IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter **January 2023**

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Welcome to the 2023 January issue of the newsletter, also available online at
http://ieeecss.org/tc/discrete-event-systems/newsletters

Editorial

You are welcome to submit new items to the newsletter (topics including schools, workshops, sessions, conferences, journals, books, software, positions). Also please encourage relevant colleagues and students to subscribe to this newsletter.

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Contents

1 Selections of Journal Publications

Contributed by: Xiang Yin (yinxiang@sjtu.edu.cn)

1.1. IEEE Transactions on Automatic Control

Volume: 68, Issue: 1, January 2023

- **Policy Synthesis for Switched Linear Systems With Markov Decision Process Switching**
  Authors: Bo Wu ; Murat Cubuktepe ; Franck Djeumou ; Zhe Xu ; Ufuk Topcu
  Abstract: In this article, we study the synthesis of mode switching protocols for a class of discrete-time switched linear systems in which the mode jumps are governed by Markov decision processes (MDPs). We call such systems MDP-JLS for brevity. Each state of the MDP corresponds to a mode in the switched system. The probabilistic state transitions in the MDP represent the mode transitions. We focus on finding a policy that selects the switching actions at each mode such that the switched system is guaranteed to be stable. Given a policy in the MDP, the considered MDP-JLS reduces to a Markov jump linear system (MJLS). We consider both mean-square stability and stability with probability one. For mean-square stability, we leverage existing stability conditions for MJLSs and propose efficient semidefinite programming formulations to find a stabilizing policy in the MDP. For stability with probability one, we derive new sufficient conditions and compute a stabilizing policy using linear programming. We also extend the policy synthesis results to MDP-JLS with uncertain mode transition probabilities.
- **Polynomial-Time Verification and Enforcement of Delayed Strong Detectability for Discrete-Event Systems**
  Authors: Kuize Zhang
  Abstract: Detectability is a fundamental property in partially observed dynamical systems. It describes whether one can use observed output sequences to determine the current and subsequent states. Delayed detectability generalizes detectability in the sense that when doing state estimation at a time instant, some outputs after the instant are also considered, making the estimation more accurate. In this article, we use a novel concurrent-composition method to give polynomial-time algorithms for verifying several delayed versions of strong detectability of discrete-event systems modeled by finite-state automata in the contexts of formal languages and ω-languages without any assumption, which strengthen the polynomial-time verification algorithms in the literature based on two fundamental assumptions of liveness (aka deadlock-freeness) and divergence-freeness (the former implies an automaton will never halt and the latter implies the running of an automaton will always be eventually observed). In addition, based on our verification algorithms, we obtain polynomial-time algorithms for enforcing these notions of delayed strong detectability in an open-loop manner, which work in a different way compared with the existing exponential-time enforcement algorithms under the supervisory control framework in a closed-loop manner. Moreover, by using our methods, polynomial-time enforcement algorithms can be designed for many polynomially verifiable inference-based properties such as diagnosability and predictability.
- **From Local to Global Consistency in Distributed Monitoring of Petri Net Models**
  Authors: George Jiroveanu ; René K. Boel
  Abstract: In this technical article we consider a distributed analysis of a plant given by local petri net models (components) that interact via shared transitions. For each component, there is a local agent that performs local calculations and exchanges information with its neighbours for monitoring the plant. We relax the standard requirement that the interaction graph between components is a tree and, for the general case, we investigate under which conditions the local consistency of the local estimates imply their global consistency. Moreover, we show that if the information exchanged between agents incorporates additional information related to the execution time intervals of the shared transitions, the globally consistent estimates become equal to the results derived in a CR.
- **Reachability Analysis in Stochastic Directed Graphs by Reinforcement Learning**
  Authors: Corrado Possieri ; Mattia Frasca ; Alessandro Rizzo
  Abstract: We characterize the reachability probabilities in stochastic directed graphs by means of reinforcement learning methods. In particular, we show that the dynamics of the transition

probabilities in a stochastic digraph can be modeled via a difference inclusion, which, in turn, can be interpreted as a Markov decision process. Using the latter framework, we offer a methodology to design reward functions to provide upper and lower bounds on the reachability probabilities of a set of nodes for stochastic digraphs. The effectiveness of the proposed technique is demonstrated by application to the diffusion of epidemic diseases over time-varying contact networks generated by the proximity patterns of mobile agents.

