IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter **January 2024**

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Welcome to the 2024 January issue of the newsletter, also available online at
https://ieeecss.org/tc/discrete-event-systems/newsletters

Editorial

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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: 69, Issue: 1, January 2024

- **A Uniform Framework for Diagnosis of Discrete-Event Systems With Unreliable Sensors Using Linear Temporal Logic**
  Authors: Weijie Dong ; Xiang Yin ; Shaoyuan Li
  Abstract: In this article, we investigate the diagnosability verification problem of partially-observed discrete-event systems (DES) subject to unreliable sensors. In this setting, upon the occurrence of each event, the sensor reading may be nondeterministic due to measurement noises or possible sensor failures. Existing works on this topic mainly consider specific types of unreliable sensors such as the cases of intermittent sensors failures, permanent sensor failures or their combinations. In this work, we propose a novel uniform framework for diagnosability of DES subject to, not only sensor failures, but also a very general class of unreliable sensors. Our approach is to use linear temporal logic (LTL) with semantics on infinite traces to describe the possible behaviors of the sensors. A new notion of φ-diagnosability is proposed as the necessary and sufficient condition for the existence of a diagnoser, when the behaviors of sensors satisfy the LTL formula φ. An effective approach is provided to verify this notion. We show that, our new notion of φ-diagnosability subsumes all existing notions of robust diagnosability of DES subject to sensor failures. Furthermore, the proposed framework is user-friendly and flexible since it supports an arbitrary user-defined unreliable sensor type based on the specific scenario of the application. As examples, we provide two new notions of diagnosability, which have never been investigated in the literature, using our uniform framework.

- **A General Architecture for Intersection-Based Decentralized Supervisory Control of Discrete Event Systems**
  Authors: Akihito Hayano ; Shigemasa Takai
  Abstract: A certain intersection-based architecture for decentralized supervisory control of discrete event systems was proposed in the literature. This existing intersection-based architecture can be regarded as an antipermissive one. In this article, we propose a dual architecture, named the permissive intersection-based architecture, and develop a general architecture by combining the antipermissive and permissive ones. Then, we define a general notion of state-estimator-intersection-based coobservability (SEI-coobservability) as a part of necessary and sufficient conditions under which the specification is achieved in the developed general architecture and show how to verify it. Moreover, SEI-coobservability is compared with inference observability for inference-based decentralized supervisory control.

- **Entropy-Regularized Partially Observed Markov Decision Processes**
  Authors: Timothy L. Molloy ; Girish N. Nair
  Abstract: In this article, we investigate partially observed Markov decision processes (POMDPs) with cost functions regularized by entropy terms describing state, observation, and control uncertainty. Standard POMDP techniques are shown to offer bounded-error solutions to these entropy-regularized POMDPs, with exact solutions possible when the regularization involves the joint entropy of the state, observation, and control trajectories. Our joint-entropy result is particularly surprising since it constitutes a novel, tractable formulation of active state estimation.

- **Risk-Averse Decision Making Under Uncertainty**
  Authors: Mohamadreza Ahmadi ; Ugo Rosolia ; Michel D. Ingham ; Richard M. Murray ; Aaron D. Ames
  Abstract: A large class of decision making under uncertainty problems can be described via Markov decision processes (MDPs) or partially observable MDPs (POMDPs), with application to artificial intelligence and operations research, among others. In this article, we consider the problem of designing policies for MDPs and POMDPs with objectives and constraints in terms of dynamic coherent risk measures rather than the traditional total expectation, which we refer

to as the constrained risk-averse problem . Our contributions can be described as follows: first, for MDPs, under some mild assumptions, we propose an optimization-based method to synthesize Markovian policies. We then demonstrate that such policies can be found by solving difference convex programs (DCPs). We show that our formulation generalize linear programs for constrained MDPs with total discounted expected costs and constraints; second, for POMDPs, we show that, if the coherent risk measures can be defined as a Markov risk transition mapping, an infinite-dimensional optimization can be used to design Markovian belief-based policies. For POMDPs with stochastic finite-state controllers (FSCs), we show that the latter optimization simplifies to a (finite dimensional) DCP. We incorporate these DCPs in a policy iteration algorithm to design risk-averse FSCs for POMDPs. We demonstrate the efficacy of the proposed method with numerical experiments involving conditional-value-at-risk and entropic-value-at-risk risk measures.

