IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter **May 2025**

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Welcome to the 2025 May issue of the newsletter, also available online at
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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. Discrete Event Dynamic Systems Theory and Applications

Volume: 35, Issue: 1, March 2025

- **Disordered discrete-time quantum walk over max-plus algebra**
  Authors: Mohamad Ilham Dwi Firmansyah ; Muhammad Syifa'ul Mufid ; Subiono ; Bijan Davvaz
  Abstract: This work is intended as an attempt to motivate a novel model of disordering discrete-time quantum walk in a one-dimensional lattice of integers. We construct such a model over max-plus algebra and give the notion of coin operator of the disordered discrete-time quantum walk in a one-dimensional lattice $\mathbb{Z}$ to derive a very complicated decision matrix. Furthermore, we investigate the properties of the decision matrix for each state and prove some results for the disordered quantum walk over max-plus algebra that are similar to the conserved quantity of the conventional disordered quantum walk.
- **Structural analysis and sequential resolution for estimation of guaranteed horizons in partially observable Petri nets**
  Authors: Philippe Declerck
  Abstract: In Partially Observable Petri Nets, a necessary parameter is the guaranteed horizon, which allows the modelling of the estimation problem with the counter form and can be exploited in estimation for any linear criterion: a problem is the on-line estimation of the guaranteed horizon, which is a maximum sequence length relevant to a sliding horizon or a receding horizon starting from the initial marking. Considering large scale Petri nets, the objective of this paper is to facilitate the resolution by the construction of a triangular form guiding a sequential resolution of the problem based on substructures. This study shows that the classical Dulmage-Mendelsohn decomposition can be applied to a class of Petri nets where the unobservable induced Petri Net is mainly Forward Conflict Free. An extension of this result to any Petri net based on the building of an associated Petri net is made.
- **Hierarchical supervisory control of discrete event systems based on reliable events**
  Authors: Rafael Garlet de Oliveira ; Max Hering de Queiroz ; José Eduardo Ribeiro Cury
  Abstract: In hierarchical supervisory control of discrete event systems, the observer property of the reporter map ensures that the high-level supervisor can rely on the occurrence of any event that is eligible in the high-level plant to implement a nonblocking closed-loop system. When combined with strict output control consistency and marking consistency, the observer property is a sufficient but not necessary condition for strong hierarchical consistency, which guarantees that the high-level model maintains the necessary information to achieve optimal nonblocking supervisory control for any high-level specification. Aiming to weaken the observer condition, this paper introduces the definitions of prefix-closing alphabet and of reliable events. The first main result demonstrates that it is sufficient to verify if the subset of reliable events is prefix-closing for the high-level controllable specification. A second result proves that nonblocking hierarchical supervision is ensured for any high-level specification if the set of uncontrollable high-level events is reliable and prefix-closing for the high-level plant. The application to the hierarchical structure of a valve circuit in process control where the reporter map is not an observer demonstrates that the novel conditions can be useful in practice.

Back to the contents

1.2. IEEE Transactions on Automatic Control

Volume: 70, Issue: 4, May 2025

- **Supervisory Control Theory With Event Forcing**
  Authors: Michel Reniers ; Kai Cai
  Abstract: In the Ramadge–Wonham supervisory control theory, the only interaction mechanism between supervisor and plant is that the supervisor may enable/disable events from the plant and the plant makes a final decision about which of the enabled events is actually taking place. In

this article, the interaction between supervisor and plant is enriched by allowing the supervisor to force specific events (called forcible events) that are allowed to preempt uncontrollable events. A notion of forcible controllability is defined that captures the interplay between controllability of a supervisor w.r.t. the uncontrollable events provided by a plant in the setting with event forcing. The existence of a maximally permissive, forcibly controllable, nonblocking supervisor is shown, and an efficient algorithm is provided that computes such a supervisor.