- **Supervisory Controller Synthesis for Nonterminating Processes Is an Obliging Game**
  Authors: Rupak Majumdar ; Anne-Kathrin Schmuck
  Abstract: In this article, we present a new algorithm to solve the supervisory control problem over nonterminating processes modeled as ω-regular automata. A solution to this problem was obtained by Thistle in 1995, which uses complex manipulations of automata. We show a new solution to the problem through a reduction to obliging games, which, in turn, can be reduced to ω-regular reactive synthesis. Therefore, our reduction results in a symbolic algorithm based on manipulating sets of states.

- **Optimal Probabilistic Motion Planning With Potential Infeasible LTL Constraints**
  Authors: Mingyu Cai ; Shaoping Xiao ; Zhijun Li ; Zhen Kan
  Abstract: This paper studies optimal motion planning subject to motion and environment uncertainties. By modeling the system as a probabilistic labeled Markov decision process (PL-MDP), the control objective is to synthesize a finite-memory policy, under which the agent satisfies complex high-level tasks expressed as linear temporal logic (LTL) with desired satisfaction probability. In particular, the cost optimization of the trajectory that satisfies infinite horizon tasks is considered, and the trade-off between reducing the expected mean cost and maximizing the probability of task satisfaction is analyzed. The LTL formulas are converted to limit-deterministic Büchi automata (LDBA) with a reachability acceptance condition and a compact graph structure. The novelty of this work lies in considering the cases where LTL specifications can be potentially infeasible and developing a relaxed product MDP between PL- MDP and LDBA. The relaxed product MDP allows the agent to revise its motion plan whenever the task is not fully feasible and quantify the revised plans violation measurement. A multi- objective optimization problem is then formulated to jointly consider the probability of task satisfaction, the violation with respect to original task constraints, and the implementation cost of the policy execution. The formulated problem can be solved via coupled linear programs. This work first bridges the gap between probabilistic planning revision of potential infeasible LTL specifications and optimal control synthesis of both plan prefix and plan suffix of the trajectory over the infinite horizons. Experimental results are provided to demonstrate the effectiveness of the proposed framework.

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1.2. Automatica

Volume: 147, January 2023

- **Dealing with sensor and actuator deception attacks in supervisory control**
  Authors: Rômulo Meira-Góes ; Hervé Marchand ; Stéphane Lafortune
  Abstract: We consider feedback control systems where sensor readings and actuator commands may be compromised by an attacker intending to damage the system. We study this problem at the supervisory layer of the control system, using discrete event systems techniques. The attacker can edit the outputs from the sensors of the system before they reach the supervisory controller as well as it can edit actuator commands before they reach the system. In this context, we formulate the problem of synthesizing a supervisor that is robust against a large class of edit attacks on the sensor readings and actuator commands. Intuitively, we search for a supervisor that guarantees the safety of the system even when sensor readings and actuator commands are compromised. Given the similarities of the investigated problem to the standard supervisory control problem, our solution methodology reduces the problem of synthesizing a robust supervisor against deception attacks to a supervisory control problem. This new and intuitive solution methodology improves upon prior work on this topic.

- **On-the-fly informed search of non-blocking directed controllers**
  Authors: Daniel Ciolek ; Matias Duran ; Florencia Zanollo ; Nicolas Pazos ; Julián Braier ; Victor Braberman ; Nicolas D'Ippolito ; Sebastian Uchitel
  Abstract: We study directed control of discrete event system expressed as the parallel composition of interacting automata. Solutions that first compose the automata and then compute a controller may result in an exponential blow up. We present a technique that builds the composition on-the-fly guided by a novel domain-independent heuristic, which attempts to discover relevant dependencies between the intervening components. We obtain safe and non-blocking directed controllers, or directors, exploring a reduced portion of the state space. We present the first experimental results on directed control comparing on-the-fly composition with informed search against the original monolithic approach to directed control.

