Free Discrete Event System Simulation 5th

Computer modeling and simulation (M&S) allows engineers tostudy and analyze complex systems. Discrete-event system(DES)-M&S is used in modern management, industrial engineering,computer science, and the military. As computer speeds and memorycapacity increase, so DES-M&S tools become more powerful andmore widely used in solving real-life problems. Based on over 20 years of evolution within a classroomenvironment, as well as on decades-long experience in developingsimulation-based solutions for high-tech industries, Modelingand Simulation of Discrete-Event Systems is the only book onDES-M&S in which all the major DES modeling formalisms –activity-based, process-oriented, state-based, and event-based– are covered in a unified manner: A well-defined procedure for building a formal model in theform of event graph, ACD, or state graph Diverse types of modeling templates and examples that can beused as building blocks for a complex, real-life model A systematic, easy-to-follow procedure combined with sample C#codes for developing simulators in various modeling formalisms Simple tutorials as well as sample model files for usingpopular off-the-shelf simulators such as SIGMA®, ACE®,and Arena® Up-to-date research results as well as research issues anddirections in DES-M&S Modeling and Simulation of Discrete-Event Systems is anideal textbook for undergraduate and graduate students ofsimulation/industrial engineering and computer science, as well asfor simulation practitioners and researchers.

Discrete Event Systems: Diagnosis and Diagnosability addresses the problem of fault diagnosis of Discrete Event Systems (DESs). This book provides the basic techniques and approaches necessary for the design of an efficient fault diagnosis system for a wide range of modern engineering applications. This book classifies the different techniques and approaches according to several criteria such as: modeling tools (Automata, Petri nets, Templates) that is used to construct the model; the information (qualitative based on events occurrences and/or states outputs, quantitative based on signal processing, data analysis) that is needed to analyze and achieve the diagnosis; the decision structure (centralized, decentralized) that is required to achieve the diagnosis; as well as the complexity (polynomial, exponential) of the algorithm that is used to determine the set of faults that the proposed approach is able to diagnose as well as the delay time required for this diagnosis. The goal of this classification is to select the efficient method to achieve the fault diagnosis according to the application constraints. This book will include illustrated examples of the presented methods and techniques as well as a discussion on the application of these methods on several real-world problems.

Computer modeling and simulation (M&S) allows engineers to study and analyze complex systems. Discrete-event system (DES)-M&S is used in modern management, industrial engineering, computer science, and the military. As computer speeds and memory capacity increase, so DES-M&S tools become more powerful and more widely used in solving real-life problems. Based on over 20 years of evolution within a classroom environment, as well as on decades-long experience in developing simulation-based solutions for high-tech industries, Modeling and Simulation of Discrete-Event Systems is the only book on DES-M&S in

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Discrete Event Systems: Analysis and Control is the proceedings of WODES2000 (the 5th Workshop on Discrete Event Systems, held in Ghent, Belgium, on August 21-23, 2000). This book provides a survey of the current state of the art in the field of modeling, analysis and control synthesis of discrete event systems, lecture notes for a mini course on sensitivity analysis for performance evaluation of timed discrete event systems, and 48 carefully selected papers covering all areas of discrete event theory and the most important applications domains. Topics include automata theory and supervisory control (12); Petri net based models for discrete event systems, and their control synthesis (11); (max,+) and timed automata models (9); applications papers related to scheduling, failure detection, and implementation of supervisory controllers (7); formal description of PLCs (6); and finally, stochastic models of discrete event systems (3).