- **On the Effect of Dynamic Event Observations in Distributed Fault Prognosis of Discrete-Event Systems**
  Authors: Bowen Li ; Jianquan Lu ; Jie Zhong ; Yaqi Wang
  Abstract: In the conventional framework for distributed fault prognosis of discrete-event systems (DESs), it is assumed that observable events are always observed [such case is called static event observations (SEOs)]. However, the assumption may not hold in many DESs such as sensor networks. This article introduces the concept of distributed fault prognosis with dynamic event observations (DEOs), in which observable events are not always observed. Communication models and extended models are constructed, based on which, for each local prognoser, an extended dynamic observation mask with two forms is constructed to capture its aggregate information. In order to verify prognosability subject to DEOs, one algorithm whose complexity is polynomial in the number of states but exponential in the number of local prognosers is presented. Furthermore, one significant condition for prognosability subject to DEOs is derived. Finally, the obtained results are applied to an Alipay online trading system and an Industry 4.0 manufacturing system.

- **A Semialgebraic Framework for Verification and Synthesis of Control Barrier Functions**
  Authors: Andrew Clark
  Abstract: Safety is a critical property for control systems in medicine, transportation, manufacturing, and other applications, and can be defined as ensuring positive invariance of a predefined safe set. This article investigates the problems of verifying positive invariance of a semialgebraic set as well as synthesizing sets that can be made positive invariant through control barrier function (CBF)-based control. The key to our approach consists of mapping conditions for positive invariance to sum-of-squares constraints via the Positivstellensatz from real algebraic geometry. Based on these conditions, we propose a framework for verifying safety of CBF-based control including single CBFs, high-order CBFs, multi-CBFs, and systems with trigonometric dynamics and actuation constraints. In the area of synthesis, we propose algorithms for constructing CBFs, namely, an alternating-descent approach and a local CBF approach. We evaluate our approach through case studies on quadrotor UAV and power converter test systems.

- **Sample-Efficient Reinforcement Learning With Temporal Logic Objectives: Leveraging the Task Specification to Guide Exploration**
  Authors: Yiannis Kantaros ; Jun Wang
  Abstract: In this article, we address the problem of learning optimal control policies for systems with uncertain dynamics and high-level control objectives specified as linear temporal logic (LTL) formulas. Uncertainty is considered in the workspace structure and the outcomes of control decisions giving rise to an unknown Markov decision process (MDP). Existing reinforcement learning (RL) algorithms for LTL tasks typically rely on exploring a product MDP state-space uniformly (using e.g., an ϵ-greedy policy) compromising sample-efficiency. This issue becomes more pronounced as the rewards get sparser and the MDP size or the task complexity increase. In this article, we propose an accelerated RL algorithm that can learn control policies significantly faster than competitive approaches. Its sample-efficiency relies on a novel task-driven exploration strategy that biases exploration toward directions that may contribute to task satisfaction. We provide theoretical analysis and extensive comparative experiments demonstrating the sample-efficiency of the proposed method. The benefit of our method becomes more evident as the task complexity or the MDP size increases.

- **Aggregated Bisimulation and Identification of Finite-Valued Networks**
  Authors: Zhengping Ji ; Xiao Zhang ; Daizhan Cheng
  Abstract: We propose a method that combines aggregation and bisimulation to approximate large finite-valued networks by smaller models. With the algebraic state-space representation of

a quotient system under observational equivalence, the aggregated bisimulation is performed by partitioning a network into blocks and replacing the dynamics of each block by that of its quotient system. If the aggregation is not a bisimulation, these quotient systems can be further replaced by probabilistic networks based on the relative frequency of transitions, which contain full information about the input–output dynamics. As an inverse problem of aggregation, simulated identification of finite-valued networks is studied. We give an upper bound on the minimal number of nodes required to identify a system, and design an online algorithm to reproduce the internal state dynamics from given input–output sequences. The results are illustrated with numerical examples.

- **Reduction for Structured Aggregated Markov Models Based on Reachable Space**
  Authors: Man Zheng ; Yoshito Ohta
  Abstract: The order of an aggregated Markov model (AMM) is an index of complexity and is closely related to the reachable subspace of a model. The AMM is called reachable-space reducible when the reachable subspace is not the whole space. Previous results demonstrate that there exists a reduced-order quasi-realization, which may not satisfy the nonnegative constraints, equivalent to a given reachable-space reducible AMM. This article focuses on the structured AMM where the transition and observation matrices have certain structured patterns. Sufficient conditions are derived for a structured AMM to be reachable-space reducible. Moreover, in this case, we show that a real reduced-order realization, instead of a quasi-realization, is obtained by choosing suitable bases for supersets of the reachable space. Finally, examples are given to support our results.