- **Automata-based controller synthesis for stochastic systems: A game framework via approximate probabilistic relations**
  Authors: Bingzhuo Zhong ; Abolfazl Lavaei ; Majid Zamani ; Marco Caccamo
  Abstract: In this work, we propose an abstraction and refinement methodology for the controller synthesis of discrete-time stochastic systems to enforce complex logical properties expressed by deterministic finite automata (a.k.a. DFA). Our proposed scheme is based on a notion of so-called (ϵ, δ)-approximate probabilistic relations, allowing one to quantify the similarity between stochastic systems modeled by discrete-time stochastic games and their corresponding finite abstractions. Leveraging this type of relations, the lower bound for the probability of satisfying the desired specifications can be well ensured by refining controllers synthesized over abstract systems to the original games. Moreover, we propose an algorithmic procedure to construct such a relation for a particular class of nonlinear stochastic systems with slope restrictions on the nonlinearity. The proposed methods are demonstrated on a quadrotor example, and the results indicate that the desired lower bound for the probability of satisfaction is guaranteed.

- **K-diagnosability analysis of bounded and unbounded Petri nets using linear optimization**
  Authors: Amira Chouchane ; Mohamed Ghazel ; Abderraouf Boussif
  Abstract: We propose an algebraic approach to investigate K-diagnosability of partially observed labeled Petri nets which can be either bounded or unbounded. Namely, a necessary and sufficient condition for K-diagnosability is established based on the resolution of an Integer Linear Programming (ILP) problem. When the system is K-diagnosable, our approach also yields the minimal value $K_{min} \leq K$ that ensures K_{min}-diagnosability. The value of K_{min} is calculated directly, using the same ILP formulation, i.e, without testing $1, \ldots, (K_{min} - 1)$-diagnosability. A second K-diagnosability approach, which is derived from the first one, is also developed on a compacted horizon providing a sufficient condition for K-diagnosability. This second technique allows for reducing the system dimensionality yielding a higher computational efficiency and allowing the characterization of the length of the sequences that lead to the fault occurrence, which is necessary to perform the K-diagnosability test of the first approach.

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1.3. IEEE Transactions on Control Systems Technology

Volume: 31, Issue: 1, January 2023

- **Validation of Industrial Automation Systems Using a Timed Model of System Requirements**
  Authors: Francesco Basile ; Luigi Ferrara
  Abstract: Validation of industrial automation systems is the process of checking that commissioner requirements are successfully implemented. Formal approaches are needed when the considered system is critical. The method presented in this article relies on a model-based approach that exploits the compactness and graphical representation of time-interpreted Petri nets, which adds inputoutput interpretation to transitions/places and embeds time information. These nets are here used with multiple-server semantic to allow effective modeling of typical automation system requirements. The key idea of the system validation approach is to compare the observed behavior

of the automation system with the expected behavior, as generated by updating online the model of system requirements using a state estimation algorithm. Also, an off-line procedure is provided to evaluate the evolutions admitted by the model but not observed. Both procedures yield useful data to the validation engineer, allowing to speed up the validation process. Technological issues due to the synchronous nature of controllers and the implications of their programming are considered.

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1.4. IEEE Transactions on Automation Science and Engineering

Volume: 20, Issue: 1, January 2023

- **Dynamic Hypergames for Synthesis of Deceptive Strategies With Temporal Logic Objectives**

