IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter **December 2024**

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Welcome to the 2024 December 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: 69, Issue: 12, December 2024

- **The Projected Bellman Equation in Reinforcement Learning**
  Authors: Sean Meyn
  Abstract: Q-learning has become an important part of the reinforcement learning toolkit since its introduction in the dissertation of Chris Watkins in the 1980s. In the original tabular formulation, the goal is to compute exactly a solution to the discounted-cost optimality equation, and thereby, obtain the optimal policy for a Markov Decision Process. The goal today is more modest: obtain an approximate solution within a prescribed function class. The standard algorithms are based on the same architecture as formulated in the 1980s, with the goal of finding a value function approximation that solves the so-called projected Bellman equation. While reinforcement learning has been an active research area for over four decades, there is little theory providing conditions for convergence of these Q-learning algorithms, or even existence of a solution to this equation. The purpose of this article is to show that a solution to the projected Bellman equation does exist, provided the function class is linear and the input used for training is a form of ε-greedy policy with sufficiently small ε. Moreover, under these conditions it is shown that the Q-learning algorithm is stable, in terms of bounded parameter estimates. Convergence remains one of many open topics for research.

- **A Decentralized Control Synthesis Approach for Networked Systems With Arbitrary Interconnections**
  Authors: Shirantha Welikala ; Hai Lin ; Panos J. Antsaklis
  Abstract: This article considers the problem of decentralized analysis and control synthesis to verify and enforce properties like stability and dissipativity of large-scale networked systems comprised of linear subsystems interconnected in an arbitrary topology. In particular, we design systematic networked system analysis and control synthesis processes that can be executed in a decentralized manner with minimal information sharing among the subsystems. We also show that, for such decentralized processes, optimizing the used subsystem indexing scheme can substantially reduce the required intersubsystem information-sharing. We also provide insights into our decentralization technique so that it can be quickly adopted to decentralize many other centralized control solutions.We conclude this article by providing several simulation results demonstrating the proposed novel decentralized processes and dissipativity-based centralized and decentralized control solutions.

- **The Landscape of Deterministic and Stochastic Optimal Control Problems: One-Shot Optimization Versus Dynamic Programming**
  Authors: Jihun Kim ; Yuhao Ding ; Yingjie Bi ; Javad Lavaei
  Abstract: Optimal control problems can be solved via a one-shot (single) optimization or a sequence of optimization using dynamic programming (DP). However, the computation of their global optima often faces NP-hardness, and thus only locally optimal solutions may be obtained at best. In this work, we consider the discrete-time finite-horizon optimal control problem in both deterministic and stochastic cases and study the optimization landscapes associated with two different approaches: one-shot and DP. In the deterministic case, we prove that each local minimizer of the one-shot optimization corresponds to some control input induced by a locally minimum control policy of DP, and vice versa. However, with a parameterized policy approach, we prove that deterministic and stochastic cases both exhibit the desirable property that each local minimizer of DP corresponds to some local minimizer of the one-shot optimization, but the converse does not necessarily hold. Nonetheless, under different technical assumptions for deterministic and stochastic cases, if there exists only a single locally minimum control policy, one-shot and DP turn out to capture the same local solution. These results pave the way to understand the performance and stability of local search methods in optimal control.

- **Reach-Avoid Controllers Synthesis for Safety Critical Systems**
  Authors: Bai Xue
  Abstract: In this article, we propose a framework for synthesizing reach-avoid controllers for deterministic systems modeled by ordinary differential equations and stochastic systems modeled by stochastic differential equations based on the notion of control guidance-barrier functions. We first consider deterministic systems and aim to synthesize a reach-avoid controller that modifies a nominal controller in a minimal way to enforce the reach-avoid objective. This objective ensures that the system enters a target set eventually while staying within an open safe set before the first target hitting time. Three control guidance-barrier functions and corresponding conditions for synthesizing reach-avoid controllers are developed. These conditions progressively weaken, facilitating optimal controller design. We then extend two of these functions for deterministic systems to stochastic systems to synthesize reach-avoid controllers in the probabilistic setting. Finally, we provide several examples to demonstrate the effectiveness of our proposed methods, using the semidefinite programming tool.