This thesis considers networked discrete-event systems. The overall system is a network of subsystems, each of which includes a technical process modelled by an I/O automaton together with a controller and a network unit. These subsystems are interconnected by physical couplings and digital communication links. An important characteristic of the networked discreteevent systems is the partial autonomy of the subsystems, which is reflected by the fact that each subsystem solves its local tasks individually. Cooperation among the subsystems becomes necessary if physical couplings or control specifications have to be resolved by two or more subsystems in order to satisfy the local tasks. Hence, the subsystems participate in satisfying cooperative tasks by adapting their behaviours while using the communication network without a coordinator. In these situations the following question arises: When and what information has to be exchanged by the subsystems and what should the structure of the communication network look like? As a main result of this thesis, it is proved that the subsystems in the networked discrete-event system determine deadlock-free execution orders of cooperative tasks with distributed model information by using the communication network and solving their local tasks. The applicability of the cooperative control solution is demonstrated by means of a collaborative process at the Handling System HANS. Markus Zgorzelski received his Bachelor in Electrical Engineering and Information Science from the Ruhr-Universität Bochum in 2011 and he received his Masters in Electrical Engineering and Information Science from the Ruhr-Universität Bochum in 2014. From 2014 to 2020 he was a scientific co-worker at the Institute of Automation and Computer Control, where he obtained his PhD. His research was focused on networked discrete-

event systems.

Discrete event systems (DES) have become pervasive in our daily lives. Examples include (but are not restricted to) manufacturing and supply chains, transportation, healthcare, call centers, and financial engineering. However, due to their complexities that often involve millions or even billions of events with many variables and constraints, modeling these stochastic simulations has long been a “hard nut to crack”. The advance in available computer technology, especially of cluster and cloud computing, has paved the way for the realization of a number of stochastic simulation optimization for complex discrete event systems. This book will introduce two important techniques initially proposed and developed by Professor Y C Ho and his team; namely perturbation analysis and ordinal optimization for stochastic simulation optimization, and present the state-of-the-art technology, and their future research directions. Contents:Part I: Perturbation Analysis:The IPA Calculus for Hybrid SystemsSmoothed Perturbation Analysis: A Retrospective and Prospective LookPerturbation Analysis and Variance Reduction in Monte Carlo SimulationAdjoints and AveragingInfinitesimal Perturbation Analysis and Optimization AlgorithmsSimulation-based Optimization of Failure-prone Continuous Flow LinesPerturbation Analysis, Dynamic Programming, and BeyondPart II: Ordinal Optimization:Fundamentals of Ordinal OptimizationOptimal Computing Budget Allocation FrameworkNested PartitionsApplications of Ordinal Optimization Readership: Professionals in industrial and systems engineering, graduate reference for probability & statistics, stochastic analysis and general computer science, and research. Keywords:Simulation;Optimization;Stochastic Systems;Discrete-Even Systems;Perturbation Analysis;Ordinal Optimization

Evolving technologies in mass production have led to the development of advanced techniques in the field of manufacturing. These technologies can quickly and effectively respond to various market changes, necessitating processes that focus on small batches of multiple products rather than large, single-product lines. Formal Methods in Manufacturing Systems: Recent Advances explores this shifting paradigm through an investigation of contemporary manufacturing techniques and formal methodologies that strive to solve a variety of issues arising from a market environment that increasingly favors flexible systems over traditional ones. This book will be of particular use to industrial engineers and students of the field who require a detailed understanding of current trends and developments in manufacturing tools. This book is part of the Advances in Civil and Industrial Engineering series collection.

The first practical textbook on AnyLogic 7 from AnyLogic developers. AnyLogic is the unique simulation software that supports three simulation modeling methods: system dynamics, discrete event, and agent based modeling and allows you to create multi-method models. The book is structured around four examples: a model of a consumer market, an epidemic model, a job shop model and an airport model. We also give some theory on different modeling methods. You can consider this book as your first guide in studying AnyLogic 7.

To promote fast and accessible service, many organizations and businesses utilize technological or structured systems

to create efficient waiting times and receptions. Managerial Approaches Toward Queuing Systems and Simulations provides emerging research on the various aspects of line management structures and organizations. While highlighting the components of queue control, such as attention capacity, quantitative analysis, and serial systems, this book will teach readers about the factors of queue systems that promote effective and efficient line areas and waiting times. This book is an important resource for managers, engineers, and researchers interested in the elements and stages of queuing management.