  Authors: Lening Li ; Haoxiang Ma ; Abhishek N. Kulkarni ; Jie Fu

  Abstract: In this paper, we study the use of deception for strategic planning in adversarial environments. We model the interaction between the agent (player 1) and the adversary (player 2) as a two-player concurrent stochastic game in which the adversary has incomplete information about the agents task specification given as a temporal logic formula. During the interaction, the adversary can infer the agents intention from observations and adapt its strategy so as to prevent the agent from satisfying the objective. To plan against such an adaptive opponent, the agent must leverage its knowledge about the adversarys incomplete information to influence the behavior of the opponent, and thereby be deceptive. To synthesize a deceptive strategy, we introduce a class of hypergame models that capture the interaction between the agent and its adversary given asymmetric, incomplete information. We develop a solution concept for this class of hypergames and show that the subjectively rationalizable strategy for the agent is deceptive and maximizes the probability of satisfying the task in temporal logic. Such a deceptive strategy is obtained by modeling the opponents evolving perception of the agents objective and integrating it into planning. This allows the agent to manipulate the opponents perception so as to induce the opponent into taking actions that benefit the agent. We demonstrate the effectiveness of our deceptive planning algorithm using robot motion planning examples with temporal logic objectives and design a detection mechanism to notify the agent of potential errors in modeling the adversarys behavior.

  Note to Practitioners: Many security and defense applications employ deception mechanisms for strategic advantages. This work presents a game-theoretic framework for planning deceptive strategies in stochastic environments and shows that the opponent modeling plays a key role in the design of effective deception mechanisms. For applications to cyber-physical security, the practitioners can employ temporal logic for specifying security properties in the system and analyze defense with deception using the proposed methods.

- **Revisiting State Estimation and Weak Detectability of Discrete-Event Systems**

  Authors: Xiaoguang Han ; Jinliang Wang ; Zhiwu Li ; Xiaoyan Chen ; Zengqiang Chen

  Abstract: In this paper, we revisit state estimation and weak detectability verification for discrete event systems (DES) from a span-new perspective. Specifically, using the semi-tensor product (STP) technique, we construct two new matrix-based information structures called a current-state estimator (C-estimator) and an initial-state estimator (I-estimator) for computing three fundamental types of state estimates, namely, current-state estimate (CSE), initial-state estimate (ISE), and delayed-state estimate (DSE). The complexity of building C-estimator and I-estimator is polynomial time with respect to the size of a plant. A notion of weak delayed detectability is introduced, which captures that, after observing a k_1-length sequence/string, whether or not one can always accurately determine the state of a plant at this moment after at most k_2 steps of delays for some trajectories. Further, using the proposed C-estimator and I-estimator, we discuss the different types of detectability verification problems, including, but not restricted to, weak current-state detectability (C-detectability), weak initial-state detectability (I-detectability), and weak delayed detectability. Accordingly, several necessary and sufficient criteria are derived for verifying the aforementioned different types of detectability. Our approaches are numerically tractable and only involve some basic matrix manipulations. Finally, some examples are given to illustrate the obtained results.

  Note to Practitioners: State estimation is one of the most fundamental problems in many

practical engineering systems. For instance, one needs to infer the state of a manufacturing system before a failure occurs. For a communication system, can we guarantee that whether important information remains secret to outsiders for security requirements? Finding an alternative and efficient approach to capture the state of a plant based on imperfect observations is still crucial for engineers. To solve these problems, in this paper we develop a novel methodology to tackle simultaneously three fundamental categories of state estimation for practical engineering systems that are inherently abstracted as partially-observed discrete-event systems. Our approaches are technically quite different from the existing ones. The novel results obtained in this paper are all of matrix-based characterization, which can be implemented algorithmically by means of the user-friendly STP software package. We believe that the alternative methodology provides an innovative insight for engineers in the field of automatic control.

- **Design of Optimal Supervisors for the Enforcement of Nonlinear Constraints on Petri Nets**
  Authors: Yufeng Chen ; Lei Pan ; Zhiwu Li
  Abstract: This paper proposes an iterative approach to separate a set of admissible markings of a nonlinear constraint into a number of subsets. At each iteration, we find a maximal subset of admissible markings that are separated from inadmissible markings by linear constraints. Then, the union of all the obtained subsets constitutes the set of all admissible markings. For each subset of admissible markings, we obtain a set of conjunctive linear constraints. Accordingly, we can equivalently transform a given nonlinear constraint to be a set of disjunctive/conjunctive linear constraints, which can deal with the case that both admissible and inadmissible marking spaces of a nonlinear constraint cannot be separated by linear constraints from each other. Furthermore, we propose a method to design a Petri net supervisor for a derived set of disjunctive/conjunctive constraints. Some examples are used to demonstrate the proposed approach.
  Note to Practitioners: Linear constraints on Petri nets have been widely studied in the literature. However, not all control specifications can be represented as linear constraints. This paper proposes to enforce nonlinear constraints on Petri nets. A maximally permissive supervisor is designed to make the controlled net live with all admissible markings with respect to a given nonlinear constraint. Meanwhile, the structural complexity is also considered by compressing the number of control places in the supervisor. Experimental results show that the proposed approach can implement the control specifications represented by nonlinear constraints.

