IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter **February 2025**

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Welcome to the 2025 February issue of the newsletter, also available online at
https://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: 70, Issue: 2, February 2025

- **Consensus Protocols in Networks With 1-to-n Joint-Agent Interactions**
  Authors: David Angeli ; Sabato Manfredi
  Abstract: In the scientific literature of the past two decades many conditions to assess consensus-ability in multiagent networks with 1-to-1 interactions have been proposed. More recently the framework has been extended to include the m-to-1 type-interactions, referred as joint-agent interactions. In this article, we consider a novel framework of networks with 1-to-n interactions, potentially extendable to m-to-n ones, and formulate sufficient and necessary analytical conditions for consensus-ability. The considered interactions may also well represent the heterophilous dynamics in opinion and social systems. Finally, shedding light on the scenario of 1-to-n interactions could inspire the formulation of new distributed algorithms to be exploited in engineering applications.
- **Approximate Dynamic Programming for Trajectory Tracking of Switched Systems**
  Authors: Max L. Greene; Masoud S. Sakha; Rushikesh Kamalapurkar; Warren E. Dixon
  Abstract: This article develops a technique for online approximate optimization of tracking control policies for a family of switched nonlinear dynamical systems. Optimization is realized via approximate dynamic programming, and integral concurrent learning is used for robustness to parametric uncertainties. The family of switched systems is composed of finitely many subsystems, which may have differing characteristics, such as dynamics and cost functions. This article develops a new result on the analysis of switched systems comprised of locally practically stable subsystems using multiple Lyapunov-like functions. Local practical stability of the overall switched system and convergence of the applied tracking control policies to a neighborhood of the optimal tracking control policies is then proven for an arbitrary switching sequence provided that a set of sufficient gain conditions and a minimum dwell-time condition are satisfied. Simulation results are presented for the optimal control of an autonomous underwater vehicle in the presence of a set of discretely varying irrotational currents to show the efficacy of the developed technique.

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1.2. Automatica

Volume: 172, February 2025

- **A joint diagnoser approach for diagnosability of discrete event systems under attack**
  Authors: Tenglong Kang ; Carla Seatzu ; Zhiwu Li ; Alessandro Giua
  Abstract: This paper investigates the problem of diagnosing the occurrence of a fault event in a discrete event system (DES) subject to malicious attacks. We consider a DES monitored by an operator through the perceived sensor observations. It is assumed that an attacker can tamper with the sensor observations, and the system operator is not aware of the attacker's presence at the beginning. We propose a stealthy joint diagnoser (SJD) that (i) describes all possible stealthy attacks (i.e., undiscovered by the operator) in a given attack scenario; (ii) records the joint diagnosis state, i.e., the diagnosis state of the attacker consistent with the original observation and the diagnosis state of the operator consistent with the corrupted observation. The SJD is used for diagnosability verification under attack. From the attacker's point of view, we present two levels of stealthy attackers: one only temporarily degrades the diagnosis state of the operator, and the other permanently causes damage to the diagnosis state of the operator, thereby resulting in a violation of diagnosability. Finally, necessary and sufficient conditions for the existence of the two levels of attackers are presented.

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1.3. International Journal of Control

Volume: 95, Issue: 2, February 2022

- **A new algorithm for supervisor reduction/localisation of discrete-event systems**

Authors: Yingying Liu ; Lihua Wu ; Renyuan Zhang ; Zhaojian Cai ; Kai Cai
Abstract: In this article, we propose a new algorithm for supervisor reduction/localisation of discrete-event systems (DES). Supervisor reduction/localisation is based on merging pairs of states of the supervisor that are control consistent. Our proposed algorithm employs two new lists – a mergeable list and a non-mergeable list – which store state pairs that have been confirmed to be control consistent or inconsistent, respectively. With these two lists, our algorithm eliminates any repeated control consistency checks, and guarantees that every state pair will be checked exactly once. We prove that the time complexity of our new algorithm is $O(n^2)$, where n is the state number of the supervisor; this improves all previously known results on supervisor reduction/localisation algorithms. We employ numerical examples to empirically compare the computation time and local controller's state number obtained by our proposed algorithm and the original supervisor reduction/localisation algorithms.

