaparadza, provides a hybrid methodology consisting of formal methods to design, refine, and verify the entities of autonomic networks. The paper focuses some discussions on the methods for meta-modeling, structural modeling, and behavior modeling and design of existing protocols and newly introduced autonomic components that autonomically manage and adapt the behavior of protocols to changing policy and network conditions. A case study, based on the recently introduced Hierarchical Autonomic Management and Control Architectural Framework called GANA, is used for highlighting the practical benefits and design choices available to modelers and autonomic components designers.

The second paper, by Cem Safak Sahin, M. Umit Uyar, Stephen Gundry, and Elkin Urrea, provides a nature-inspired approach to achieving self-organization of mobile nodes over unknown terrains. In this framework, each mobile node uses a genetic algorithm as a self-distribution mechanism to decide its next speed and movement direction to obtain a uniform distribution. The paper presents a formal analysis of the effectiveness of the genetic algorithm and introduces an inhomogeneous Markov chain model to prove its convergence.

The third paper, by Phan Cong-Vinh, first constructs algebraic models for data-aware self-organizing networks (DASNs). Second, an algebraic model of data streams is developed and quantitative behaviors for data streams in DASNs are computed. Third, using algebraic models for DASNs, the paper forms monoids of data-aware self-organizations and shapes streams of data-aware self-organizations. Finally, a category of data-aware self-organization monoids is established and streams of data-aware self-organization monoids are considered.

The fourth paper, by Pruet Boonma and Junichi Suzuki, discusses inherent tradeoffs on wireless sensor networks (WSNs) among conflicting performance objectives such as data yield, data fidelity, and power consumption. In order

to address this challenge, the paper proposes a biologically inspired application framework for WSNs. The proposed framework, called El Nino, models an application as a decentralized group of software agents.

The fifth paper, by Emil Vassev and Serguei A. Mokhov, discusses research towards developing special properties that introduce autonomic behavior in pattern-recognition systems. In the paper, ASSL (Autonomic System Specification Language) is used to formally develop such properties for DMARF (Distributed Modular Audio Recognition Framework).

The sixth paper, by Antonio Manzalini, Nermin Brgulja, Corrado Moiso, and Roberto Minerva, aims at looking inside the black box of an autonomic bio-inspired eco-system. Specifically, a model of autonomic component is elaborated allowing the evolution of ecosystems enabled by means of self-awareness and self-organization. This approach goes beyond a traditional mechanistic one, where concepts derived from biology are applied to explain what happens in an ecosystem.

The seventh paper, by Sylvain Halle, Roger Villemaire, Omar Cherkaoui, and Rudy Deca, stems from the observation that, when "data-aware" constraints are expressed using mathematical logic, automated sequence generation becomes a case of satisfiability solving. This approach has the advantage that, for many logical languages, existing satisfiability solvers can be used off-the-shelf. The paper surveys three logics suitable to express real-world data-aware constraints and discusses the practical implications, with respect to automated sequence generation, of some of their theoretical properties.

We owe our deepest gratitude to Dr. Nguyen Manh Hung, Rector of NTT University at Ho Chi Minh City in Vietnam for his useful support, and to all the authors for their valuable contribution to this special issue and their great efforts, and also to the referees for ensuring the high quality of the material presented here. All of them were extremely professional and cooperative. We wish to express our thanks to the Editor-in-Chief, Marina L. Gavrilova, for her important assistance with the process of assembling the special issue.

November 2011 Cong-Vinh Phan

LNCS Transactions on Computational Science – Editorial Board

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