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1.5. IEEE Transactions on Systems, Man, and Cybernetics: Systems

Volume: 53, Issue: 1, January 2023

- **A Refined Siphon-Based Deadlock Prevention Policy for a Class of Petri Nets**
  Authors: ShouGuang Wang ; Xin Guo ; Oussama Karoui ; MengChu Zhou ; Dan You ; Abdullah Abusorrah
  Abstract: Resource allocation systems (RASs) exist in various fields of modern society. The deadlock control problem is a crucial issue in control theory of RAS. This work is concentrated on a special class of shared resource and process-oriented Petri nets whose initial marking can have only a token in every resource place. Using mixed-integer programming (MIP) and iterative siphon control, we present a two-stage deadlock prevention policy. In particular, a modified MIP technique is developed for the first stage to compute a specific type of emptiable siphons and a siphon control method introducing monitors with related arcs whose weights all equal to one is established in the second stage. This policy leads to a maximally permissive liveness-enforcing supervisor and such an obtained controlled net is ordinary. Moreover, it avoids the exhaustive enumeration of siphons and the reachability analysis. Examples are provided to explain the policy.

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2 Call for Participants & Registrations

2.1 Virtual Workshop on Control Software Synthesis for CPS – On Harvesting Structural and Information-Flow Properties

When: January 18th 2023 and February 15th 2023 at 1pm UTC

Registration: free but required via https://css-workshop-23.mpi-sws.org/registration-2023/

More information: More information on the scope of the workshop, the speakers and the talks can be found here: https://css-workshop-23.mpi-sws.org/. The workshop consists of two sessions.

- **Session 1: Structural Properties in Controller Synthesis**
  January 18th 2023, 1pm UTC
  - "Compositional synthesis using the least-violating control framework" by Antoine Girard
  - "Unified bisimulation for compositional verification, synthesis and time optimization" by Bengt Lennartson
  - "Compositional verification and synthesis of interconnected control systems" by Majid Zamani
- **Session 2: Information-Flow Properties in Dynamic Systems**
  February 15th, 2023, 1pm UTC
  - "Probabilistic hyperproperties of Markov decision processes: information-flow properties and beyond" by Rayna Dimitrova
  - "A unified framework for verification of observational properties for partially-observed discrete-event systems" by Xiang Yin

2.2 2023 Virtual Talk Series on Discrete Event Systems

Dear members of the TC and previous participants,

We are excited to announce the 2023 edition of the Virtual Talk Series on Discrete Event Systems for which we invite everyone to register here:
https://tc-des.mpi-sws.org/registration-2023/

As in previous years, registration is free and only required for security reasons. Please feel free to forward this announcement to any interested person! We think that this year's series compasses an exciting and diverse program again.

In January and February the VTS will feature a Virtual Workshop on Control Software Synthesis for CPS happening Wednesdays, January 18th 2023 and February 15th 2023 at 1pm UTC. From March to December the VTS will host two PhD forums and multiple 'classical' talks, happening, as usual, Thursdays 1pm UTC with confirmed speakers being:

- Laurent Hardouin, University of Angers, France
- Cristian Mahulea, University of Zaragoza, Spain
- Tomas Masopust, Faculty of Science, Palacky University in Olomouc, Czechia
- Anca Muscholl, LaBRI, Univ. of Bordeaux, France
- Sophie Pinchinat, Univ. Rennes, France

We are still in the process of finalizing the program of the VTS and will circulate the website with the final program when it is available.