The problem of controlling sensory perception for use in discrete event feedback control systems is addressed in this thesis. The sensory perception controller (SPC) is formulated as a sequential Markov decision problem. The SPC has two main objectives; 1) to collect perceptual information to identify discrete events with high levels of confidence and 2) to keep the sensing costs low. Several event recognition techniques are available where each of the event recognisers produces confidence levels of recognised events. For a discrete event control system running in normal operation, the confidence levels are typically large and only a few event recognisers are needed. Then, as the event recognition becomes harder, the confidence levels will decrease and additional event recognisers are utilised by the SPC. The final product is an intelligent architecture with the ability to actively control the use of sensory input and perception to achieve high performance discrete event recognition. The discrete event control framework is chosen for several reasons. First, the theory of discrete event systems is applicable to a wide range of systems. In particular, manufacturing, robotics, communication networks, transportation systems and logistic systems all fall within the class of discrete event systems. Second, the dynamics of the sensing signals used by the event recognisers are often strong and contain a large amount of information at the occurrence of discrete events. Third, because of the discrete nature of events, feedback information is not required continuously. Hence, valuable processing time is available between events. Fourth, the discrete events are a natural common representational format for the sensors. A common sensor format aids the decision process when dealing with different sensor types. Fifth, the sensing aspect of discrete event systems has often been neglected in the literature. In this thesis we present a unique approach to on-line discrete event identification. The thesis contains both theoretical results and demonstrated real-world applications. The main theoretical contributions of the thesis are 1) the development of a sensory perception controller for the dynamic real-time selection of event recognisers. The proposed solution solves the Markov decision process using stochastic dynamic programming (SDP). SDP guarantees cost-efficiency of the real-time SPC by solving a sequential constrained optimisation problem. 2) A sensitivity analysis method for the sensory perception controller has been developed by exploring the relationship between Markov decision theory and linear programming. The sensitivity analysis aids in the robust tuning of the SPC by finding low sensitivity areas for

the controller parameters. Two real-world applications are presented. First, several event recognition techniques have been developed for a robotic assembly task. Robotic assembly fits particularly well in the discrete event framework, where discrete events correspond to changes in contact states between the workpiece and the environment. Force measurements in particular contain a significant amount of information when the contact state changes. Second, the sensory perception control theory and the sensitivity analysis have been demonstrated for a mobile navigation problem. The cost-efficient use of sensory perception reduces the need for mobile robots to carry heavy computational resources.
This work presents a novel approach to modeling, analysis and diagnosis of coupled mechatronical systems with partially autonomous behavior and asynchronous state transitions. The systems under consideration are assumed to have the following properties: The internal interactions are immeasurable but reliable and the measurements relevant for diagnosis are given as a sequence of events. Asynchronous networks of input/output automata (I/O-automata) are developed to cope with partial coupling between components and to reduce the computational complexity of the diagnostic algorithms. I/O-automata are used to model those components. Their measurable inputs and outputs are modeled as control signals. Interconnection signals are used to model the internal dependencies among the components. They are linked via an interaction block to one another. The criterion known from synchronous networks of I/O-automata is extended to ensure the well-posedness of this modeling formalism. To check for partially autonomous behavior, two types of autonomy are introduced and discussed: Structural autonomy and state-dependent autonomy. To carry out the diagnosis, three different information structures are investigated: Centralized, decentralized and partially coordinated. The centralized approach yields the ideal diagnostic result, but reduction of the computational complexity by using online composition is rather small. Further reduction of the computational complexity is accomplished by decentralized diagnosis. It yields only in the case of state-dependent autonomy a complete and sound diagnostic result. In general, the lack of soundness arises. Both, obtaining an ideal diagnostic result and reducing the computational complexity, is obtained by the partially coordinated diagnostic algorithm.
The three-volume set LNCS 3514-3516 constitutes the refereed proceedings of the 5th International Conference on Computational Science, ICCS 2005, held in Atlanta, GA, USA in May 2005. The 464 papers presented were carefully reviewed and selected from a total of 834 submissions for the main conference and its 21 topical workshops. The papers span the whole range of computational science, ranging from numerical methods, algorithms, and computational kernels to programming environments, grids, networking, and tools. These fundamental contributions dealing with computer science methodologies and techniques are complemented by papers discussing computational applications and needs in virtually all scientific disciplines applying advanced computational methods and tools to achieve new discoveries with

greater accuracy and speed.

