Advances on the theory of M&S

Achieving a widely accepted theoretical foundation with a sound computational framework in modeling and simulation (M&S) is still a hot topic. The path to a complete theory of M&S (TMS) crosses many well-established areas, such as systems theory, software engineering, automata theory, graph theory, etc. This special issue aims at highlighting the most recent advances in such an effort. It contains five papers which emphasize specification as a key issue, each in its specific way.

The first paper introduces an environment that aims at providing easy-to-use graphical modeling tools to simplify the construction and the execution of discrete-event simulation models based on the DEVS formalism. This work underlines the power of visual languages to improve model development in an assisted manner as well as to reduce modeling efforts. The proposed extensible open-source environment called CD++ Builder provides code templates that are synchronized with their graphical versions, hence automating code synthesis.

The second paper proposes a novel approach to multi-resolution M&S. The novelty is based on concepts of decoupling multi-resolution modeling and multi-resolution simulation. This separation of concerns makes it possible to define generic and stable operational semantics for multi-resolution models. The proposed specification has two facets: resolution conversion for dynamically changing simulation model structures and resolution matching interfaces between events in different resolutions. A main advantage of the proposed method is that it can be combined to existing modeling methodologies for different model types, including continuous time, discrete time and discrete event models.

The third paper introduces a series of methods to verify real-time models specified with the DEVS formalism. First, a new extension to the DEVS formalism, called the Rational Time-Advance DEVS (RTA-DEV'S), is proposed to allow modeling the behavior of real-time systems as well as checking the specifications with standard model-checking algorithms and tools. The checking is done through the creation of timed automata models that are behaviorally equivalent to the original RTA-DEV'S models. Secondly, a methodology is proposed to transform classic DEV'S models into RTA-DEV'S models, thus enabling formal verification of classic DEV'S with an acceptable accuracy.

The fourth paper proposes an approach to modeling, analysis and execution of workflows with timing constraints using a time stream Petri net (TSPN). Functional and temporal properties of a TSPN model can be checked using exhaustive verification or a DEV'S-based simulation tool. Enactment rests on a decentralized enactment engine based on the service-oriented computing paradigm, which enables execution of workflow processes where the coordinated activities may involve cross-boundary organizations.

The fifth paper presents a fuzzy-logic-based microscopic traffic simulation model to describe human behavior on the urban road network in many possible situations. The applicability and suitability of the proposed approach are evaluated using the observed data from the Japanese city of Gifu.

The guest editor sincerely expresses his appreciation to all of the authors of this special issue for contributing the high quality papers. Warm thanks are expressed to the referees who have critically evaluated the papers.

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