One last remark: You will see that the virtual workshop mentioned above also has a separate registration site. If you register to the VTS, you do NOT need to register for the workshop separately. If you plan to ONLY attend the workshop, we kindly ask you to register on the workshop registration site.

We are looking forward to your active participation.

Kind regards,

Anne-Kathrin Schmuck on behalf of all TC co-chairs

3 Conferences

Contributed by: Xiang Yin (yinxiang@sjtu.edu.cn)

3.1 **2023 ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)**
San Antonio, USA, May 9-12, 2023
https://iccps.acm.org/2023/

3.2 **2023 IEEE International Conference on Robotics and Automation (ICRA)**
London, United Kingdom, May 29-June 02 2023, 2023
https://www.icra2023.org/

3.3 **2023 American Control Conference (ACC)**
San Diego, USA, May 31 - June 2, 2023
https://acc2023.a2c2.org/

3.4 **2023 IFAC World Congress (IFAC)**
Yokohama, Japan, July 9-14, 2023
https://www.ifac2023.org/

3.5 **2023 IEEE Conference on Control Technology and Applications (CCTA)**
Bridgetown, Barbados, August 16-18, 2023.
https://ieeeccta.org/

3.6 **2023 IEEE International Conference on Automation Science and Engineering (CASE)**
Auckland, New Zealand, August 26-29, 2023.
https://case2023.org/

3.7 **2023 IEEE International Conference on Systems, Man, and Cybernetics (SMC)**
Maui, Hawaii, October 14, 2023.
https://ieeesmc2023.org/

3.8 **2023 IEEE Conference on Decision and Control (CDC)**
Singapore, December 13-15, 2023.
https://cdc2023.ieeecss.org/

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4 Books

4.1 Analysis and Control for Resilience of Discrete Event Systems

Authors: Joao Carlos Basilio, Christoforos N. Hadjicostis and Rong Su

Description: System resilience captures the ability of the system to withstand a major disruption within acceptable performance degradation and to recover within an acceptable time frame. In this monograph we consider two possible sources of major disruptions, i.e., component faults and cyber intrusions. A component fault is an indigenous activity that renders unavailability or inaccessibility of certain functions within a component, either permanently or temporarily. It typically generates safety and performance concerns. Cyber intrusion on the other hand is an exogenous activity that tampers privacy, confidentiality, availability, or integrity of the system. These two sources are not always independent from each other. For example, a cyber intrusion may trigger a component fault, whereas a component fault may open a door for cyber intrusion, e.g., by keeping it undetected. For cyber intrusion, we will focus on opacity, which describes the systems ability to hide certain secrets from an external observer (or eavesdropper), and sensor and actuator attacks that exploit the systems existing controller to generate undesirable behaviours.

In this monograph, we provide a detailed account of most recent research outcomes on fault diagnosis, opacity analysis and enhancement, and cyber security analysis and enforcement, within suitable discrete event system modelling frameworks. In each case, we describe basic problem statements and key concepts, and then point out the key challenges in each research area. After that, we present a thorough review of state-of-the-art techniques, and discuss their advantages and disadvantages. Finally, we highlight key research directions for further exploration.

ISBN: 978-1-68083-856-5
https://www.nowpublishers.com/article/Details/SYS-024

4.2 Introduction to Discrete Event Systems (Third Edition)

Authors: Christos Cassandras and Stéphane Lafortune

Description: Christos Cassandras and Stéphane Lafortune are happy to announce the publication of the third edition of their textbook, Introduction to Discrete Event Systems, by Springer in November 2021. The first two editions of this popular textbook were published in 1999 (Kluwer Academic Publishers) and 2008 (Springer), respectively. This unique textbook comprehensively introduces 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 queueing theory, discrete-event simulation, and perturbation analysis and concurrent estimation techniques. The third edition is a superset of the second one, with new material added based on our teaching of discrete event systems courses at Boston University and at the University of Michigan, and they reflect active research trends in discrete event systems since the publication of the second edition.