Estimation and Inference in Discrete Event Systems chooses a popular model for emerging automation systems—finite automata under partial observation—and focuses on a comprehensive study of the key problems of state estimation and event inference. The text includes treatment of current, delayed, and initial state estimation. Related applications for assessing and enforcing resiliency—fault detection and diagnosis—and security—privacy and opacity—properties are discussed, enabling the reader to apply these techniques in a variety of emerging applications, among them automated manufacturing processes, intelligent vehicle/highway systems, and autonomous vehicles. The book provides a systematic development of recursive algorithms for state estimation and event inference. The author also deals with the verification of pertinent properties such as: the ability to determine the exact state of a system, “detectability”; the ability to ensure that certain classes of faults can be detected/identified, “diagnosability”; and the ability to ensure that certain internal state variables of the system remain “hidden” from the outside world regardless of the type of activity that is taking place, “opacity”. This book allows students, researchers and practicing engineers alike to grasp basic aspects of state estimation in discrete event systems, aspects like distributivity and probabilistic inference, quickly and without having to master the entire breadth of models that are available in the literature.

In recent years, there has been a growing debate, particularly in the UK and Europe, over the merits of using discrete-event simulation (DES) and system dynamics (SD); there are now instances where both methodologies were employed on the same problem. This book details each method, comparing each in terms of both theory and their application to various problem situations. It also provides a seamless treatment of various topics--theory, philosophy, detailed mechanics, practical implementation--providing a systematic treatment of the methodologies of DES and SD, which previously have been treated separately.

Object-Oriented Computer Simulation of Discrete-Event Systems offers a comprehensive presentation of a wide repertoire of computer simulation techniques available to the modelers of dynamic systems. Unlike other books on simulation, this book includes a complete and balanced description of all essential issues relevant to computer simulation of discrete event systems, and it teaches simulation users how to design, program and exploit their own computer simulation models. In addition, it uses the object-oriented methodology throughout the book as its main programming platform. The reader is expected to have some background in the theory of probability and statistics and only a little programming experience in C++, as the book is not tied down to any particular simulation language. The book also provides 50 complete simulation problems to assist with writing such simulation programs. Object-Oriented Computer Simulation of Discrete-Event Systems demonstrates the basic and generic concepts used in computer simulation of

discrete-event systems in a comprehensive, uniform and self-contained manner.

Introduction to Discrete Event Systems is a comprehensive introduction to the field of discrete event systems, offering a breadth of coverage that makes the material accessible to readers of varied backgrounds. The book emphasizes a unified modeling framework that transcends specific application areas, linking the following topics in a coherent manner: language and automata theory, supervisory control, Petri net theory, Markov chains and queuing theory, discrete-event simulation, and concurrent estimation techniques. This edition includes recent research results pertaining to the diagnosis of discrete event systems, decentralized supervisory control, and interval-based timed automata and hybrid automata models.

"This is an excellent and well-written text on discrete event simulation with a focus on applications in Operations Research. There is substantial attention to programming, output analysis, pseudo-random number generation and modelling and these sections are quite thorough. Methods are provided for generating pseudo-random numbers (including combining such streams) and for generating random numbers from most standard statistical distributions." --ISI Short Book Reviews, 22:2, August 2002

Researches and developers of simulation models state that the Java program ming language presents a unique and significant opportunity for important changes in the way we develop simulation models today. The most important characteristics of the Java language that are advantageous for simulation are its multi-threading capabilities, its facilities for executing programs across the Web, and its graphics facilities. It is feasible to develop compatible and reusable simulation components that will facilitate the construction of newer and more complex models. This is possible with Java development environments. Another important trend that begun very recently is web-based simulation, i.e., and the execution of simulation models using Internet browser software. This book introduces the application of the Java programming language in discrete-event simulation. In addition, the fundamental concepts and prac tical simulation techniques for modeling different types of systems to study their general behavior and their performance are introduced. The approaches applied are the process interaction approach to discrete-event simulation and object-oriented modeling. Java is used as the implementation language and UML as the modeling language. The first offers several advantages compared to C++, the most important being: thread handling, graphical user interfaces (QUI) and Web computing. The second language, UML (Unified Modeling Language) is the standard notation used today for modeling systems as a collection of classes, class relationships, objects, and object behavior.