Back to the contents

1.3. Automatica

Volume: 175, May 2025

- **On the detection of Markov decision processes**
  Authors: Xiaoming Duan ; Yagiz Savas ; Rui Yan ; Zhe Xu ; Ufuk Topcu
  Abstract: We study the detection problem for a finite set of Markov decision processes (MDPs) where the MDPs have the same state and action spaces but possibly different probabilistic transition functions. Any one of these MDPs could be the model for some underlying controlled stochastic process, but it is unknown a priori which MDP is the ground truth. We investigate whether it is possible to asymptotically detect the ground truth MDP model perfectly based on a single observed history (state–action sequence). Since the generation of histories depends on the policy adopted to control the MDPs, we discuss the existence and synthesis of policies that allow for perfect detection. We start with the case of two MDPs and establish a necessary and sufficient condition for the existence of policies that lead to perfect detection. Based on this condition, we then develop an algorithm that efficiently (in time polynomial in the size of the MDPs) determines the existence of policies and synthesizes one when they exist. We further extend the results to the more general case where there are more than two MDPs in the candidate set, and we develop a policy synthesis algorithm based on the breadth-first search and recursion. We demonstrate the effectiveness of our algorithms through numerical examples.
- **Projection-free computation of robust controllable sets with constrained zonotopes**
  Authors: Abraham P. Vinod ; Avishai Weiss ; Stefano Di Cairano
  Abstract: We study the problem of computing robust controllable sets for discrete-time linear systems with additive uncertainty. We propose a tractable and scalable approach to inner- and outer-approximate robust controllable sets using constrained zonotopes, when the additive uncertainty set is a symmetric, convex, and compact set. Our least-squares-based approach uses novel closed-form approximations of the Pontryagin difference between a constrained zonotopic minuend and a symmetric, convex, and compact subtrahend. We obtain these approximations using two novel canonical representations for full-dimensional constrained zonotopes. Unlike existing approaches, our approach does not rely on convex optimization solvers, and is projection-free for ellipsoidal and zonotopic uncertainty sets. We also propose a least-squares-based approach to compute a convex, polyhedral outer-approximation to constrained zonotopes, and characterize sufficient conditions under which all these approximations are exact. We demonstrate the computational efficiency and scalability of our approach in several case studies, including the design of abort-safe rendezvous

trajectories for a spacecraft in near-rectilinear halo orbit under uncertainty. Our approach can inner-approximate a 20-step robust controllable set for a 100-dimensional linear system in under 15 s on a standard computer.

- **Maxentropic continuous-time homogeneous Markov chains**
  Authors: Paolo Bolzern ; Patrizio Colaneri ; Giuseppe De Nicolao
  Abstract: In this paper, we investigate the notion of entropy rate and its maximization for continuous-time time-homogeneous irreducible finite-state Markov chains. The definitions available in continuous-time suffer from an apparent paradox, as they do not properly account for the role of the average commutation frequency. In fact, we show that the entropy rate is the sum of a finite and an infinite component, the latter depending on the average commutation frequency. Thus, entropy maximization is meaningful only between chains that share the same average frequency. After settling this issue, we address entropy rate maximization under different constraints on the stationary probability: unconstrained, completely fixed, partially fixed. Closed-form solutions and provably convergent iterative algorithms are provided. The results are illustrated through several examples, including chains with string and lattice graph topology. Interesting connections with quantum mechanics topics (particle-in-a-box model, Born rule, and Anderson localization property) are highlighted.