Topics and features:
- detailed treatment of automata and language theory in the context of discrete event systems, including application to state estimation and diagnosis
- comprehensive coverage of centralized and decentralized supervisory control
- timed models, including timed automata and hybrid automata - stochastic models for discrete event systems and controlled Markov chains
- discrete event simulation - an introduction to stochastic hybrid systems
- sensitivity analysis and optimization of discrete event and hybrid systems
- new in the third edition: opacity properties, enhanced coverage of event diagnosis and of supervisory control under partial observation, overview of latest software tools, updated treatment of Infinitesimal Perturbation Analysis and of concurrent estimation

This proven textbook is essential to students and researchers in a variety of disciplines where the study of discrete event systems is relevant: control, communications, computer engineering, computer science, manufacturing engineering, transportation networks, operations research, and industrial engineering. This book is available through SpringerLink as an e-book (PDF and EPUB formats) or as a print-on-demand hard cover at https://link.springer.com/book/10.1007/978-3-030-72274-6 The e-book is available for free download at Springer subscribing institutions.

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4.3 Hybrid Dynamical Systems – Fundamentals and Methods

Authors: Hai Lin and Panos Antsaklis

Description: This book is based on courses on hybrid systems, cyber-physical systems, and formal methods taught by the authors in the past years. It is a graduate level textbook and provides an accessible and comprehensive introduction to the theory of hybrid systems with a balanced treatment on fundamentals and methods from both control theory and computer science. It also serves as a reference book for researchers in the fields of hybrid dynamical systems, cyber-physical systems, formal methods and robotics.

More information may be found at the books Springer webpage:

https://link.springer.com/book/10.1007/978-3-030-78731-8

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5 Software Tools

5.1 DESpot 1.10.0 Released

DESpot is a discrete-event system (DES) software, research tool. It supports both flat projects (collection of plant and supervisor DES), and Hierarchical Interface-Based Supervisory Control (HISC) projects.

DESpot 1.10.0 supports a number of new Features:

- DESpot now targets version 4.8.7 of the Qt libraries, RedHat Enterprise Linux 7.x, and MS Windows 10 with MS Visual Studios 2019.
- Support for defining template DES, and then instantiating multiple copies for flat or HISC projects.
- Now includes curved transition arrows for DES diagrams, and the ability to export DES diagrams to EPS.
- Support for verification of timed controllability, including BDD-based algorithms.
- Support for Fault-Tolerant (FT) Supervisory Control, including both timed and untimed controllability and nonblocking BDD-based algorithms, for several fault scenarios.
- Support for specifying decentralized supervisory control structure for a project, and verifying co-observability.

To find out more information and to download a copy, see: http://www.cas.mcmaster.ca/~leduc/DESpot.html

DESpot is open source software, released under the GNU General Public license (GPL), version 2.

DESpot is written in C++ and uses the QT GUI libraries. At the moment, DESpot is available as source code and as a Windows' installer. It runs under Linux, and Windows.

5.2 Eclipse ESCET™ version 0.8 release

The Eclipse Supervisory Control Engineering Toolkit (Eclipse ESCET) project provides a model-based approach and toolkit for the development of supervisory controllers. It includes the languages CIF, Chi and ToolDef. ESCET, initially developed by Eindhoven University of Technology, is since January 2020 an Eclipse Foundation open-source project. More information can be found on the toolkits website at https://www.eclipse.org/escet/.

