IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter **July 2023**

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Welcome to the 2023 July issue of the newsletter, also available online at
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Editorial

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

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1 Selections of Journal Publications

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

1.1. IEEE Transactions on Automatic Control

Volume: 68, Issue: 7, July 2023

- **Event-Triggered Control for Safety-Critical Systems With Unknown Dynamics**
  Authors: Wei Xiao; Calin Belta; Christos G. Cassandras
  Abstract: This article addresses the problem of safety-critical control for multiagent systems with unknown dynamics in unknown environments. It has been shown that stabilizing affine control systems to desired (sets of) states while optimizing quadratic costs subject to state and control constraints can be reduced to a sequence of quadratic programs (QPs) by using control barrier functions (CBFs) and control Lyapunov functions (CLFs). One of the main challenges in this approach is obtaining accurate system dynamics of all components in the system, which is especially difficult when online model identification is required given limited computational resources and system data. We address this problem by proposing a robust framework (to unknown dynamics including uncertainties) through defining adaptive affine control dynamics that are updated based on the error states obtained by real-time sensor measurements. We define a CBF for a safety requirement on the unmodeled agents based on the adaptive dynamics and error states, and reformulate the safety-critical control problem as the abovementioned sequence of QPs. Then, we determine a set of events that trigger the QPs and ensure safety when solving them. We also derive a condition that guarantees the satisfaction of a CBF constraint between events. The proposed framework can also be used for state convergence guarantees for systems with unknown dynamics based on CLFs. We illustrate the effectiveness of the proposed framework on a robot control problem, an adaptive cruise control problem and a traffic merging problem using autonomous vehicles. We also compare the proposed event-driven method with the classical time-driven approach.
- **Toward Event-Based State Estimation for Neuromorphic Event Cameras**
  Authors: Xinhui Liu; Meiqi Cheng; Dawei Shi; Ling Shi
  Abstract: In this article, a dynamic information extraction problem for neuromorphic event cameras is investigated from a state estimation perspective. The ego-motion pose estimation task of an event camera is formulated as a state estimation problem for a finite-state hidden Markov model subject to a special event-triggering mechanism. We model the threshold mismatch and the bandwidth limit of the event-camera output generalization process as a stochastic event-triggering condition equipped with a state-dependent packet dropout process. For this problem, the recursive expression of the system state conditioned on the event-triggered measurement information is constructed under a suitably designed reference probability measure, based on which the event-based minimum mean squared error (MMSE) estimate for the considered estimation problem is further obtained. The effectiveness of proposed results is illustrated by numerical analysis and comparative evaluation of an ego-motion pose estimation example.
- **Stochastic Event-Triggered Variational Bayesian Filtering**
  Authors: Xiaoxu Lv; Peihu Duan; Zhisheng Duan; Guanrong Chen; Ling Shi
  Abstract: This article proposes an event-triggered variational Bayesian filter for remote state estimation with unknown and time-varying noise covariances. After presetting multiple nominal process noise covariances and an initial measurement noise covariance, a variational Bayesian method and a fixed-point iteration method are utilized to jointly estimate the posterior state vector and the unknown noise covariances under a stochastic event-triggered mechanism. The proposed algorithm ensures low communication loads and excellent estimation performances for a wide range of unknown noise covariances. Finally, the performance of the proposed algorithm is demonstrated by tracking simulations of a vehicle.
- **Verification of k-Step and Definite Critical Observability in Discrete-Event Systems**
  Authors: Yin Tong ; Ziyue Ma
  Abstract: In this article, we study the verification of critical observability in discrete-event systems in which a plant and its observer are connected via an unreliable communication channel. We

consider a communication protocol in which each packet sent from the plant consists of an event and the sequence number of the packet. We define two novel notions of critical observability called first, the k-step critical observability that requires that the critical states can be distinguished from noncritical ones after a loss of consecutive k events, and second, the definite critical observability that is a generalization of k-step critical observability for all nonnegative integers k. Then, a structure called k-extended detector is proposed. Necessary and sufficient conditions for k-step critical observability are derived, which can be verified with polynomial complexity. Moreover, we prove that the definite critical observability can be verified by checking the $(1/2(|Q|^2 + |Q|))$ -step critical observability, where Q is the set of states of a plant. For a plant that is not definitely critically observable, a polynomial algorithm has been proposed to obtain a maximal nonnegative integer k_{max} (if it exists) such that the plant is kmax -step critically observable.