Back to the contents

1.4. IEEE Transactions on Automation Science and Engineering

Volume: 22, Issue: 4, April 2025

- **Generalized Critical Observability of Labeled Petri Nets Under Nondeterministic Observations**
  Authors: Yuling Zhang ; Christoforos N. Hadjicostis ; Zhiwu Li
  Abstract: This paper addresses the property of critical observability in labeled Petri nets. A system is deemed critically observable if its state estimate (formed by observing the system output) can be determined to belong to a set of either critical markings or non-critical markings. More generally, for a critically observable system, there may be multiple types of critical markings and the operator may desire to know the type to which the current state estimate belongs. We propose a generalized version of critical observability, namely generalized critical observability, and provide two necessary and sufficient conditions to check it based on basis markings and integer linear programs, effectively circumventing the need for an exhaustive enumeration of all reachable markings of the net. In addition, we investigate (generalized) critical observability of Petri nets under nondeterministic observations, which may arise due to the loss of transmission signals or due to interference with sensor measurement outputs. To handle this, an augmented system is constructed from the original Petri net by adding new transitions that capture the effect of transitions associated with nondeterministic labels. Thus, we transform the verification of (generalized) critical observability of a Petri net under nondeterministic observations to that of the augmented model. Two real-world examples illustrate the applicability of the presented notion and methodology.
  Note to Practitioners: In most real safety-critical applications, such as train control systems, air traffic management systems, and electric power networks, it is crucial to determine whether the system state estimate falls within a set of dangerous or faulty states (or, more broadly, states of interest). Critical observability guarantees that the current state estimate, i.e., the set of states consistent with observations, is either a subset of critical states or a subset of non-critical states. In practical scenarios, there may be multiple types of faulty states, and operators need to accurately identify the fault type when a system operates abnormally, i.e., they need to determine the type to which the current state estimate belongs, in order to make correct decisions. Therefore, a generalized version of critical observability (namely, generalized critical observability) is proposed, which allows for the determination of the specific type of critical states. Furthermore, to handle unreliable sensor readings (e.g., due to influences from external factors, such as extreme environments), we investigate (generalized) critical observability for labeled Petri nets (LPN) under nondeterministic observations. The two proposed basis reachability graph-based approaches are provably computationally efficient when verifying generalized critical observability of LPNs, which facilitates engineers

to apply the methods developed in this research to real-world systems. Two examples, one involving a manufacturing system and the other involving an airport system, demonstrate the proposed approach.

- **Task Allocation of Heterogeneous Robots Under Temporal Logic Specifications With Inter-Task Constraints and Variable Capabilities**
  Authors: Lin Li ; Ziyang Chen ; Hao Wang ; Zhen Kan
  Abstract: Multi-Robot task allocation (MRTA) exploits different capabilities of heterogeneous robots to facilitate collaborative tasks. However, existing works are mainly built on a key assumption that the robot capabilities are invariant and few consider variable capabilities (e.g., task-dependent or time-dependent capabilities). Besides, there may also exist a variety of inter-task constraints (e.g., unrelated tasks, compatible tasks, and exclusive tasks). Motivated by this practical need, we develop a novel task allocation framework for heterogeneous multi-robot systems with variable capabilities subject to inter-task constraints and temporal logic task specifications. Specifically, we extend conventional linear temporal logic (LTL) to capability LTL, namely $CaLTL^T$, to describe heterogeneous multi-robots systems with variable capabilities and inter-task constraints. The Task Batch Planning Decision Tree Plus ($TB - PDT^+$) is then developed, which encodes the states of Büchi automaton, the system states, and the task process into a tree structure to represent the exploration progress. Based on the $TB - PDT^+$, the Variable Capability and Inter-task Constraints Search (Var-CICS) is developed to find feasible task allocations and plans. Rigorous analysis shows that Var-CICS is valid (i.e., the generated task allocation is guaranteed to satisfy the task requirements) and complete (i.e., if a feasible task allocation exists, it is ensured to be found by Var-CICS). The complexity analysis also shows that the computation time of finding a satisfactory task allocation scales only quadratically with the number of automaton states, versus the exponential growth due to the product automaton in standard model checking methods. Numerical simulations and experiments demonstrate the effectiveness of Var-CICS.
  Note to Practitioners: Real-world applications often require a heterogeneous multi-robot system working collaboratively on a variety of tasks. Within such applications, robots can have diverse capabilities which may vary depending on the task at hand or over time, and are subject to inter-task constraints. Thus, in this work, we propose a new temporal logic to enrich the expressiveness in describing heterogeneous multi-robots systems with variable capabilities and inter-task constraints. We then develop the task batch planning decision tree plus and the variable capability and inter-task constraints search (Var-CICS) for the task allocation of heterogeneous multi-robot system. In contrast to automata-based methods, our method does not require sophisticated product automaton, which enables efficient and effective search of feasible task allocations. Furthermore, theoretical analyses show that Var-CICS is both complete and valid, while experimental results demonstrate its validity, efficiency and scalability.