- **Viscosity solutions approach to finite-horizon continuous-time Markov decision process**
Authors: Zhong-Wei Liao ; Jinghai Shao
Abstract: This paper investigates the optimal control problems for the finite-horizon continuous-time Markov decision processes with delay-dependent control policies. We develop compactification methods in decision processes and show that the existence of optimal policies. Subsequently, through the dynamic programming principle of the delay-dependent control policies, the differential-difference Hamilton-Jacobi-Bellman (HJB) equation in the setting of discrete space is established. Under certain conditions, we give the comparison principle and further prove that the value function is the unique viscosity solution to this HJB equation. Based on this, we show that among the class of delay-dependent control policies, there is an optimal one which is Markovian.

- **Robust set stability of large-scale Boolean networks with disturbance via network aggregation**
Authors: Weiyu Li
Abstract: This paper explores the robust set stability problem of large-scale Boolean networks (BNs) with disturbances by resorting to the network aggregation method. Firstly, the network graph of large-scale BNs is partitioned into several small subnetworks, which converts the robust set stability of large-scale BNs into the (robust) set stability of subnetworks under arbitrary switching signal. Secondly, by perceiving the input nodes from other subnetworks as a switching signal, several new criteria are proposed for the robust set stability of each subnetwork with disturbance inputs under arbitrary switching signal. Finally, by combining the (robust) set stability of all subnetworks, the robust set stability of large-scale BNs with disturbance inputs is discussed. Moreover, as an application, the robust partial stability of large-scale BNs is considered.

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1.4. Systems & Control Letters

Volume: 196, February 2025

- **Formal safety verification of non-deterministic systems based on probabilistic reachability computation**
Authors: Yuminghao Xiao ; Tianbing Xia ; Hongdong Wang
Abstract: In this paper, we develop a formal safety verification method based on analytic probabilistic reachability computation, which can estimate the probability of controlled non-deterministic systems entering unsafe states subject to disturbances. Specifically, we employ stochastic differential equations (SDEs) to describe the dynamics of the system and resort to a regularized indicator function to express the collision probability between the state trajectory of the system and unsafe states. We proceed to formulate this collision probability as the viscosity solution to a second-order variational-inequality and provide a rigorous proof for such a novel interpretation. Moreover, we discuss the ENO-Godunov scheme for solving the deduced variational-inequality, which obviates the need for Monte-Carlo simulations and the optimality condition along a complex boundary. The developed framework offers a structured approach to identify potential risks in safety critical systems and maintains a user-friendly implementation. Lastly, we demonstrate the above application in a safety verification problem related to maritime navigation.