- **Exploiting Partial Observability for Optimal Deception**
  Authors: Mustafa O. Karabag ; Melkior Ornik ; Ufuk Topcu
  Abstract: Deception is a useful tool in situations where an agent operates in the presence of its adversaries. We consider a setting where a supervisor provides a reference policy to an agent, expects the agent to operate in an environment by following the reference policy, and partially observes the agent's behavior. The agent instead follows a different deceptive policy to achieve a different task. We model the environment with a Markov decision process and study the synthesis of optimal deceptive policies under partial observability. We formalize the notion of deception as a hypothesis testing problem and show that the synthesis of optimal deceptive policies is nondeterministic polynomial-time hard (NP-hard). As an approximation, we consider the class of mixture policies, which provides a convex optimization formulation of the deception problem. We give an algorithm that converges to the optimal mixture policy. We also consider a special class of Markov decision processes where the transition and observation functions are deterministic. For this case, we give a randomized algorithm for path planning that generates a path for the agent in polynomial time and achieves the optimal value for the considered objective function.

- **Certifying the LTL Formula p Until q in Hybrid Systems**
  Authors: Hyejin Han ; Mohamed Maghenem ; Ricardo G. Sanfelice
  Abstract: In this article, we propose sufficient conditions to guarantee that a linear temporal logic formula of the form p Until q , denoted by pUq, is satisfied for a hybrid system. Roughly speaking, the formula pUq is satisfied means that the solutions, initially satisfying proposition p , keep satisfying this proposition until proposition q is satisfied. To certify such a formula, connections to invariance notionsspecifically, conditional invariance and eventual conditional invarianceas well as finite-time convergence properties are established. As a result, sufficient conditions involving the data of the hybrid system and an appropriate choice of Lyapunov-like functions, such as barrier functions, are derived. Examples illustrate the results throughout the article.

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1.2. Automatica

Volume: 153, July 2023

- **Diagnosis of timed patterns for discrete event systems by means of state isolation**
  Authors: Dimitri Lefebvre ; Zhiwu Li ; Ye Liang
  Abstract: This paper deals with the diagnosis of timed patterns for discrete event systems that are modeled by a particular class of timed automata. A timed pattern is a set of behaviors characterized by a sequence of events, occurring in a given order, and a group of time intervals, during which the underlying events occur. The problem addressed in this research is to detect the occurrence of such timed patterns by the analysis of the timed observations. For this purpose, we define a completely synchronous composition of a timed automaton and a given timed pattern. Then, a timed pattern recognizer and a diagnoser are designed, which are suitable to solve the timed pattern diagnosis problem as a state isolation problem. A necessary and sufficient condition for timed pattern diagnosability is also proposed from a timed-logical perspective.

- **Structural controllability in timed continuous Petri nets**
  Authors: César Arzola ; Carlos Renato Vázquez ; Antonio Ramírez-Treviño ; Manuel Silva

Abstract: This work deals with the controllability analysis in timed continuous Petri nets (TCPNs) under infinite server semantics, a class of linear hybrid systems. In the literature, this problem has been addressed by analyzing each configuration (that defines a linear mode) of the system. However, the number of configurations may grow exponentially. Here, by using a global structural approach, we study the net rank-controllability (NRC), a structural property of the TCPN. Under the assumption of liveness, it is shown that NRC is a sufficient condition for controllability; nevertheless, if liveness is not fulfilled then controllability is not guaranteed by NRC The advantage of this approach is that NRC is characterized in terms of global structural objects of the net, thus, avoiding the analysis by configurations. In this sense, some new structural sufficient conditions for NRC are introduced for general TCPNs. Finally, polynomial-time algorithms for the verification of NRC are provided.

- **Interval dominance based structural results for Markov decision process**
  Authors: Vikram Krishnamurthy
  Abstract: Structural results impose sufficient conditions on the model parameters of a Markov decision process (MDP) so that the optimal policy is an increasing function of the underlying state. The classical assumptions for MDP structural results require supermodularity of the rewards and transition probabilities. However, supermodularity does not hold in many applications. This paper uses a sufficient condition for interval dominance (called $\mathcal{I}$) proposed in the micro-economics literature, to obtain structural results for MDPs under more general conditions. We present several MDP examples where supermodularity does not hold, yet $\mathcal{I}$ holds, and so the optimal policy is monotone; these include sigmoidal rewards (arising in prospect theory for human decision making), bi-diagonal and perturbed bi-diagonal transition matrices (in optimal allocation problems). We also consider MDPs with TP3 transition matrices and concave value functions. Finally, reinforcement learning algorithms that exploit the differential sparse structure of the optimal monotone policy are discussed.