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1.2. Automatica

Volume: 170, December 2024

- **State estimation for constant-time labeled automata under dense time**
  Authors: Jun Li ; Dimitri Lefebvre ; Christoforos N. Hadjicostis ; Zhiwu Li
  Abstract: In this paper, we focus on state estimation for constant-time labeled automata in a dense time context, i.e., the time constraints of the automata can be given according to real numbers. Given a sequence of timed observations (i.e., pairs of logical observations with their time stamps) collected from a system within a finite time window, a state estimation method is proposed to find the set of states in which the system might reside by the end of the time window. By using both labeling and timing information as well as the structure of the system, we can express any finite time evolution from one state to another into constraint satisfaction problems (CSPs). This structural analysis is independent of all collected sequences of timed observations and can be achieved offline, although its cost is exponential with respect to the number of states in the system. Consequently, two algorithms are designed to perform state estimation under a single observation and no observation, respectively, by solving a finite number of CSPs generated according to the system's structural information. Both algorithms can be jointly used in an iterative approach to perform state estimation for any sequence of timed observations. In such a case, the number of generated CSPs in the algorithms increases linearly with respect to the length of the observed sequence.
- **Quantitatively nonblocking supervisory control of discrete-event systems**
  Authors: Renyuan Zhang ; Jiahao Wang ; Zenghui Wang ; Kai Cai
  Abstract: In this paper, we propose a new property of quantitative nonblockingness of an automaton with respect to a given cover on its set of marker states. This property quantifies the standard nonblocking property by capturing the practical requirement that every subset (i.e. cell) of marker states can be reached within a prescribed number of steps from any reachable state and following any trajectory of the system. Accordingly, we formulate a new problem of quantitatively nonblocking supervisory control, and characterize its solvability in terms of a new concept of quantitative language completability. It is proven that there exists the unique supremal quantitatively completable sublanguage of a given language, and we develop an effective algorithm to compute the supremal sublanguage. Finally, combining with the algorithm of computing the supremal controllable sublanguage, we design an algorithm to compute the maximally permissive solution to the formulated quantitatively nonblocking supervisory control problem.
- **Stability and stabilization of discrete-time linear compartmental switched systems via Markov chain**
  Authors: sZhitao Li ; Yuqian Guo ; Weihua Gui
  Abstract: The stabilizing switching signal design of discrete-time linear compartmental switched systems (DT-LCSSs) has been heretofore unsolved. It has been proven that a DT-LCSS is stabilizable if and only if it is stabilizable by a periodic switching signal. However, it still needs to be

determined whether the period of a stabilizing switching signal can be confined within a bound. Moreover, the existing design method for stabilizing periodic switching signals requires the diagonal entries of system matrices of all subsystems to be strictly positive. In this study, we propose a novel approach to solve this problem completely. We construct a discrete-time Markov chain for a given DT-LCSS, termed the associated Markov chain, and prove the equivalence of stability and stabilizability between the DT-LCSS and the associated Markov chain. Based on this, verifiable necessary and sufficient conditions for stability and stabilizability are derived. Especially, the period of a stabilizing switching signal for an n-dimensional DT-LCSS can always be chosen within the bound $n^2 - n + 1$. We propose a state-independent stabilizing switching signal design method for general stabilizable DT-LCSSs. We also prove the equivalence between stabilizability by state-independent switching laws and stabilizability by state-dependent switching laws. A state-dependent global stabilizing switching signal design method is also proposed. Additionally, the proposed results are applied to the consensus analysis of discrete-time leader–follower multi-agent systems with switching communication digraphs. The effectiveness of the theoretical results is demonstrated by examples.