In December 2022, ESCET version 0.8 has been released and can be downloaded from https://www.eclipse.org/escet/download.html. The main changes in this version are

- This release is based on Eclipse 2022-06, rather than Eclipse 2021-06. Eclipse 2022-06 may show for all projects in your existing workspace a warning that they dont have an explicit encoding set. The solution is described in the full release notes.
- Eclipse 2022-06 may automatically use a dark theme if your operating system is configured to use a dark theme. The Console view, Application view, and CIF simulator windows now support dark mode as well (in addition to the ones from version 0.7).
- Eclipse ESCET now bundles Java 17 rather than Java 11.
- Very long lines in the Console view and text editors now render correctly on Windows.
- CIF has improved type checking for the = and != binary expressions to support more expressions. For example, both expressions x = 1 and 1 = x are now supported, with x a real-valued variable.
- The CIF data-based synthesis tool now has a second hyper-edge creator, the linearized hyper-edge creator, which may improve performance. The legacy hyper-edge creator is still used by default.
- A new CIF example model and a new CIF benchmark model have been added. Furthermore, the CIF benchmarking models now come with scripts to easily benchmark data-based synthesis.
- he CIF to Supremica transformation, the CIF to UPPAAL transformation, and CIF PLC code precondition checks have improved output. The preconditions themselves have not changed.

The full ESCET release notes, including links to the language specific release notes and release notes from previous versions, are available from https://www.eclipse.org/escet/release-notes.html.

5.3 IDES: An Open-Source Software Tool

IDES, the discrete-event systems software tool in Karen Rudie's lab is now available as open-source software at https://github.com/krudie/IDES. More information on IDES can also be found at https://www.ece.queensu.ca/people/K-Rudie/qdes.html#fndtn-software.

5.4 MDESops

MDESops is an open-source tool written in Python for analysis and control of discrete event systems modeled as finite-state automata. It includes a growing set of operations on automata, including: (i) manipulation of models (e.g., parallel composition, observer); (ii) diagnosis and opacity verification; (iii) common supervisory control functions (e.g., computation of supremal controllable and normal sublanguages); and (iv) more advanced functions on synthesis of attackers and of resilient supervisors in the presence of sensor deception attacks. The repository is a Git server maintained by the EECS Department at the University of Michigan, USA. Download from https://gitlab.eecs.umich.edu/M-DES-tools/desops.

5.5 Supremica 2.7, New Version

The development team has just released a new version of Supremica, Waters/Supremica IDE 2.7.

Supremica is a DES and SCT drawing and calculation tool, that includes a multitude of efficient algorithms for modeling, verification, and synthesis of maximally permissive supervisors. In addition there are general algorithms for standard operations like synchronization, minimization, determinization, etc. Supremica also handles finite automata extended with bounded discrete variables. A feature-full simulation tool is also included.

New in this version:

- Conditional blocks or IF statements can now be created in the components list or on label blocks to allow conditional compilation of automata or events. They can also be used as an alternative to guard/action blocks.
- Update to Log4j 2.17.1 to avoid the Log4shell vulnerability.

Supremica is free to use for education and research; for commercial use, please contact fabian@chalmers.se. Download from www.supremica.org.

5.6 UltraDES 2.2 Release

UltraDES is an open-source library to the modeling, analysis and control of DES, written using C# in .NET Standard 2.0, which allows its use in multiple platforms, such as Windows, Linux, Mac, IOS, Android, so on. The library is under development at LACSED (Laboratory of Analysis and Control of Discrete Event Systems, at the Universidade Federal de Minas Gerais, Brazil) and has basic operations with automata as long as the monolithic, modular and local modular supervisory control (Alves et. al., 2017).

The main improvements of the UltraDES 2.2 version are:

- Supervisor Reduction Algorithm (Su and Wonham, 2004)
- Supervisor Localization (Cai and Wonham, 2010)
- Basic Petri Nets Functions (incidence matrix, coverability/reachability graph, Petri Net marking simulation, etc.)

Knowing that many researchers/students are not familiar with the C# language, we created an experimental python wrapper, that is less object oriented and easier to use.

Another initiative to improve the usability of UltraDES was the creation of a Web Application, developed using Blazor/WebAssembly, that allows the use of UltraDES online. This version is more limited in processing power and memory but it is useful for small examples and teaching.

We invite the community to download and contribute. Algorithms implemented may be integrated to the main distribution. Just let us know. Contact Lucas Alves lucasvra@ufmg.br or Patricia Pena ppena@ufmg.br for more information. Bugs should be informed using the UltraDES GitHub page.
Link: `https://github.com/lacsed/UltraDES`.

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