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Book review

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INTRODUCTION TO DISCRETE EVENT SYSTEMS
by Christos G. Cassandras and Stèphane Lafortune,
2008, Springer Science + Business Media LLC, XXIV + 776 p.,
ISBN: 978-0-387-33332-8.

Discrete event systems (DES) represent a class of dynamic, discrete - time systems whose states can take values only in a discrete-value space and can change only as a result of asynchronous occurrences of planned or spontaneous events. At present, there are ever more numerous subclasses of discrete event systems. Queuing systems, computer and communication systems, manufacturing and traffic systems are only a few examples of DES which are described in the book.

This is a second revised and added edition of a book written by professors Cassandras of Boston University and Lafortune of the University of Michigan. It builds upon the Cassandras' book entitled "Discrete Event Systems: Modelling and Performance Analysis", which was published in 1993 by Irwin and Aksen Associates and received in 1999 the "Harold Chesnut" prize of IFAC (International Federation of Automatic Control) for the best text book in control engineering.

The necessity of the book was perceived by the authors as a consequence of remarking several facts as it follows. There are more and more various complex real-life technical objects, which can be viewed as instances of DES class. They are to be understood, their operations are to be controlled and, if it is possible, optimized. The traditional methods, which are based on differential or difference equations, though have been proved effective in controlling many systems which show a continuous in time function to represent the state trajectories, are not adequate for the DES, whose sample paths (state trajectories) are described by piece-wise constant functions of time. Consequently, there is a need to develop new modelling frameworks, analysis techniques, design tools, testing methods, and systematic control, and optimization procedures for this new generation of highly complex systems. To fulfil their objective the authors adopt a multidisciplinary approach by building on control theory ("for performance optimization via feed back control"), computer science ("for modelling and verification of event-driven processes"), and operations research ("for analysis and simulation of stochastic DES"). Also the authors propose modelling frameworks and describe new analysis and control methods which are specific for DES and introduce new paradigms to allow combining mathematical tools with processing experimental data. In the Preface, the authors emphasize the critical role of the electronic computer in performing various activities such as system analysis, design, and control.

The authors are well aware of the existence of numerous books and papers addressing various subclasses of DES such as: language and automata theory, Petri nets , queuing models, Markov chains, discrete time simulation, perturbation analysis and so on , all using specific representations of the objects studied. The authors aim at proposing in the book a unified modelling framework with a view to enabling a coherent and systematic study of the objects which belong to almost all DES subclasses mentioned above. Consequently, two discrete event modeling formalisms are utilized throughout the book to represent the state transition structures: automata and, to a lesser extent, Petri nets. In section 1.3.3,

the authors introduce three *levels of abstraction* in the study of DES (*untimed, or logical, timed, and stochastic*) to describe sequences of events. The levels of abstraction are used to gradually refine the presentation of the notions and methods contained in the book.

The *first chapter* of the book contains an introduction to system concepts and parallel presentations of the main concepts of continuous variable dynamic systems, (CDS) and discrete event - driven systems. It also introduces hybrid systems; which most of the time be have as CDS, but in certain time moments when discrete events cause discontinuities in the state trajectory.

Chapter 2, 3 and *4* contain a study of DES at the *logical (or untimed)* level of abstraction. Language models of DES and the representation of languages by automata are described in *Chapter 2*. Software tools for analysis of DSS are presented too. Supervisory control issues are studied in *Chapter 3*, which contains also a detailed presentation of decentralized control. In *Chapter 4*, Petri nets concepts are addressed.

Chapter 5 refines the models presented in chapter 2 (automata) and 4 (Petri nets) to include time through the *clock mechanism* and gives an introduction to *hybrid systems*.

Chapters 6-11 utilise the third (*stochastic*) level of abstraction. The first three chapters (7, 8, and 9) contain aspects which are presented in the "traditional" manner of stochastic models based on probability theory. Markov chains, and classical queuing theory models are presented in chapters 7 and 8, respectively. Control and decision models based on Markov chains are described in *Chapter 9*.

Chapters 10 and *11* presents several concepts and techniques which heavily rely on the use of computer and do not require adopting the assumptions which were necessary when using classical stochastic models. *Chapter 10* contains an introduction to discrete - event simulation including a presentation of languages and corresponding software products (in section 10.4.). *Chapter 11* presents sensitivity analysis and concurrent estimation methods, including the new “Infinitesimal Perturbation Analysis” (IPA).

The book contains also auxiliary material such as: a) a review of Probability theory, and b) a description of IPA estimator. A web site (http://vita.bu.edu/cgc/Book), which is continuously maintained, can help the reader in his/her study.

This is a high quality book, rich in content, up-to-date, and well written. The presentation style utilized throughout the book is a formal one. Various examples presented and references made to relevant web sites increase value and usability of the book.

The book can be of great value for various categories of senior undergraduate and postgraduate students and of the people which are interested in control, communications, computer science as well as in manufacturing and industrial engineering. Therefore, I warmly recommend it to the readers of the *International Journal of Computers, Communications, and Control* (IJCCC).

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