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1.3. IEEE Control Systems Letter

Volume: 8, Issue: 11, December 2024

- **Co-Büchi Control Barrier Certificates for Stochastic Control Systems**
  Authors: Daniel Ajeleye ; Majid Zamani
  Abstract: This letter addresses the problem of synthesizing controllers that enforce properties expressed by Universal Co-Büchi Automata (UCA) over stochastic control systems. Our approach introduces a notion of Stochastic Co-Büchi Control Barrier Certificates (SCBC), which, together with their associated controllers, ensure that specific regions in the state set are visited only a limited number of times during the system's evolution. The SCBC is formulated over a hybrid domain that combines the system's state, the UCA's state, and a counter variable that tracks the number of visits to the UCA's accepting states. We require the SCBC to satisfy a supermartingale condition, thereby, enforcing the property expressed by the UCA on the stochastic control system without any restriction over the time horizon. Additionally, we propose a method for constructing SCBCs and corresponding controllers that guarantee the enforcement of UCA properties over stochastic control systems with formal probabilistic guarantee. The practical applicability of our approach is demonstrated through a case study involving a stochastic three-tank system, whose dynamics is both nonlinear and influenced by noise.
- **Optimal Sensor Scheduling for Remote State Estimation Over Hidden Markovian Channels**
  Authors: Bowen Sun ; Xianghui Cao
  Abstract: This letter investigates the sensor scheduling problem in a multi-sensor, multi-channel remote state estimation system with time-varying channel states. Due to channel constraints, only a subset of sensors can transmit data to the remote state estimator at each time step. To prevent packet loss when transmitting when the channel state is busy, channel sensing is performed before transmission; however, sensing results are unreliable in practice. To address these challenges, we propose a channel state estimation algorithm using a Hidden Markov Model (HMM) to estimate the true channel state. We then formulate the sensor transmission scheduling problem as a Markov decision process (MDP) and prove the existence of a deterministic, stationary optimal policy. Additionally, we show that the optimal policy follows a monotone structure. Numerical examples are presented to illustrate the effectiveness of the proposed method.

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1.4. Control Engineering Practice

Volume: 135, December 2024

- **Signal-Interpreted Coloured Petri Nets: A modelling tool for rapid prototyping in feedback-based control of discrete event systems**

Authors: Matheus Ungaretti Borges ; Alessandro Pilloni ; Gustavo Ribeiro Pontes ; Carla Seatzu ; Eduardo José Lima II

Abstract: Petri nets (PNs) are typically used for design and verification rather than direct control implementation. In this paper, aligning with the Industry 4.0 paradigm's focus on flexible and reconfigurable control systems, we propose a modelling tool for rapidly prototyping feedback-based discrete-event control algorithms on programmable controllers such as PLCs or microcontroller boards. This modelling tool, named Signal Interpreted Coloured Petri Nets (SICPNs), aims to combine the formal modelling expressiveness of Coloured PNs with the capabilities of Signal Interpreted PNs, which are specialised in processing plant measurements and determining actuator commands. This contribution involves: (a) the formal definition of SICPN; (b) the presentation in the IEC61131-3 compliant SCL language of the so-called Token Player, a software entity designed to support feedback-based decision-making within the SICPN; (c) the validation of the effectiveness of the proposed formalism in controlling an extended configuration of the FESTO Modular Processing Station (MPS) using an Arduino microcontroller via two-way UART serial communications; (d) the modelling of a Digital Twin of the FESTO MPS testbed. The tests demonstrate that, during transitions, the colour and signal interpretation conditions enable the microcontroller to accurately schedule and dynamically reconfigure control actions while keeping the size of the PN-based controller small relative to the control problem's complexity.