Back to the contents

1.5. Nonlinear Analysis: Hybrid Systems

Volume: 56, May 2025

- **STL and wSTL control synthesis: A disjunction-centric mixed-integer linear programming approach**
  Authors: Gustavo A. Cardona ; Disha Kamale ; Cristian-Ioan Vasile
  Abstract: This paper introduces an efficient optimization-based control synthesis methodology tailored for Signal Temporal Logic (STL) and its extension, weighted Signal Temporal Logic (wSTL). While STL captures Boolean and temporal operators, wSTL further allows users to express preferences and priorities over concurrent and sequential tasks denoted by weights over logical and temporal operators along with satisfaction times. The proposed approach utilizes Mixed Integer Linear Programming (MILP) for synthesis with both STL and wSTL formulae. We introduce efficient disjunction-centric encodings for STL and wSTL that capture both qualitative and quantitative semantics. This encoding minimizes the number of variables and constraints necessary to represent STL and wSTL formulae by efficiently handling conjunction operations (e.g., conjunction, always operators) and only introducing variables when disjunction operations are used (e.g., disjunction,

eventually). Multiple case studies are conducted to demonstrate the proposed methodology's operation and computational efficiency for the control synthesis with STL and wSTL specifications. While non-linear dynamics and predicates can be considered using piecewise linear functions, this work focuses on linear predicates and dynamics. We show how cost functions involving potentially conflicting objectives expressed in terms of states, controls, and satisfaction robustness impact the solutions to the control synthesis problem for STL and wSTL. We conduct a sensitivity analysis of weights used in wSTL formulae, offering detailed insights into how these weights modulate solutions for given formulae. Finally, the time performance of the disjunction-centric encodings for both STL and wSTL is compared against state-of-the-art frameworks, comprehensively evaluating their efficiency and practical applicability.

- **Reachability analysis for linear systems with uncertain parameters using polynomial zonotopes**
  Authors: Yushen Huang ; Ertai Luo ; Stanley Bak ; Yifan Sun
  Abstract: In real world applications, uncertain parameters are the rule rather than the exception. We present a reachability algorithm for linear systems with uncertain parameters and inputs using set propagation of polynomial zonotopes. In contrast to previous methods, our approach is able to tightly capture the non-convexity of the reachable set. Building up on our main result, we show how our reachability algorithm can be extended to handle linear time-varying systems as well as linear systems with time-varying parameters. Moreover, our approach opens up new possibilities for reachability analysis of linear time-invariant systems, nonlinear systems, and hybrid systems. We compare our approach to other state of the art methods, with superior tightness on two benchmarks including a 9-dimensional vehicle platooning system. Moreover, as part of the journal extension, we investigate through a polynomial zonotope with special structure named multi-affine zonotopes and its optimization problem. We provide the corresponding optimization algorithm and experiment over the examples obtained from two benchmark systems, showing the efficiency and scalability comparing to the state of the art method for handling such type of set representation.

- **Recurrent output tracking of Boolean networks**
  Authors: Chunfeng Jiang ; Shihua Fu ; Carmen Del Vecchio ; Biao Wang ; Jianjun Wang ; Jianli Zhao
  Abstract: This paper addresses the recurrent output tracking problem (ROTP) in Boolean networks (BNs), that is the property of systems output to intermittently and infinitely track a desired reference signal over long-term operation. Leveraging the semi-tensor product of matrices as the primary analytical tool, the study proposes solvability criteria for ROTP in both BNs and Boolean control networks (BCNs), and proposes algorithms to identify all states that enable recurrent tracking of the reference signal in these systems. Additionally, a truth matrix-based method is used to design state feedback controllers, ensuring ROTP solvability for BCNs initiating from such states. The study also explores the periodicity of the recurrent output tracking in B(C)Ns, demonstrating that the output tracking problem is a specific instance of the ROTP. The effectiveness of the proposed methods and results is validated through illustrative examples.