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1.3. IEEE Transactions on Automation Science and Engineering

Volume: 20, Issue: 3, July 2023

- **Synthesis and Implementation of Distributed Supervisory Controllers With Communication Delays**
  Authors: Lars Moormann ; Reinier H. J. Schouten ; Joanna M. van de Mortel-Fronczak ; Wan J. Fokkink ; Jacobus E. Rooda
  Abstract: This paper discusses a method to distribute a synthesized supervisor for implementation on multiple physical controllers. Dependency structure matrices are used to determine a distribution of a system. The supervisor is then distributed accordingly, using an existing localization method. Communication delays between the distributed components of a supervisor may affect its behavior, due to changes in the order of events. Therefore, a new delay-robustness check is proposed and where needed mutex locks are employed to make the distributed supervisor delay robust. The controller performance is analyzed and optimized through a parameter study and a mutex implementation evaluation. In a real-life case study, the method is demonstrated by synthesizing, distributing, implementing, and validating a supervisor for a road tunnel.
  Note to Practitioners: This article is motivated by the desire to bridge the gap between the asynchronous, discrete-event, world of synthesized supervisors and the synchronous, real-time, world of networked PLC controllers. The main focus lies on maintaining the guarantees of supervisor synthesis while taking into account all aspects of real-time implementation, such as cycle-driven code execution and communication delays.
- **Deadlock Avoidance in Closed Guide-Path Based MultiAGV Systems**
  Authors: Daiyu He ; Bo Ouyang ; Hongkai Fan ; Chenjia Hu ; Kailai Zhang ; Zhi Yan
  Abstract: Automated guided vehicle (AGV) is widely used in transportation and distribution of materials. In the development of multi-AGV systems, how to handle deadlocks is a core issue. Most existing researches focus on open systems. Thus those results are not applicable in real-world systems. A few works have paid attention to closed systems recently, but the results are not flexible

and generic enough. Therefore, an improved deadlock avoidance algorithm in closed guide-path system is proposed in this paper. The proposed algorithm is divided into an offline stage and an online stage. At the offline stage, the guide-path graph is processed to obtain useful information for the online stage. At the online stage, the algorithm assesses the safety of each resource allocation to ensure a deadlock-free operation. The computational complexity of the algorithm is shown to be $O(|E|)$, where E is the set of the edges in the guide-path graph. Based on the algorithm, an overall control strategy is also developed, and then implemented and tested in real systems. It is also compared with Bankers algorithm and its variants, the results of which show that the proposed algorithm has a better performance.
Note to Practitioners: Deadlock is a core issue in guide-path based multi-AGV systems. Once deadlock occurs, the whole system will collapse. This problem is more serious in closed systems, which is paid less attention to in literature. Current deadlock solutions are either too restrictive, resulting in inefficient resource utilization and poor flexibility, or computationally intensive and thus are unable to scale to large systems. To solve this problem, an improved deadlock avoidance algorithm with polynomial computational complexity is proposed in this paper, and it is more flexible than the Bankers algorithm and its variants. Furthermore, an overall control framework (i.e., including task assignment, path planning and real-time scheduling) is developed based on the deadlock avoidance algorithm, which keeps persistent operation of the considered system while still guaranteeing deadlock-free. However, in this overall control framework, the choice of path is not optimized with respect to travel distance and makespan, which is the direction of future research.

- **A Petri Nets-Based Simulation Methodology for Modular Modeling and Performance Evaluation of Car-Sharing Networks**
Authors: Ali Hamroun ; Karim Labadi ; Mourad Lazri ; Jean-Pierre Barbot
Abstract: In the field of urban and green mobility, electric car-sharing networks have recently emerged as one of the promising alternatives, dealing with both environmental and transportation issues. Despite the increasing success of the shared mobility concept over the world, the design and management of such urban mobility systems implies strategic, tactical and operational challenges. To support designers and operators, all these issues constitute an emerging and challenging research topic, aiming to develop techniques and tools for modeling, analysis and optimization of such complex systems. In this contribution, based on the modeling and analysis power of stochastic timed Petri nets, a discrete event simulation approach is developed, taking into account their dynamic behavior complexities due to their self-service mode and characteristics including capacities of the stations, energy availability, rebalancing and maintenance activities. A real-life application is presented, to demonstrate the applicability and the potential of the proposed modeling and simulation analysis approach.
Note to Practitioners: To support designers, providers and managers of shared mobility programs, performance and optimization models and decision-making tools are needed. In this contribution, we deals with a powerful and modular stochastic timed Petri net methodology suitable for performance modeling and simulation analysis of such complex dynamical systems. The authors believe that this discrete event dynamic approach has significant promise for the future and to influence economic viability and operational efficiency of such emerging urban transportation systems.