- **Formal Synthesis of Controllers for Uncertain Linear Systems Against -Regular Properties: A Set-Based Approach**
  Authors: Bingzhuo Zhong ; Majid Zamani ; Marco Caccamo
  Abstract: In this article, we present how to synthesize controllers to enforce ω-regular properties over linear control systems affected by bounded disturbances. In particular, these controllers are synthesized based on so-called hybrid controlled invariant (HCI) sets. To compute these sets, we first construct a product system between the linear control system and the deterministic Streett automata (DSA) modeling the desired property. Then, we propose a set-based approach, which exploits a new iterative scheme over hybrid state sets of the product system, to compute the maximal HCI set. To ensure the termination of the iterative scheme within a finite number of steps, we propose two alternative approaches to compute approximations of the maximal HCI set. Moreover, we show the relations between the (worst-case) complexities of the proposed iterative schemes over hybrid sets and the structure of the DSA modeling ω-regular properties. Finally, we demonstrate the effectiveness of our results via two case studies.

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1.2. Automatica

Volume: 159, January 2024

- **Sensor deception attacks against security in supervisory control systems**
  Authors: Jingshi Yao ; Shaoyuan Li ; Xiang Yin
  Abstract: This paper investigates the problem of synthesizing sensor deception attacks against security in the context of supervisory control of discrete-event systems (DES). We consider a DES plant controlled by a supervisor, whose security requirement is to maintain the initial-secret of the system undetected, i.e., it does not want to reveal the fact that it was initiated from a secret state. On the other hand, there exists an active attacker that can tamper with the observations received by the supervisor by, e.g., hacking into the communication channel between the sensors and the supervisor. The objective of the attacker is to deceive the supervisor such that the initial-secret is revealed due to incorrect control actions. We investigate the problem from the attacker's point of view and focus on synthesizing attack strategies that threaten the security of the system. We consider two levels of success of the attacker: one requires that the attacker can detect the initial-secret of the system "almost surely" and the other only requires that the attacker has the possibility to detect the initial-secret of the system. For both cases, we present algorithms for synthesizing successful attack strategies. Our approach is based on the All Attack Structure (AAS) which records state estimates for both the supervisor and the attacker. Structural properties of the security requirements are also leveraged to reduce the synthesis complexity. A running academic example is provided to illustrate the proposed synthesis procedures.

- **Data-driven verification and synthesis of stochastic systems via barrier certificates**
  Authors: Ali Salamati ; Abolfazl Lavaei ; Sadegh Soudjani ; Majid Zamani
  Abstract: In this work, we study verification and synthesis problems for safety specifications over unknown discrete-time stochastic systems. When a model of the system is available, barrier certificates have been successfully applied for ensuring the satisfaction of safety specifications. In this work, we formulate the computation of barrier certificates as a robust convex program (RCP). Solving the acquired RCP is hard in general because the model of the system that appears in one

of the constraints of the RCP is unknown. We propose a data-driven approach that replaces the uncountable number of constraints in the RCP with a finite number of constraints by taking finitely many random samples from the trajectories of the system. We thus replace the original RCP with a scenario convex program (SCP) and show how to relate their optimizers. We guarantee that the solution of the SCP is a solution of the RCP with a priori guaranteed confidence when the number of samples is larger than a specific value. This provides a lower bound on the safety probability of the original unknown system together with a controller in the case of synthesis. We also discuss an extension of our verification approach to a case where the associated robust program is non-convex and show how a similar methodology can be applied. Finally, the applicability of our proposed approach is illustrated through three case studies.