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1.5. IEEE Transactions on Cybernetics

Volume: 54, Issue: 12, December 2024

- **Identification of Multievent Stochastic Fuzzy Discrete Event Systems**

  Authors: Hao Ying ; Feng Lin

  Abstract: We recently introduced a novel category of fuzzy discrete event systems (FDESs) termed stochastic FDESs (SFDESs), wherein multiple fuzzy automata occur randomly with different probabilities. We also developed two techniques for identifying event transition matrices in single-event SFDES employing the max-product fuzzy inference. One of them, named the equation-systems-based technique, focuses on the single-event SFDES identification, where the fuzzy automaton of each FDES has only one event. Expanding on our research, this article delves into multievent SFDES identification, allowing each FDES to encompass a sequence of events. This is a new research direction that has not been mentioned in the literature before. Upon activation of an FDES, all its events occur sequentially. Our mathematical proof first establishes the associativity of the max-product inference operation, leading to the introduction of a pivotal and novel concept called an equivalent overall event transition matrix for a consecutive event sequence. This concept establishes a theoretical framework for utilizing the equation-systems-based technique in a novel three-step method for identifying multievent SFDESs. The technique is employed in the first two steps to: 1) determine the number of fuzzy automata in an SFDES and 2) calculate their occurrence frequencies. In the third step, multievent transition matrices of the SFDES are learned by using the stochastic-gradient-descent-based algorithms that we previously developed for multievent FDESs, provided the numbers of consecutive events for each fuzzy automaton within the SFDES are known. Theoretical analysis reveals, for the first time, the interconnections between the event transition matrices learned by the algorithms, the equivalent overall event transition matrices derived from these matrices, and the target event transition matrices. To illustrate our findings, we present an informative example.

- **A Nonaugmented Method for the Minimal Observability of Boolean Networks**

  Authors: Yifeng Li ; Baoyu Liu ; Xuewen Liu ; Zhichun Yang ; Yongduan Song

  Abstract: This article proposes a nonaugmented method for investigating the minimal observability problem of Boolean networks (BNs). This method can be applied to more general BNs and reduce the computational and space complexity of existing results. First, unobservable states concerning an unobservable BN are classified into three categories using the vertex-colored state transition graph, each accompanied by a necessary and sufficient condition for determining additional measurements to make them distinguishable. Then, an algorithm is designed to identify the

additional measurements that would render an unobservable BN observable using the conditions. Next, to determine the minimum added measurements, a necessary and sufficient condition and an algorithm based on a constructed matrix are presented. Finally, the results obtained are compared with existing literature and illustrated with examples.

- **Optimal Reconstruction of Probabilistic Boolean Networks**
  Authors: Jiahao Wu ; Yang Liu ; Jianquan Lu ; Weihua Gui
  Abstract: In gene regulatory networks (GRNs), it is important to model gene regulation based on a priori information and experimental data. As a useful mathematical model, probabilistic Boolean networks (PBNs) have been widely applied in GRNs. This article addresses the optimal reconstruction problem of PBNs based on several priori Boolean functions and sampled data. When all candidate Boolean functions are known in advance, the optimal reconstruction problem is reformulated into an optimization problem. This problem can be well solved by a recurrent neural network approach which decreases the computational cost. When parts of candidate Boolean functions are known in advance, necessary and sufficient conditions are provided for the reconstruction of PBNs. In this case, two types of reconstruction problems are further proposed: one is aimed at minimizing the number of reconstructed Boolean functions, and the other one is aimed at maximizing the selection probability of the main dynamics under noises. At last, examples in GRNs are elaborated to demonstrate the effectiveness of the main results.

- **A Nonaugmented Method for the Minimal Observability of Boolean Networks**
  Authors: Yifeng Li ; Baoyu Liu ; Xuewen Liu ; Zhichun Yang ; Yongduan Song
  Abstract: This article proposes a nonaugmented method for investigating the minimal observability problem of Boolean networks (BNs). This method can be applied to more general BNs and reduce the computational and space complexity of existing results. First, unobservable states concerning an unobservable BN are classified into three categories using the vertex-colored state transition graph, each accompanied by a necessary and sufficient condition for determining additional measurements to make them distinguishable. Then, an algorithm is designed to identify the additional measurements that would render an unobservable BN observable using the conditions. Next, to determine the minimum added measurements, a necessary and sufficient condition and an algorithm based on a constructed matrix are presented. Finally, the results obtained are compared with existing literature and illustrated with examples.