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1.4. IEEE Transactions on Systems, Man, and Cybernetics: Systems
Volume: 53, Issue: 7, July 2023

- **Rumor Containment by Blocking Nodes in Social Networks**
Authors: Lan Yang ; Ziyue Ma ; Zhiwu Li ; Alessandro Giua
Abstract: Rumor spreads fast in social networks and may seriously damage our society. In this article, we present a mathematical programming formulation based on integer linear programming (ILP) to minimize rumor spread by blocking a subset of nodes (called blockers) in complex social networks modeled as a linear threshold model. We also propose a modified approach which solves the top-k blockers problem with a reduced computational effort and formally proves that

its performance is still optimal. Then, the presented method is evaluated for its effectiveness of containing rumor spread in four different networks and its performance is compared with a greedy-based and two centrality-based approaches. The experimental analysis shows that the ILP-based method outperforms the other three approaches and is applicable to large-scale networks.

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2 Conferences

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

2.1 **2023 IEEE Conference on Control Technology and Applications (CCTA)**
Bridgetown, Barbados, August 16-18, 2023.
https://ieeeccta.org/

2.2 **2023 IEEE International Conference on Automation Science and Engineering (CASE)**
Auckland, New Zealand, August 26-29, 2023.
https://case2023.org/

2.3 **2023 IEEE International Conference on Systems, Man, and Cybernetics (SMC)**
Maui, Hawaii, October 14, 2023.
https://ieeesmc2023.org/

2.4 **2023 IEEE Conference on Decision and Control (CDC)**
Singapore, December 13-15, 2023.
https://cdc2023.ieeecss.org/

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3 Books

3.1 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).

3.2 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 systems ability to hide certain secrets from an external observer (or eavesdropper), and sensor and actuator attacks that exploit the systems existing controller to generate undesirable behaviours.

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

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

3.3 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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3.4 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 books Springer webpage:

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

3.5 A New Framework for Discrete-Event Systems

Author: Kuize Zhang

Description: Real-world problems are often formulated as diverse properties of different types of dynamical systems. Hence property verification and synthesis have been long-standing research interests. The supervisory control framework developed in the 1980s provides a closed-loop property enforcement framework for discrete-event systems which usually consist of discrete states and transitions between states caused by spontaneous occurrences of labeled events. In this comprehensive review, the author develops an open-loop property enforcement framework for discrete event systems which scales better and can be implemented in more models. The author demonstrates the practicality of this framework using a tool called concurrent composition, and uses this tool to unify multiple inference-based properties and concealment-based properties in discrete-event systems. In the second part, the author introduces a new model called labeled weighed automata over monoids (LWAMs). LWAMs provide a natural generalization of labeled finite-state automata in the sense

that each transition therein carries a weight from a monoid, the weight of a run is the product of the weights of the runs transitions. This book introduces the reader to a new paradigm in discrete event dynamic systems. It provides researchers, students and practitioners with the basic theory and a set on implementable tools that will have a significant impact on systems of the future.

More information may be found at the books publisher webpage:

https://www.nowpublishers.com/article/Details/SYS-028

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4 Software Tools

4.1 DESpot 1.10.0 Released

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

DESpot 1.10.0 supports a number of new Features:

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

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

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

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

4.2 Eclipse ESCET™ version 0.9 release

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

In March 2023, ESCET version 0.9 has been released and can be downloaded from https://www.eclipse.org/escet/download.html. The main changes in this version are