- **Disturbance decoupling controller design of switched Boolean control networks in recursion**
  Authors: Xiangshan Kong ; Haitao Li
  Abstract: This paper studies the disturbance decoupling problem (DDP) of switched Boolean control networks (SBCNs) by the methodology of recursion. All the state nodes of the original SBCNs are split into two parts based on whether or not the state node influences the outputs. By driving the part of state nodes which influence the outputs to the largest control invariant set, the concept of DDP in recursion is proposed. Using the algebraic state space representation (ASSR) method, both mode-independent and mode-dependent state feedback controllers are constructed to solve the DDP in recursion of SBCNs. Furthermore, based on the obtained mode-independent state feedback DDP controllers, the mode-independent output feedback controllers are designed for the DDP in recursion of SBCNs.

Back to the contents

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

Volume: 55, Issue: 5, May 2025

- **Diagnosability Verification and Enforcement in Labeled Petri Nets Under Sensor Attacks**

  Authors: Shaopeng Hu ; Zhiwu Li ; Ding Liu

  Abstract: This article formalizes and solves the problems of diagnosability verification and enforcement in discrete event systems modeled with labeled Petri nets (LPNs) under sensor attacks. Given a plant, attackers work as a group in the framework of a coordinated distributed architecture and have the ability to edit some sensor readings to conceal the faults to confuse the operator. Furthermore, attackers necessarily remain furtive, i.e., their presence should not be discovered by the operator. In order to describe the set of all possible furtive attacks, a joint furtive diagnoser is established. We prove that an LPN under the above attacks is diagnosable if and only if its joint furtive diagnoser does not have the cycles composed of pairs of either faulty states and normal states, or faulty states and uncertain states. A new labeling function is proposed to enforce a plant to be diagnosable against as many attacks as possible. Examples are provided to illustrate the proposed method.

Back to the contents

2 Conferences

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

2.1 **2025 Annual Learning for Dynamics & Control Conference (L4DC)**
Ann Arbor, Michigan, USA, June 4-6, 2025.
https://sites.google.com/umich.edu/l4dc2025/

2.2 **2025 IFAC Workshop on Smart Energy Systems for Efficient and Sustainable Smart Grids and Smart Cities (SENSYS 2025)**
Bari, Italy, June 18-20, 2025.
https://conferences.ifac-control.org/sensys2025/

2.3 **2025 European Control Conference (ECC)**
Thessaloniki, Greece, June 24-27, 2025.
https://ecc25.euca-ecc.org/

2.4 **2025 American Control Conference (ACC)**
Denver, Colorado, USA, July 8-10, 2025.
https://acc2025.a2c2.org/

2.5 **2025 International Conference on Automation Science and Engineering (CASE)**
Los Angeles, California, USA, August 17-21, 2025.
https://2025.ieeecase.org/

2.6 **2025 IEEE Conference on Control Technology and Applications (CCTA)**
San Diego, California, USA, August 25-27, 2025.
https://ccta2025.ieeecss.org/

2.7 **2025 IEEE International Conference on Emerging Technologies and Factory Automation (ETFA)**
Porto, Portugal, September 9-12, 2025.
https://etfa2025.ieee-ies.org/

2.8 **2025 International Conference on Systems, Man, and Cybernetics (SMC)**
Vienna, Austria, October 5-8, 2025.
https://www.ieeesmc2025.org/

2.9 **2025 IEEE Conference on Decision and Control (CDC)**
Rio de Janeiro, Brazil December 9-12, 2025.
https://cdc2025.ieeecss.org/

Back to the contents

3 Books

3.1 Invitation to Supervisory Control of Discrete-Event Systems with Hands-On Python Software Tool

Author: Kai Cai, Osaka Metropolitan University.

Publish Information: Kindle Direct Publishing, 2024, ISBN: 9798373331449

Book website:
https://www.caikai.org/invitation-scdes

About the book:
This book is for anyone who is interested in getting a quick start with the supervisory control theory of discrete-event systems. A companion software package PyTCT (python-based TCT) is available for the reader to get hands-on experience with the theory.
Your feedback comments on how the book materials may be improved are highly appreciated and please send them to: cai@omu.ac.jp

3.2 Cybersecurity of Discrete Event Systems—From Smart Attacks to Resilient Defence

Author: Rong Su, Nanyang Technological University.