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

Volume: 54, Issue: 12, December 2022

- **On the Equivalence Between Robustness and Liveness in Automated Manufacturing Systems**
  Authors: Benyuan Yang ; Hesuan Hu
  Abstract: There are two foundational problems in automated manufacturing systems. One is to determine their robustness (i.e., checking whether a marking is robust or nonrobust) while the other is to determine their liveness (i.e., determining whether a marking is live, bad, deadlock, or livelock). However, existing methods deal with them separately. This renders the existing methods inefficient in practice. In this article, we investigate the relation between robustness and liveness. First, we show how to define robustness in different net systems, i.e., the live, bounded, and nonreversible or reversible net systems. Second, we present a reachability graph-based method to assess the robustness of markings. Third, we clarify the relation between robustness and liveness, and conclude that liveness is a special case of robustness, under which the set of unreliable transitions is null. As a result, the robustness determination method developed in this article proves to be much general and can be used to check the liveness of each marking.

- **A Two-Timescale Learning Automata Solution to the Nonlinear Stochastic Proportional Polling Problem**
  Authors: Anis Yazidi ; Hugo Hammer ; David S. Leslie
  Abstract: In this article, we introduce a novel learning automata (LA) solution to the nonlinear

stochastic proportional polling (NSPP) problem. The only available solution to this problem in the literature is that given by Nicopolitidis et al. (2003), Obaidat et al. (2002), and Papadimitriou et al. (2002). It was shown to solve a large set of the adaptive resource allocation problems under noisy environments (Nicopolitidis et al., 2003; Obaidat et al., 2002; Papadimitriou and Pomportsis, 2000 and 1999; Nicopolitidis et al., 2004; Obaidat et al., 2001; and Papadimitriou and Pomportsis, 2000). We make a threefold contribution. First, we take a two-timescale approach to the field of LA by estimating the reward probabilities on a faster timescale than the timescale for updating the polling probabilities. Second, by making a not-obvious choice of the objective function, we show that the NSPP problem is indeed an instantiation of the stochastic nonlinear fractional equality knapsack (NFEK) problem, which is a substantial resource allocation problem based on the incomplete and noisy information (Granmo and Oommen, 2010). Third, in contrast to the legacy approach taken by Papadimitriou and Maritsas (1992 and 1996), we show through the extensive experimental results that our solution is remarkably robust to the choice of tuning parameters and that it outperforms the state of the art solution in terms of the Bayesian expected loss.

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2 Call for Participants

2.1 Invited Session at CCTA'25–Current Advances of Discrete Event System Applications

Dear Colleagues,

We are considering to propose a special session for CCTA 2025 (https://ccta2025.ieeecss.org) organized in San Diego, CA, USA, August 25-27.

The objective of the special session is to present the current advances of discrete event system (DES) applications from a control perspective with emphasis on methods and/or software tools enabling efficient handling of real-sized systems. We welcome contributions that demonstrate the impact of DES control on any aspects of (engineering) practice. Applications including manufacturing systems, transportation systems, logistic systems, power production, distributed systems, health-related topics are welcome, but contributions in any field where a discrete-event based problem formulation can play a crucial role and has a significant impact on real world are solicited.

Deadline for submission of papers is February 5, 2025. If you can contribute to this special session, please inform me (fbasile@unisa.it) or (cai@omu.ac.jp) as soon as possible. I would like to receive tentative title and tentative list of authors. Your cooperation is highly appreciated.

Forwarding this message to potentially interested colleagues is also appreciated.

Organizers
1. Francesco Basile (Università di Salerno, Italy)
2. Kai Cai (Osaka Metropolitan University, Japan)

Best regards,
Francesco Basile

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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