- **Dynamic programming principle for stochastic optimal control problem under degenerate G-expectation**
  Authors: Xiaojuan Li
  Abstract: In this paper, we study a stochastic optimal control problem under degenerate G-expectation. By using implied partition method, we show that the approximation result for admissible controls still hold. Based on this result, we obtain the dynamic programming principle, and prove that the value function is the unique viscosity solution to the related HJB equation under degenerate case.
- **Some big issues with small noise limits in Markov decision processes**
  Authors: Vivek S. Borkar
  Abstract: Using the framework of Markov decision processes (equivalently, controlled Markov chains) as a test case, we point out some non-robustness issues that arise in small noise limits in stochastic control. This is used to motivate a novel formulation of multi-chain Markov decision processes.
- **Dynamic event-triggered predictive control strategy for networked semi-Markov jump systems**
  Authors: Li Qiu ; Lingtao Dong ; Zhixing Shao ; Shuyou Zhou
  Abstract: The coexistence of network denial of service (DoS) attacks and trigger transmission mechanism poses a challenge to the stability and control accuracy of semi-Markov jump systems (S-MJSs). DoS attacks with random characteristics and event-triggered mechanisms with dynamic parameters are studied in this paper. The communication topology jump process between multiple sub-actuators is modeled as a semi-Markov chain, and a S-MJSs with dual-channel DoS attacks and dynamic event-triggered mechanism (DETM) of sensor-to-controller (S-C) channel is obtained. In order to match the predictive compensation sequence with the trigger time of the S-C channel, a dynamic event-triggered predictive control (ETPC) strategy is designed by combining the controller with the trigger. In addition, the dynamic ETPC strategy proposed in this paper is applied to the tracking control of multi-motor, which effectively guarantees the tracking performance of multi-motor. Finally, the feasibility and superiority of the control strategy are verified by comparing with the network predictive control (NPC) strategy and the static ETPC strategy.
- **Approximate linear programming for decentralized policy iteration in cooperative multi-agent Markov decision processes**
  Authors: Lakshmi Mandal ; Chandrashekar Lakshminarayanan ; Shalabh Bhatnagar
  Abstract: In this work, we consider a 'cooperative' multi-agent Markov decision process (MDP) involving $m(> 1)$ agents. At each decision epoch, all the m agents independently select actions in order to minimize a common long-term cost objective. In the policy iteration process of multi-agent setup, the number of actions grows exponentially with the number of agents, incurring huge computational costs. Thus, recent works consider decentralized policy improvement, where each agent improves its decisions unilaterally, assuming that the decisions of the other agents are fixed. However, exact value functions are considered in the literature, which is computationally expensive for a large number of agents with high dimensional state–action space. Thus, we propose approximate decentralized policy iteration algorithms, using approximate linear programming with function approximation to compute the approximate value function for decentralized policy improvement. Further, we consider (both) cooperative multi-agent finite and infinite horizon discounted MDPs and propose suitable algorithms in each case. Moreover, we provide theoretical guarantees for our algorithms and also demonstrate their advantages over existing state-of-the-art algorithms in the literature.
- **Parameter estimation of probabilistic Boolean control networks: An optimization-based approach**
  Authors: Lulu Li ; Haodong Chen ; Yuchi Guo ; Jianquan Lu
  Abstract: This paper addresses the parameter estimation of probabilistic Boolean control networks (PBCNs) that exhibit unknown and time-varying switching probability distributions (SPDs). We begin by transforming PBCNs with time-varying SPDs into an algebraic form within the framework of algebraic state-space representation (ASSR). In contrast to traditional PBCNs, our investigation

incorporates uncertainty through variable switching probabilities. We propose an optimization-based approach for estimating the unknown and time-varying SPD of PBCNs. While existing methods typically focus on estimating Boolean networks (BNs) states, our approach targets the more challenging task of estimating time-varying SPDs. We validate the effectiveness of the proposed method using a simplified apoptosis network model.

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

Volume: 55, Issue: 2, February 2025

- **Over-Approximation State Estimation for Networked Timed Discrete Event Systems With Communication Delays and Losses**

  Authors: Zhaoyu Xiang ; Yufeng Chen ; Naiqi Wu ; Zhiwu Li

  Abstract: This article investigates the state estimation for a networked timed discrete event system, where a plant communicates with a supervisor via a multichannel network characterized by bounded delays and losses. To address delays and losses in observation channels, we augment the plant by integrating the dynamics of these channels, thus capturing the system's open-loop behavior. To tackle delays and losses in control channels, we augment the supervisor by considering all control decisions with potential impact on the system's behavior. By integrating the augmented plant and supervisor, we introduce a compensated system that enables the derivation of an over-approximation of the closed-loop system's behavior. Ultimately, we devise an online over-approximation state estimation algorithm for the closed-loop system, to compute all possible system states under communication delays and losses. We provide a simulation example to illustrate the efficacy of the proposed method.

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2 Call for Participants

2.1 Invited Session at CDC'25–Verification and Control of Discrete-Event Systems for Safety and Security

Dear Colleagues,

I am writing to invite you to contribute to an invited session on "**Verification and Control of Discrete-Event Systems for Safety and Security**" that we are organizing for the 2025 IEEE Conference on Decision and Control (CDC 2025), which is planned to take place in December 9-12 2025 (https://cdc2025.ieeecss.org/).

