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Editorial

Advances in complex systems modeling

This Feature Issue of EJOR contains a selection of papers that were submitted in response to the open call for papers published in April 2002. The call defined the scope of the issue as follows: *The feature issue focuses on innovative methods and tools supporting the entire life-cycle of model development, maintenance and analysis, including various modeling paradigms, techniques and tools. The methodology for modeling and analysis of complex systems includes optimization-based approaches, multi-criteria decision analysis, non-standard simulation and multi-agent systems approaches. Modeling of uncertainty using uncertainty theories, such as probability theory, fuzzy set theory and possibility theory, is an integral part of the complex systems we are focusing on. Development of new methodologies is closely related to real world applications. Application areas of particular interest for this feature issue include telecommunication, production planning and scheduling, logistics, transportation, environmental policy-making, and electronic commerce. One particular focus is on virtual worlds and modeling, including distributed decision technologies and collaborative modeling.*

Authors of papers presented at the two workshops listed below, were particularly invited to submit their full papers for this Feature Issue:

- The VEAM Workshop on *Virtual Environments for Advanced Modeling*, organized jointly by the IFIP Working Group 7.6. and the Japan Advanced Institute of Science and Technology (JAIST) on 25–27 March, 2002, at JAIST, Kanazawa, Japan.
- CSM'02, the 16th JISR-IIASA Workshop on *Methodologies and Tools for Complex System Modeling*, organized jointly by the Japan Institute of Systems Research (JISR) and the International Institute for Applied Systems Analysis (IIASA) on 15–17 July, 2002, at IIASA, Laxenburg, Austria.

The VEAM Workshop was the eighth conference organized by the IFIP Working Group 7.6 *Optimization-based Computer aided Modeling and Design*. This Working Group is part of IFIP's TC 7 Technical Committee on *System Modeling and Optimization*, and considers high-performance computer-aided systems to support modeling, decision analysis, optimization and multi-criteria decision making support. The focus of the Working Group is on applications in policy and management. The Working Group has particular interests in the following types of problems: network design, planning and scheduling in transportation, traffic and telecommunication, production planning and scheduling, and environmental planning. The methodology used to solve these applied problem types is mainly located in the fields of optimization, simulation and multi-criteria decision analysis. Finally, the Working Group explores intelligent decision support systems

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designed to successfully deal with large scale and complex systems from policy and management.

The CSM'02 was the 16th workshop organized jointly by JISR and IIASA. The long-term collaboration between these two institutes has focused on the development of methodologies and tools needed for complex system modeling and integrated policy assessment, as well as on actual applications of such methods and tools. In particular:

- Innovative methods and tools supporting the entire life-cycle of model development, maintenance and analysis; various modeling paradigms, techniques and tools applicable for large and complex and/or not well structured problems; especially, multi-criteria model analysis and other non-standard simulation—and optimization-based methods and tools for model analysis.
- Methodologies for modeling and analyzing complex systems, including the integration of models, multi-agent models, methods and software for integrated assessment, subjective evaluation models, decision analysis models, and catastrophic risk management models.
- Applications of innovative methodologies to analyze complex real-world problems. Environmental, social, industrial, and financial applications were considered, including policy measures for improving the quality of the environment, and ex-ante measures for mitigating the consequences of catastrophic events.
- Software tools supporting the development of applications in the areas mentioned above.

More than 70 papers were presented during VEAM and CSM'02 Workshops. There was a major overlap of interests in these workshops: both were dealing with modeling methodologies and real-world applications.

However, the Feature Issue was not limited to these two events. The editors encouraged all OR researchers and practitioners to submit papers that present original contributions to Complex Systems Modeling that are within the scope summarized above. Finally, 33 papers have been submitted; 16 papers passed the review procedure and are presented in this Issue.

Due to the scope of the issue defined above, the presented papers cover a diversified range of topics. However, each paper deals with an innovative modeling method and/or an innovative application. All methodological papers at least outline a complex application to which the presented method has been applied. Because of the characteristics of the papers it was not practical to organize the issue by grouping papers according to any crisp classification rule. Therefore, the issue is organized into the following four parts:

1. Modeling methodologies;
2. Agent-based modeling;
3. Optimization and
4. Applications.

Each part is composed of papers whose main contribution corresponds best to the part's scope:

1. Modeling methodologies: The four papers in this part present various novel modeling paradigms which are illustrated by using real-world applications. In the first paper, J. Gu and X. Tang introduce the Meta-synthesis approach based on Chinese intellectual tradition; the paper shows how complex systems can be analyzed by an integration of various modeling techniques and synthesis of tacit knowledge of experts and decision makers. M. Makowski presents the methodological background and the implementation of a structured modeling technology developed for supporting the whole modeling process for model-based decision-making support; the technology is implemented for huge linear models developed and used at distant locations; the applicability of this technology is illustrated by its applications to the next generation of a complex model used for supporting international negotiations aimed at improving European air quality. Z. Pawlak then follows with a new approach to conflict analysis that exploits capabilities of rough sets; although there are many formal models for conflict analysis the presented approach has attractive features