- **Bounded confidence opinion dynamics: A survey**
  Authors: Carmela Bernardo ; Claudio Altafini ; Anton Proskurnikov ; Francesco Vasca
  Abstract: At the beginning of this century, Hegselmann and Krause proposed a dynamical model for opinion formation that is referred to as the Bounded Confidence Opinion Dynamics (BCOD) model and that has since attracted a wide interest from different research communities. The model can be viewed as a dynamic network, in which each agent is endowed with a state variable representing an opinion and two agents interact if the distance between their opinions does not exceed a constant confidence bound. This relation of instantaneous proximity between the opinions naturally induces a dynamic interaction graph. At each stage of the opinion iteration, all agents synchronously update their opinion to the average of all opinions that belong to the neighbors in the interaction graph.
  BCOD models exhibit a broad variety of phenomena that cannot be studied by traditional methods, and their analysis has enriched the systems and control field with a number of novel mathematical tools. This fact, together with the existence of an extensive literature on the topic scattered across different fields, calls for a systematic presentation of the existing results on this class of dynamic networks. The aim of this survey is to provide an overview of BCOD models with time-synchronous interactions, with possibly asymmetric and heterogeneous confidence bounds. Conditions on the different classes of BCOD which ensure the convergence (in finite time or asymptotically) of the opinions are discussed, and the possible structures of the terminal opinions are described. The numerous phenomena highlighted in the literature from numerical studies, e.g., the characterization of steady state behaviors and the sensitivity to confidence thresholds, are also reviewed. Finally, some recent modifications and applications of BCOD models are discussed, and suggestions of directions for future research are provided.

- **Time minimization and online synchronization for multi-agent systems under collaborative temporal logic tasks**
  Authors: Zesen Liu ; Meng Guo ; Zhongkui Li
  Abstract: Multi-agent systems can be efficient when solving a team-wide task in a concurrent manner. However, without proper synchronization, the correctness of the combined behavior is hard to guarantee, such as to follow a specific ordering of subtasks or to perform a simultaneous collaboration. This work addresses the minimum-time task planning problem for multi-agent systems under complex global tasks stated as syntactically co-safe Linear Temporal Logic (sc-LTL) formulas. These tasks include the temporal and spatial requirements on both independent local actions and direct sub-team collaborations. The proposed solution is an anytime algorithm that combines the partial-ordering analysis of the underlying task automaton for task decomposition, and the branch and bound (BnB) search method for task assignment. We analyze the soundness, completeness and optimality regarding the minimal completion time. We show that a feasible and near-optimal solution is quickly reached while the search continues within the time budget. Furthermore, to handle fluctuations in task duration and agent failures during online execution, we propose an adaptation algorithm to synchronize execution status and re-assign unfinished subtasks dynamically to maintain correctness and optimality. Both algorithms are validated over systems of more than 10 agents via numerical simulations and hardware experiments, against several established baselines.

- **A polynomial-time criterion for stability of large-scale switched conjunctive Boolean**

networks
Authors: Haitao Li ; Xiaojun Pang
Abstract: This paper investigates the global stability of large-scale switched conjunctive Boolean networks (SCBNs) under arbitrary switching signal from the graph-theoretic perspective. With the help of node removal technique, the Thomas' rule in Boolean case is proved, that is, a Boolean network is globally stable when its network graph is acyclic, and meanwhile the stable equilibrium is constructed. Secondly, the combination of node removal and Thomas' rule is used to analyse the stability of each mode in SCBNs. Thirdly, when the joint graph is weakly connected and acyclic, a polynomial-time criterion is built for the global stability of large-scale SCBNs under arbitrary switching signal. Finally, the application on the SCBN model in the processing of Toll ligand Spz demonstrates the effectiveness of the criterion.

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1.3. IEEE Transactions on Automation Science and Engineering
Issue: 1, January 2024

- **On Active Learning for Supervisor Synthesis**
Authors: Ashfaq Farooqui ; Ramon Tijsse Claase ; Martin Fabian
Abstract: Supervisory control theory provides an approach to synthesize supervisors for cyber-physical systems using a model of the uncontrolled plant and its specifications. These supervisors can help guarantee the correctness of the closed-loop controlled system. However, access to plant models is a bottleneck for many industries, as manually developing these models is an error-prone and time-consuming process. An approach to obtaining a supervisor in the absence of plant models would help industrial adoption of supervisory control techniques. This paper presents $SupL^*$, an algorithm to learn a maximally permissive controllable supervisor in the absence of plant models. It does so by actively interacting with a simulation of the plant by means of queries. If the obtained supervisor is blocking, existing synthesis techniques are employed to prune the blocking supervisor and obtain the maximally permissive controllable and non-blocking supervisor. Additionally, this paper presents an approach to interface the $SupL^*$ with a PLC to learn supervisors in a virtual commissioning setting. This approach is demonstrated by learning a supervisor of the well-known Machine Buffer Machine example simulated in Xcelgo Experior and controlled using a PLC. $SupL^*$ interacts with the PLC and learns a maximally permissive controllable supervisor for the simulated system.
Note to Practitioners: Ensuring the correctness of automated systems is crucial. Supervisory control theory proposes techniques to help build control solutions that have certain correctness guarantees. These techniques rely on a model of the system. However, such models are typically unavailable and hard to create. Active learning is a promising technique to learn models by interacting with the system to be learned. This paper aims to integrate active learning and supervisory control such that the manual step of creating models is no longer needed, thus, allowing the use of supervisory control techniques in the absence of models. The proposed approach is implemented in a tool and demonstrated using a case study.

