IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter May 2023

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

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

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Contents

1 Selections of Journal Publications

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

1.1. IEEE Transactions on Automatic Control

Volume: 68, Issue: 5, May 2023

- **Formal Verification of Unknown Discrete- and Continuous-Time Systems: A Data-Driven Approach**
  Authors: Ameneh Nejati ; Abolfazl Lavaei ; Pushpak Jagtap ; Sadegh Soudjani ; Majid Zamani
  Abstract: This article is concerned with a formal verification scheme for both discrete- and continuous-time deterministic systems with unknown mathematical models. The main target is to verify the safety of unknown systems based on the construction of barrier certificates via a set of data collected from trajectories of systems while providing an a-priori guaranteed confidence on the safety. In our proposed framework, we first cast the original safety problem as a robust convex program (RCP). Solving the proposed RCP is not tractable in general since the unknown model appears in one of the constraints. Instead, we collect finite numbers of data from trajectories of the system and provide a scenario convex program (SCP) corresponding to the original RCP. We then establish a probabilistic closeness between the optimal value of SCP and that of RCP, and as a result, we formally quantify the safety guarantee of unknown systems based on the number of data points and a required level of confidence. We propose our framework in both discrete-time and continuous-time settings. We illustrate the effectiveness of our proposed results by first applying them to an unknown continuous-time room temperature system. We verify that the temperature of the room maintains in a comfort zone with some desirable confidence by collecting data from trajectories of the system. To show the applicability of our techniques to higher dimensional systems with nonlinear dynamics, we then apply our results to a continuous-time nonlinear jet engine compressor and a discrete-time DC motor.
- **PAC Reinforcement Learning Algorithm for General-Sum Markov Games**
  Authors: Ashkan Zehfroosh ; Herbert G. Tanner
  Abstract: This article presents a theoretical framework for probably approximately correct (PAC) multi-agent reinforcement learning (MARL) algorithms for Markov games. Using the idea of delayed Q-learning, this article extends the well-known Nash Q-learning algorithm to build a new PAC MARL algorithm for general-sum Markov games. In addition to guiding the design of a provably PAC MARL algorithm, the framework enables checking whether an arbitrary MARL algorithm is PAC. Comparative numerical results demonstrate the algorithm's performance and robustness.
- **A General Framework for Learning-Based Distributionally Robust MPC of Markov Jump Systems**
  Authors: Mathijs Schuurmans ; Panagiotis Patrinos
  Abstract: In this article, we present a data-driven learning model predictive control (MPC) scheme for chance-constrained Markov jump systems with unknown switching probabilities. Using samples of the underlying Markov chain, ambiguity sets of transition probabilities are estimated, which include the true conditional probability distributions with high probability. These sets are updated online and used to formulate a time-varying, risk-averse optimal control problem. We prove recursive feasibility of the resulting MPC scheme and show that the original chance constraints remain satisfied at every time step. Furthermore, we show that under sufficient decrease of the confidence levels, the resulting MPC scheme renders the closed-loop system mean-square stable with respect to the true-but-unknown distributions, while remaining less conservative than a fully robust approach. Finally, we show that the data-driven value function of the learning MPC converges from above to its nominal counterpart as the sample size grows to infinity. We illustrate our approach on a numerical example.

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1.2. Automatica

Volume: 151, May 2023

- **Synthesis of optimal covert sensoractuator attackers for discrete-event systems**
  Authors: Ruochen Tai ; Liyong Lin ; Rong Su
  Abstract: This work introduces an approach for the synthesis of optimal covert sensoractuator attackers in the context of discrete-event systems (DES). Building upon existing works on optimal supervisor synthesis, on one hand, and the base model construction in the transformation of covert sensoractuator attacker synthesis to supervisor synthesis, on the other hand, we show how the optimal covert sensoractuator attacker synthesis problem could be transformed to the optimal supervisor synthesis problem, thus generalizing its logic counterpart. We consider several different types of optimization objectives, such as (1) minimization of attack energy cost, and (2) minimization of time cost to cause damage infliction; for the latter one, asynchronous event firings and concurrent event firings at the plant are both considered. We provide the necessary and sufficient conditions for the existence of an optimal attacker for both the energy minimization case and damage infliction time minimization case. Thus, this work may potentially provide a unified approach for the optimal synthesis of covert sensoractuator attackers in different setups.