Discrete-event dynamic systems (DEDs) permeate our world. They are of great importance in modern manufacturing processes, transportation and various forms of computer and communications networking. This book begins with the

mathematical basics required for the study of DEDs and moves on to present various tools used in their modeling and control. Industrial examples illustrate the concepts and methods discussed, making this book an invaluable aid for students embarking on further courses in control, manufacturing engineering or computer studies.

Discover How to Apply DES to Problems Encountered in HTA Discrete event simulation (DES) has traditionally been used in the engineering and operations research fields. The use of DES to inform decisions about health technologies is still in its infancy. Written by specialists at the forefront of this area, Discrete Event Simulation for Health Technology Assessment is the first book to make all the central concepts of DES relevant for health technology assessment (HTA). Accessible to beginners, the book requires no prerequisites and describes the concepts with as little jargon as possible. The book first covers the essential concepts and their implementation. It next provides a fully worked out example using both a widely available spreadsheet program (Microsoft Excel) and a popular specialized simulation package (Arena). It then presents approaches to analyze the simulations, including the treatment of uncertainty; tackles the development of the required equations; explains the techniques to verify that the models are as efficient as possible; and explores the indispensable topic of validation. The book also covers a variety of non-essential yet handy topics, such as the animation of a simulation and extensions of DES, and incorporates a real case study involving screening strategies for breast cancer surveillance. This book guides you in leveraging DES in your assessments of health technologies. After reading the chapters in sequence, you will be able to construct a realistic model designed to help in the assessment of a new health technology.

This book constitutes the refereed proceedings of the 32nd International Conference on Applications and Theory of Petri Nets and Other Models of Concurrency, PETRI NETS 2011, held in Newcastle, UK, in June 2011. The 13 regular papers and 4 tool papers presented were carefully reviewed and selected from 49 submissions. The book also contains 3 full paper length invited talks. All current issues on research and development in the area of Petri nets and related models of concurrent systems are addressed.

Complex artificial dynamic systems require advanced modeling techniques that can accommodate their asynchronous, concurrent, and highly non-linear nature. Discrete Event systems Specification (DEVS) provides a formal framework for hierarchical construction of discrete-event models in a modular manner, allowing for model re-use and reduced development time. Discrete Event Modeling and Simulation presents a practical approach focused on the creation of discrete-event applications. The book introduces the CD++ tool, an open-source framework that enables the simulation of discrete-event models. After setting up the basic theory of DEVS and Cell-DEVS, the author focuses on how to use the CD++ tool to define a variety of models in biology, physics, chemistry, and artificial systems. They also demonstrate how to map different modeling techniques, such as Finite State Machines and VHDL, to DEVS. The in-depth coverage elaborates on the creation of simulation software for DEVS models and the 3D visualization environments associated with these tools. A much-needed practical approach to creating

discrete-event applications, this book offers world-class instruction on the field’s most useful modeling tools.

Information previously available only in journal articles and research papers has been brought together in this outstanding text. Uses the unifying theme of monotone structure to transcend the two-perspective approach to DES--one stressing logical/qualitative issues and the other temporal/quantitative analysis--to encompass elements from both. Features notes and references at the end of each chapter.

Stochastic discrete-event systems (SDES) capture the randomness in choices due to activity delays and the probabilities of decisions. This book delivers a comprehensive overview on modeling with a quantitative evaluation of SDES. It presents an abstract model class for SDES as a pivotal unifying result and details important model classes. The book also includes nontrivial examples to explain real-world applications of SDES.