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1.4. IEEE Control Systems Letter
Volume: 7, Issue: 12, December 2023

- **Formal Abstraction of General Stochastic Systems via Noise Partitioning**
Authors: John Skovbekk ; Luca Laurenti ; Eric Frew ; Morteza Lahijanian
Abstract: Verifying the performance of safety-critical, stochastic systems with complex noise distributions is difficult. We introduce a general procedure for the finite abstraction of nonlinear stochastic systems with non-standard (e.g., non-affine, non-symmetric, non-unimodal) noise distributions for verification purposes. The method uses a finite partitioning of the noise domain to construct an interval Markov chain (IMC) abstraction of the system via transition probability intervals. Noise partitioning allows for a general class of distributions and structures, including multiplicative and mixture models, and admits both known and data-driven systems. The partitions

required for optimal transition bounds are specified for systems that are monotonic with respect to the noise, and explicit partitions are provided for affine and multiplicative structures. By the soundness of the abstraction procedure, verification on the IMC provides guarantees on the stochastic system against a temporal logic specification. In addition, we present a novel refinement-free algorithm that improves the verification results. Case studies on linear and nonlinear systems with non-Gaussian noise, including a data-driven example, demonstrate the generality and effectiveness of the method without introducing excessive conservatism.

- **Efficient Computation of Weapon-Target Assignments Using Abstraction**
  Authors: D. Sawyer Elliott ; Maansi Vatsan
  Abstract: This letter details an algorithm for solving large weapon-target assignment problems using a novel abstraction approach that improves average computation time over other methods. Provided proofs show that the algorithm converges to a solution in finite time, if one exists. Numerical results demonstrate the improved computational efficiency of the algorithm compared to a baseline approach that does not use abstraction. Application to additional domains is discussed, facilitating application.

- **Formal Synthesis of Safety Controllers for Unknown Systems Using Gaussian Process Transfer Learning**
  Authors: Asad Ullah Awan ; Majid Zamani
  Abstract: In this letter, we propose a data-driven approach for synthesizing safety controllers for unknown nonlinear control systems using Gaussian Process (GP) transfer learning. Our approach involves two steps. The first step involves learning a GP model using data sampled from the system. Our method allows for leveraging a previously learned GP model of a related system, known as the source system (e.g., robot deployed in slightly different environmental conditions), to learn a GP model for the system at hand, known as the target system. This is required in situations where data collection for the target system is expensive or time consuming. In the second step, we compute a control barrier function together with a corresponding controller based on the learned GP model. In addition, we quantify the lower bound on the probability of safety satisfaction for the target system equipped with the synthesized controller. We demonstrate the effectiveness of the proposed approach by applying it to a jet engine case study.

- **Safety Verification of Neural-Network-Based Controllers: A Set Invariance Approach**
  Authors: Louis Jouret ; Adnane Saoud ; Sorin Olaru
  Abstract: This letter presents a novel approach to ensure the safety of continuous-time linear dynamical systems controlled by a neural network (NN) based state-feedback. Our method capitalizes on the use of continuous piece-wise affine (PWA) activation functions (e.g., ReLU) which render the NN a PWA continuous function. By computing the affine regions of the latter and applying Nagumo's theorem, a subset of boundary points can effectively verify the invariance of a potentially non-convex set. Consequently, an algorithm that partitions the state space in affine regions is proposed. The scalability of our approach is thoroughly analyzed, and extensive tests are conducted to validate its effectiveness.