The session is organized by myself, Xiang Yin, and Kai Cai. The session will focus on theoretical and practical advancements in the verification and control of discrete-event systems (DESs), with an emphasis on ensuring safety and security properties. Topics of interest include, but are not limited to:

- Formal methods for verification;
- Supervisory control;
- Cyber security and safety;
- Resilience and robustness;
- Fault diagnosis and tolerance;
- Applications of DESs in safety-critical/cyber-physical systems.

The session will undergo the same review process as regular CDC papers, and if accepted, the papers will be published in the conference proceedings. There is also the option to publish papers in the 64th IEEE Control Systems Letters (L-CSS). The paper submission deadline for regular CDC papers is **March 31, 2025**, and for L-CSS papers, it is March 17, 2025.

If you are interested in contributing to this invited session, please inform us by **March 1, 2025**, with a tentative list of authors and a tentative title. The final confirmation of your contribution (including title, abstract, and list of authors) will be needed by **March 17, 2025**, to finalize the session proposal. We would be delighted to include a contribution from you and your collaborators in this session, which we expect to be of significant interest to the DESs and control systems community. Thank you for considering this invitation, and please feel free to reach out if you have any questions or need further details.

Best regards,
Yin Tong
(on behalf of the organizers: Yin Tong, Xiang Yin, and Kai Cai)

3 Conferences

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

2.1 **2025 ACM International Conference on Hybrid Systems: Computation and Control (HSCC)**
Irvine, California, USA, May 6-9, 2025.
https://hscc.acm.org/2025/

2.2 **2025 IEEE International Conference on Robotics and Automation (ICRA)**
Atlanta, USA, May 19-23, 2025.
https://2025.ieee-icra.org/

2.3 **2025 Annual Learning for Dynamics & Control Conference (L4DC)**
Ann Arbor, Michigan, USA, June 4-6, 2025.
https://sites.google.com/umich.edu/l4dc2025/

2.4 **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/

2.5 **2025 European Control Conference (ECC)**
Thessaloniki, Greece, June 24-27, 2025.
https://ecc25.euca-ecc.org/

2.6 **2025 American Control Conference (ACC)**
Denver, Colorado, USA, July 8-10, 2025.
https://acc2025.a2c2.org/

2.7 **2025 International Conference on Automation Science and Engineering (CASE)**
Los Angeles, California, USA, August 17-21, 2025.
https://2025.ieeecase.org/

2.8 **2025 IEEE Conference on Control Technology and Applications (CCTA)**
San Diego, California, USA, August 25-27, 2025.
https://ccta2025.ieeecss.org/

2.9 **2025 IEEE International Conference on Emerging Technologies and Factory Automation (ETFA)**
Porto, Portugal, September 9-12, 2025.
https://etfa2025.ieee-ies.org/

2.10 **2025 International Conference on Systems, Man, and Cybernetics (SMC)**
Vienna, Austria, October 5-8, 2025.
https://www.ieeesmc2025.org/

2.11 **2025 IEEE Conference on Decision and Control (CDC)**
Rio de Janeiro, Brazil December 9-12, 2025.
https://cdc2025.ieeecss.org/

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4 Books

4.1 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

4.2 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.

4.3 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

4.4 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).

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5 Software Tools

5.1 Eclipse ESCET™ version 6.0 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 December 2024, ESCET version 6.0 has been released and can be downloaded from https://www.eclipse.dev/escet/download.html. he main changes in this version are

- The CIF PLC code generator that was previously labeled as the 'experimental' version is now the 'stable' version. Support for some targets is still experimental. The CIF PLC code generator that was previously labeled as the 'stable' version is now the 'deprecated' version. Furthermore, the now 'stable' version includes several bug fixes and improvements.
- The performance of data-based synthesis as well as the bounded response, confluence and non-blocking under control checks may have slightly improved due to fixing a BDD variable leak in computing edge support variable sets. Furthermore, the printed output of several checks have been improved.
- A new Convert to interface transformation is now available that converts a CIF specification to its interface. It comes in two flavors: one to generate a full interface and one to generate a reduced interface.
- Several improvements to the HTML code generator. Furthermore, the generator generates now by default HTML code and not Simulink code.

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.

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