Description: This book describes analysis and control against smart cyberattacks in discrete event systems (DES), modelled by regular languages or finite-state automata. "Smart attacks" cannot be detected by the supervisor until an irreversible process towards ensured damage occurs. An attack may be conducted either in the observation channel (i.e., the input of the supervisor) or in the command channel (i.e., the output of the supervisor), or both simultaneously. Therefore, defense strategies against these attacks are urgently needed. This book provides an overview of the latest theories and includes empirical examples to illustrate concepts and methods. By centering on what information is available and how such information is used, the readers are provided with methods to evaluate the cyber vulnerability of a given system and to design a resilient supervisor against relevant smart attacks. By focusing on a conceptual introduction and systematic analysis, this book provides a solid theoretical foundation for future exploration by researchers and graduate students who are interested in cybersecurity research, not necessarily limited to those in the DES community. Readers are recommended to have a background in formal language theory.

Additional information on the book can be found at
https://www.routledge.com/Cybersecurity-of-Discrete-Event-Systems-From-Smart-Attacks-to-Resilient
Su/p/book/9781032368108?srsltid=AfmBOor9fqjhOR7YfMgGE8coz0rHXF6YyKhoucc7UzqYlY9GhcWpQBg3,
where an inspection copy is possible for educational institutions.

3.3 Graph-Theoretical Methods in Systems Theory and Control

Author: Jan Lunze, Ruhr-University, Germany

Description: The book describes for numerous scenarios how to use the structural properties of a system represented by a graph to simplify modelling, analysis, and design tasks. For example, block diagrams and coupling graphs can be used to decompose systems, automata graphs to analyse discrete-event systems and Markov chains, structure graphs to find generic properties of linear systems or communication graphs to design networked control systems. The book includes many examples derived from diverse fields of application, exercises with solutions and MATLAB scripts to implement graph-theoretical methods for systems analysis.

Additional information on the book can be found at
www.editionmora.de/gmsc

The book is produced as "print-on-demand" and can be ordered directly at the printer:
https://publish.bookmundo.de/books/349971

3.4 Safe Autonomy with Control Barrier Functions: Theory and Applications

Authors: Wei Xiao, Christos G. Cassandras, and Calin Belta

Description: The book presents the concept of Control Barrier Function (CBF), which captures the evolution of safety requirements during the execution of a system and can be used to enforce safety. Safety is central to autonomous systems since they are intended to operate with minimal or no human supervision. The book includes both theoretical and application perspectives on how safety can be guaranteed. It explains how the CBF approach is computationally efficient and can easily deal with nonlinear models and complex constraints used in a wide spectrum of applications, including autonomous driving, robotics, and traffic control. Safety guarantees can be integrated into the operation of such autonomous systems, including typical safety requirements that involve collision avoidance, technological system limitations, and bounds on real-time executions. Adaptive and event-driven approaches for safety are also discussed for time-varying execution bounds and noisy dynamics, as well as for systems with unknown dynamics.

Additional information on the book can be found at
https://link.springer.com/book/10.1007/978-3-031-27576-0
where an eBook version can also be downloaded (free for some educational institutions).

Back to the contents

4 Software Tools

4.1 Eclipse ESCET™ version 7.0 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 toolkit's website at https://www.eclipse.dev/escet/.

In March 2025, ESCET version 7.0 has been released and can be downloaded from https://www.eclipse.dev/escet/download.html. The main changes in this version are

- The data-based synthesis tool may internally produce simpler predicates, such as 'true or X' now becoming 'true', in the conversion of the specification to BDDs. This may lead to differences in conversion performance, variable ordering, and debug output. The benchmarks shown only minimal changes (less than 0.1% change in memory/time). However, for the wafer_scanner_n1 benchmark, synthesis requires about 12% less BDD operations.
- The CIF language now features input parameters, a new kind of parameters for component definitions (automaton and group definitions). For such parameters, only input variables and input parameters can be used as arguments in component instantiations. A primary use case for using input parameters instead of algebraic parameters, is that input parameters can be assigned by SVG input mappings within component definitions.
- A new Eliminate state invariants CIF to CIF transformation has been added. It comes in three variants: one that eliminates all state invariants, one that only eliminates plant state invariants, and one that only eliminates supervisor state invariants.
- Several improvements to the HTML code generator, including a new HTML frequencies.
- The Developers section of the documentation now contains a page about how to reliably extract information from a CIF specification, by converting the CIF specification to XML and using XML queries.

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.dev/escet/release-notes.html.

Back to the contents