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

Volume: 54, Issue: 1, January 2024

- **An Evolutionary Game With the Game Transitions Based on the Markov Process**
  Authors: Minyu Feng ; Bin Pi ; Liang-Jian Deng ; Jürgen Kurths
  Abstract: The psychology of the individual is continuously changing in nature, which has a significant influence on the evolutionary dynamics of populations. To study the influence of the continuously changing psychology of individuals on the behavior of populations, in this article, we consider the game transitions of individuals in evolutionary processes to capture the changing psychology of individuals in reality, where the game that individuals will play shifts as time progresses and is related to the transition rates between different games. Besides, the individual's reputation is taken into account and utilized to choose a suitable neighbor for the strategy updating of the individual.

Within this model, we investigate the statistical number of individuals staying in different game states and the expected number fits well with our theoretical results. Furthermore, we explore the impact of transition rates between different game states, payoff parameters, the reputation mechanism, and different time scales of strategy updates on cooperative behavior, and our findings demonstrate that both the transition rates and reputation mechanism have a remarkable influence on the evolution of cooperation. Additionally, we examine the relationship between network size and cooperation frequency, providing valuable insights into the robustness of the model.

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1.6. IEEE/CAA Journal of Automatica Sinica

Volume: 11, Issue: 1, January 2024

- **Non-Deterministic Liveness-Enforcing Supervisor Tolerant to Sensor-Reading Modification Attacks**

  Authors: Dan You ; Shouguang Wang

  Abstract: In this paper, we study the supervisory control problem of discrete event systems assuming that cyber-attacks might occur. In particular, we focus on the problem of liveness enforcement and consider a sensor-reading modification attack (SM-attack) that may disguise the occurrence of an event as that of another event by intruding sensor communication channels. To solve the problem, we introduce non-deterministic supervisors in the paper, which associate to every observed sequence a set of possible control actions offline and choose a control action from the set randomly online to control the system. Specifically, given a bounded Petri net (PN) as the reference formalism and an SM-attack, an algorithm that synthesizes a liveness-enforcing non-deterministic supervisor tolerant to the SM-attack is proposed for the first time.

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2 Call for Participants

2.1 EECI-IGSC Course: Introduction to Discrete Event Systems

Dear Colleagues,

We would like to draw your attention to the course titled "**Introduction to Discrete Event Systems**", to be taught by **Christos Cassandras** (Boston University, USA) and **Stéphane Lafortune** (University of Michigan, USA), which will be held from **June 3 to June 7, 2024, at the Campus Saint Charles, in Marseille, France**. Isabel Demongodin is the local organizer.

This course of 21 hours, offered as part of the European Embedded Control Institute-International Graduate School on Control (M13 of EECI-IGSC-2024), is especially designed for doctoral students, post-docs and junior researchers, who will have the opportunity to learn the main concepts and recent results in the theory and application of discrete event systems.

While the area of discrete event systems started as a sub-discipline in control engineering almost 40 years ago, the study of discrete event systems (DES) remains highly relevant to control engineering problems nowadays, such as in cyber-physical systems, transportation, software engineering, and in the study of privacy and security in engineered systems. In fact, DES form the centerpiece of the event-driven (cyber) component in the hybrid systems that comprise much of today's technology, complementing the time-driven (physical) components.

This course will strike a balance between introducing the students to the key concepts, models, and results of discrete-event control theory for logical and stochastic models, while at the same time emphasizing current research trends in DES theory and applications.

Please see the EECI's webpage, http://www.eeci-igsc.eu/, for further details.

The registration is open as "M13-MARSEILLE-03/06/2024-07/06/2024" at: http://www.eeci-igsc.eu/earlyregistrationm03tom18/. While the early registration deadline is April 1, 2024, please register as "Administration fee" (20€) as soon as possible and by February 15, 2024, to ensure participation.

Looking forward to seeing many of you in Marseille next year!

Best regards,

Isabel Demongodin, Christos Cassandras and Stéphane Lafortune

2.2 Invited Session at CASE'24–AI Enabled Discrete Event Dynamic Systems

Conference: 2024 IEEE 20th International Conference on Automation Science and Engineering
August 28 - September 1, 2024 | Bari, Italy

Organizer

- Qianchuan Zhao, Professor, Tsinghua University, zhaoqc@tsinghua.edu.cn
- Kai Cai, Professor, Osaka Metropolitan University, cai@omu.ac.jp
- Xiang Yin, Associate Professor, Shanghai Jiao Tong University, yinxiang@sjtu.edu.cn
- Li Xia, Professor, Sun Yat-sen University, xiali5@sysu.edu.cn