CONTENIDO: Models - Random-number generation - Discrete-event simulation - Statistics - Next-event simulation - Discrete random variables - Continuous random variables - Output analysis - Input modeling - Projects.

Discrete Event Simulation is a process-oriented text/reference that utilizes an eleven-step model to represent the simulation process from problem formulation to implementation and documentation. The book presents the necessary level of detail required to fully develop a model that produces meaningful results and considers the tools necessary to interpret those results. Sufficient background information is provided so that the underlying concepts of simulation are understood. Major topics covered in Discrete Event Simulation include probability and distributional theory, statistical estimation and inference, the generation of random variates, verification and validation techniques, time management methods, experimental design, and programming language considerations. The book also examines distributed simulation and issues related to distributing the physical process over a network of tightly coupled processors. Topics covered in this area include deadlock, synchronization, rollback, event management, and communication processes. Fully worked examples and numerous practical exercises have been drawn from the engineering disciplines and computer science, although they have been structured so that they will be useful as well to other disciplines such as economics, business administration, and management science. The presentation of techniques and methods in Discrete Event Simulation make it an ideal text/reference for all practitioners of discrete event simulation.

Die Wettbewerbsfahigkeit von Industrieunternehmen hangt massgeblich von der Produktivitat der eingesetzten Anlagen und Produktionsprozesse ab. Um ein hohes Mass an Produktivitat zu garantieren, mussen durch Fehler verursachte Standzeiten so kurz wir moglich gehalten werden. Dazu werden effiziente Methoden zur Fehlerdiagnose benotigt. In der vorliegenden Arbeit wurde ein modellbasiertes Diagnose-Verfahren fur ereignisdiskrete Closed-Loop Systeme entwickelt. Die betrachteten Systeme bestehen aus dem geschlossenen Kreis von Steuerung und Prozess. Durch den systematischen Vergleich von aktuell beobachtetem und durch ein Systemmodell erwartetem Verhalten konnen Fehler in Echtzeit erkannt und isoliert werden. In der Arbeit wurden geeignete Modellidentifikationsverfahren fur Ereignisdiskrete Systeme entwickelt, sodass die aufwandige manuelle Modellbildung vermieden wird. Die entwickelten Methoden wurden im Labor und im Rahmen einer Industrieanwendung erfolgreich getestet.

Petri Net Synthesis for Discrete Event Control of Manufacturing Systems develops two essential resource-sharing concepts: parallel and sequential mutual exclusions and theoretical results in Petri synthesis. A parallel mutual exclusion (PME) is defined to model a resource shared by independent distributed processes, and a sequential mutual exclusion is a sequential composition of PMEs, modeling a resource shared by sequentially-related processes. A hybrid synthesis methodology for Petri net models and controllers is proposed using top-down, modular, and bottom-up design ideas and the mutual exclusion theory. An aggregate Petri net model is refined by replacing places and /or

transitions with basic design modules which are mathematically and graphically described. Petri net design methods are presented for such buffers as automatic storage and retrieval systems. Using the proposed method synthesizes both Petri net structure and feasible initial markings, guaranteeing that resulting Petri nets have desirable system properties such as freedom from deadlock and cyclic behavior. A Petri net controller is extended to error recovery for automated manufacturing systems. The theory can guarantee that the desired system properties achieved by the original design will be preserved when the controller is augmented to deal with an error in the prescribed methods. Control code has been directly generated from Petri net definitions. The algorithm and implementation details are given for a flexible manufacturing system. Using the approach presented in Petri Net Synthesis for Discrete Event Control of Manufacturing Systems, engineers and research workers can develop their own discrete event control applications and experiments.

dynamic analysis of repetitive decision-free discrete event processes: the algebra of times marked grpahs and algorithmic issuesSupervisory Control of Discrete Event Systems Using Petri NetsSpringer Science & Business Media