- Eclipse ESCET is now released for the both the x86_64 and aarch64 architectures of macOS. This should result in a significant performance improvement for users with the M1 and M2 chips.
- The CIF data-based synthesis tool variable ordering configuration has been generalized and extended. This includes the addition of a new BDD advanced variable ordering option. It offers much more flexibility in configuring variable ordering, including configuration of the order in which to apply various algorithms, and configuration of the settings to use per algorithm. As a result of the changes, the debug output has been changed considerably. See the documentation of the new option for more information.
- The CIF data-based synthesis tool options that influence the variable ordering have some new defaults. The DCSH variable ordering algorithm is no longer considered experimental, and is now enabled by default. The BDD hyper-edge creation algorithm option has a new default value that is set by default. It uses the linearized hyper-edges for the FORCE and sliding window algorithms, while for all other variable orderers the legacy hyper-edges are still used. These changes to the default variable ordering configuration have been shown to improve the out-of-the-box performance of data-based synthesis in many cases, especially for models that take longer to synthesize or require more memory to synthesize. However, the effect greatly depends on the model being synthesized, and for some models synthesis using default settings may now be slower.
- The CIF data-based synthesis tool now has a State requirement invariant enforcement option, adding an alternative second approach to apply state requirement invariants during synthesis. Both

approaches have potential benefits and drawbacks, making for a trade-off between their various effects. Which approach is most efficient depends on the model. The default has not been changed.

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

4.3 IDES: An Open-Source Software Tool

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

4.4 MDESops

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

4.5 Supremica 2.7, New Version

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

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

New in this version:

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

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

4.6 UltraDES 2.2 Release

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

The main improvements of the UltraDES 2.2 version are:

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

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

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

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

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5 Open Positions

5.1 Open PhD position in the cyber-physical systems lab @UCLouvain

The department of applied mathematics at UCLouvain is recruiting a PhD Student in the framework of the ERC project L2C-Learning to control. The PhD will be under the supervision of Prof. Raphael Jungers. The goal of the thesis is to develop machine learning techniques for smart symbolic control of cyber-physical systems, and implement them within our dedicated platform in the language Julia. The ideal background of the applicant would feature control engineering and software implementation. The contract duration is 4 years, and conditions are good; please contact raphael.jungers@uclouvain.be for more information. Starting date between august and October 2023.

5.2 Open PhD position in Centre Automatique et Systemes (MINES Paris, France) and IFPEN (Lyon, France)

PhD Title: Control strategies for a wind farm based on a simplified dynamical wake modeling for optimal management of energy management and fatigue mitigation

Department: Digital Science and Technology Division, in Solaize (Lyon, France)

FPEN advisors:

- Main advisor: COLLET David (david.collet@ifpen.fr), control, signal, and systems department
- Co-advisors:
  Olivier Lepreux, PhD, solid mechanics department
  Frédéric Blondel, PhD, fluid mechanics department

Academic advisors:

- Florent Di Meglio, HDR, Head of Centre Automatique et Systèmes, MINES Paris PSL (florent.di_meglio@minesparis.psl.eu)
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IFP Energies nouvelles (IFPEN) is a major research and training player in the fields of energy, transport and the environment. From research to industry, technological innovation is central to all its activities, structured around three strategic priorities: sustainable mobility, new energies and responsible oil and gas.

In the field of wind energy, operators are now focusing on using wind turbines located in wind farms in the best possible way, to either produce the maximum energy possible, or produce the right amount of energy at the right time, to meet power grid requirements while limiting the wind turbine mechanical stress, in order to eventually minimize the cost of energy. It is possible to limit the interactions between a turbine wake and the downwind turbines by controlling its yaw angle and power produced, and thus alleviating the production losses and mechanical fatigue. In this context, our central question will be How to robustly minimize a wind farm cost of energy via a control algorithm using a dynamic wind farm flow model, and how to implement it in real world?. Indeed, the implementation in real world, dynamic wind farm flow model and cost of energy minimization aspect of things are very important.

On one hand, most of current works focus on cases where the farm is operated in normal conditions, whereas it is of primal importance to detect and manage cases where the farm is in abnormal operating conditions, for a robust real-world implementation.

On the other hand, most of the works are using steady state models for wind farm control. Therefore, the capacity to derive an optimal control problem, relying on innovative dynamic wind farm flow models, constitutes an important contribution of the thesis.

Eventually, some recent works had as an objective to either maximize energy production, either regulate power production with wind turbines load alleviation as secondary objective. However, very few

contributions focused on the explicit minimization of energy cost, which is one of the main drivers for operators.

The PhD results will contribute to three majors advances:

1. Develop wind farm control strategies based on a time-varying wake modeling and evaluate their added value;
2. Define a cost criterion allowing to efficiently minimize the cost of energy over long time horizons.
3. Contribute to the implementation and deployment of the developed control algorithms and prove and illustrate their robustness and efficiency.

The candidate must be graduated of a master's degree in mathematics or mechanical engineering with a preferred specialization in automatic, optimization or signal processing.

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