Summary Statement

Discrete event dynamic systems (DEDS) aim at studying the man-made systems driven by events, such as the systems of manufacturing, transportation, computer, communication, energy, robots, etc. The foundation of DEDS is built on mathematical models, such as Markov models, Petri net, automata, queueing models, etc. The decision and control of DEDS is fundamental to improve the operation efficiency of those man-made systems, which involves the optimization theory such as Markov decision process (MDP), optimal control, supervisory control, etc. Recently, the remarkable successes of AI attract intensive attention on the study of data-driven learning and optimization. One of the main research streams of AI is to handle the dynamic decision-making problem with reinforcement learning, whose mathematical foundation is MDP. Therefore, with these facts, the research development of DEDS theory encounters a crossroad, combining the techniques of AI and enabling the study of DEDS in a manner of data-driven learning and optimization.

This special session aims to bring together the international scholars and industry practitioners to discuss the recent progress of DEDS in the background of big development of AI techniques, while focusing on the field of automation science and engineering. The potential topics include but are not limited to the development of DEDS theory such as Markov systems, Petri net, automata, the development of reinforcement learning MDP decision theory, the AI enabled solution to dynamic games multi-agent systems, and the application of above theories to solve engineering problems in the field of automation science and engineering.

- Fundamental theory development of DEDS
- Controlled Markov systems
- Control in reinforcement learning
- Petri Nets for Automation Control
- Formal Methods in Robotics and Automation
- New advancement in automata
- Security control and Supervisory control
- Control and management in queueing models

Session Code: **41pkv**

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3 Conferences

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

3.1 **2024 IFAC Workshop on Discrete Event Systems (WODES)**
Rio de Janeiro, Brazil, April 29-May 1, 2024.
https://wodes2024.eventos.ufrj.br

3.2 **2024 IFAC Conference on Analysis and Design of Hybrid Systems (ADHS)**
Boulder, Colorado, July 1-3, 2024.
https://www.colorado.edu/conference/adhs2024/

3.3 **2024 American Control Conference (ACC)**
Toronto, Canada, July 8-12, 2024.
https://acc2024.a2c2.org/

3.4 **The IEEE Conference on Control Technology and Applications (CCTA)**
Newcastle upon Tyne, UK, August 21-24, 2024.
https://ccta2024.ieeecss.org/

3.5 **2024 International Conference on Automation Science and Engineering (CASE)**
Bari, Italy, August 28-September 1, 2024.
https://www.ieeesmc2024.org/

3.6 **2024 International Conference on Systems, Man, and Cybernetics (SMC)**
Sarawak, Malaysia, October 7-10, 2024.
https://www.ieeesmc2024.org/

3.7 **2023 IEEE Conference on Decision and Control (CDC)**
Milan, Italy, December 16-19, 2024.
https://cdc2024.ieeecss.org/

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4 Books

4.1 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).

4.2 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 system's ability to hide certain secrets from an external observer (or eavesdropper), and sensor and actuator attacks that exploit the system's 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

4.3 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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https://doi.org/10.1007/978-3-030-72274-6

4.4 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 book's Springer webpage:

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

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5 Software Tools

5.1 Eclipse ESCET™ version 2.0 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.org/escet/.

In December 2023, ESCET version 2.0 has been released and can be downloaded from https://www.eclipse.org/escet/download.html. The main changes in this version are

- A new CIF PLC code generator has been added to the CIF toolset. The new PLC code generator is currently being developed, and should be considered experimental. In due time, it will replace the current stable CIF PLC code generator.
- The CIF code generator can now generate HTML files and JavaScript code. The HTML files allow executing the model in a browser. Both are currently an experimental feature.
- The CIF explorer and the tools from the event-based toolset that output CIF models, now generate CIF models with state annotations. These state annotations indicate the current location of each automaton and the current value of each variable of the input CIF models. The generation of state annotations can be disabled using the tool's new Add state annotations option
- The CIF type checker now warns about certain duplicate state invariants. Furthermore, the CIF type checker now produces improved error messages in case of a mismatch between an argument of a component instantiation and the corresponding parameter of the instantiated component definition.
- The Eclipse ESCET project now deploys 'nightlies', in-development versions of the ESCET website and toolkit. See the nightly website at https://eclipse.dev/escet/nightly/. From the nightly website the nightly releases can be downloaded.

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.

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