Supervisory Control of Discrete Event Systems Using Petri Nets presents a novel approach to its subject. The concepts of supervisory control and discrete event systems are explained, and the background material on general Petri net theory necessary for using the book's control techniques is provided. A large number of examples is used to illustrate the concepts and techniques presented in the text, and there are plenty of references for those interested in additional study or more information on a particular topic. Supervisory Control of Discrete Event Systems Using Petri Nets is intended for graduate students, advanced undergraduates, and practicing engineers who are interested in the control problems of manufacturing, communication and computer networks, chemical process plants, and other high-level control applications. The text is written from an engineering perspective, but it is also appropriate for students of computer science, applied mathematics, or economics. The book contains enough background material to stand alone as an introduction to supervisory control with Petri nets, but it may also be used as a supplemental text in a course on discrete event systems or intelligent autonomous control.

Over the last decades Discrete Event Simulation has conquered many different application areas. This trend is, on the one hand, driven by an ever wider use of this technology in different fields of science and on the other hand by an incredibly creative use of available software programs through dedicated experts. This book contains articles from scientists and experts from 10 countries. They illuminate the width of application of this technology and the quality of problems solved using Discrete Event Simulation. Practical applications of simulation dominate in the present book. The book is aimed to researchers and students who deal in their work with Discrete Event Simulation and which want to inform them about current applications. By focusing on discrete event simulation, this book can also serve as an inspiration source for practitioners for solving specific problems during their work. Decision makers who deal with the question of the introduction of discrete event simulation for planning support and optimization this book provides a contribution to the orientation, what specific problems could be solved with the help of Discrete Event Simulation within the organization.

This book shows how supervisory control theory (SCT) supports the formulation of various control problems of standard types, like the synthesis of controlled dynamic invariants by state feedback, and the resolution of such problems in terms of naturally definable control-theoretic concepts and properties, like reachability, controllability and observability. It exploits a simple, abstract model of controlled discrete-event systems (DES) that has proved to be tractable, appealing to control specialists, and expressive of a range of control-theoretic ideas. It allows readers to choose between automaton-based and dually language-based forms of SCT, depending on whether their preference is for an internal-structural or external-behavioral description of the problem. The monograph begins with two chapters on algebraic and linguistic

preliminaries and the fundamental concepts and results of SCT are introduced. To handle complexity caused by system scale, architectural approaches—the horizontal modularity of decentralized and distributed supervision and the vertical modularity of hierarchical supervision—are introduced. Supervisory control under partial observation and state-based supervisory control are also addressed; in the latter, a vector DES model that exploits internal regularity of algebraic structure is proposed. Finally SCT is generalized to deal with timed DES by incorporating temporal features in addition to logical ones. Researchers and graduate students working with the control of discrete-event systems or who are interested in the development of supervisory control methods will find this book an invaluable aid in their studies. The text will also be of assistance to researchers in manufacturing, logistics, communications and transportation, areas which provide plentiful examples of the class of systems being discussed.

Research of discrete event systems is strongly motivated by applications in flex ible manufacturing, in traffic control and in concurrent and real-time software verification and design, just to mention a few important areas. Discrete event system theory is a promising and dynamically developing area of both control theory and computer science. Discrete event systems are systems with non-numerically-valued states, inputs, and outputs. The approaches to the modelling and control of these systems can be roughly divided into two groups. The first group is concerned with the automatic design of controllers from formal specifications of logical requirements. This re search owes much to the pioneering work of P.J. Ramadge and W.M. Wonham at the beginning of the eighties. The second group deals with the analysis and op timization of system throughput, waiting time, and other performance measures for discrete event systems. The present book contains selected papers presented at the Joint Workshop on Discrete Event Systems (WODES'92) held in Prague, Czechoslovakia, on Au gust 26-28, 1992 and organized by the Institute of Information Theory and Au tomation of the Czechoslovak Academy of Sciences, Prague, Czechoslovakia, by the Automatic Control Laboratory of the Swiss Federal Institute of Technology (ETH) , Zurich, Switzerland, and by the Department of Computing Science of the University of Groningen, Groningen, the Netherlands.

Shows pastors how to balance new worship ideas with the traditional while focusing on the purpose of praise and fellowship.