- **Adaptive constraint satisfaction for Markov decision process congestion games: Application to transportation networks**
  Authors: Sarah H.Q. Li ; Yue Yu ; Nicolas I. Miguel ; Dan Calderone ; Lillian J. Ratliff ; Behçet Açkmee
  Abstract: Under the Markov decision process (MDP) congestion game framework, we study the problem of enforcing population distribution constraints on a population of players with stochastic dynamics and coupled congestion costs. Existing research demonstrates that the constraints on the players' population distribution can be satisfied by enforcing tolls. However, computing the minimum toll value for constraint satisfaction requires accurate modeling of the player's congestion costs. Motivated by settings where an accurate congestion cost model may be unavailable (e.g. transportation networks), we consider an MDP congestion game with unknown congestion costs. We assume that a constraint-enforcing authority can repeatedly enforce tolls on a population of players that converges to an ϵ-optimal population distribution for any given toll. We then construct a myopic update algorithm to compute the minimum toll value while ensuring that the constraints are satisfied on average. We analyze how the players' sub-optimal responses to tolls impact the rates of convergence towards the minimum toll value and constraint satisfaction. Finally, we construct a congestion game model for Uber drivers in Manhattan, New York City (NYC) using data from the Taxi and Limousine Commission (TLC) to illustrate how to efficiently reduce congestion while minimizing the impact on driver earnings.

- **A Markovian model for the spread of the SARS-CoV-2 virus**
  Authors: Luigi Palopoli ; Daniele Fontanelli ; Marco Frego ; Marco Roveri
  Abstract: We propose a Markovian stochastic approach to model the spread of a SARS-CoV-2-like infection within a closed group of humans. The model takes the form of a Partially Observable Markov Decision Process (POMDP), whose states are given by the number of subjects in different health conditions. The model also exposes the different parameters that have an impact on the spread of the disease and the various decision variables that can be used to control it (e.g, social distancing, number of tests administered to single out infected subjects). The model describes the stochastic phenomena that underlie the spread of the epidemic and captures, in the form of deterministic parameters, some fundamental limitations in the availability of resources (hospital beds and test swabs). The model lends itself to different uses. For a given control policy, it is possible to verify if it satisfies an analytical property on the stochastic evolution of the state (e.g., to compute probability that the hospital beds will reach a fill level, or that a specified percentage of the population will die). If the control policy is not given, it is possible to apply POMDP techniques to identify an optimal control policy that fulfils some specified probabilistic goals. Whilst the paper primarily aims at the model description, we show with numeric examples some of its potential applications.

- **A note on the existence of optimal stationary policies for average Markov decision processes with countable states**
  Authors: Li Xia ; Xianping Guo ; Xi-Ren Cao
  Abstract: In many practical stochastic dynamic optimization problems with countable states, the optimal policy possesses certain structural properties. For example, the (s, S) policy in inventory control, the well-known $c\mu$-rule and the recently discovered c/μ-rule (Xia et al. (2022)) in scheduling of queues. A presumption of such results is that an optimal stationary policy exists. There are many research works regarding to the existence of optimal stationary policies of Markov decision processes with countable state spaces (see, e.g., Bertsekas (2012); Hernández-Lerma and Lasserre (1996); Puterman (1994); Sennott (1999)). However, these conditions are usually not easy to verify in such optimization problems. In this paper, we study the optimization of long-run average of continuous-time Markov decision processes with countable state spaces. We provide an intuitive approach to prove the existence of an optimal stationary policy. The approach is simply based on compactness of the policy space, with a special designed metric, and the continuity of the long-run average in the space. Our method is capable to handle cost functions unbounded from both above and below, which makes a complementary contribution to the literature work where the cost function is unbounded from only one side. Examples are provided to illustrate the application of our main results.

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1.3. Control Engineering Practice

Volume: 134, May 2023

- **Event-Based Automaton Model for identification of discrete-event systems for fault detection**
  Authors: Thiago H. de M.C. Machado ; Gustavo S. Viana ; Marcos V. Moreira
  Abstract: Fault diagnosis is a crucial task to guarantee reliability, and reduce losses and production cost in industrial systems. In the traditional techniques for designing a fault diagnoser, it is necessary to obtain the complete model of the system, including its post-fault behavior. However, in general, industrial systems are large and composed of several subsystems which makes their modeling a laborious and time-consuming task. In addition, only predefined faults can be detected using the traditional fault diagnosis approach. In order to circumvent these problems, black-box identification techniques have been proposed in the literature to obtain an automaton that models the fault-free behavior of the system from the observation of the input and output signals of the system controller. Then, this model is used in a fault detection algorithm, and, after detection, the fault is isolated offline based on a comparison between the identified model and the sequence of observed signals. In all these approaches, it is assumed that the system has the same initial status of inputs and outputs of the controller. In practice, however, the system may start the execution of tasks with different input and output controller signal values. In this work, we present a new identification model, called Event-Based Automaton Model (EBAM). Differently from the other models proposed in the literature, the EBAM can be used to represent the fault-free system behavior when the tasks executed by the system start with different controller input and output values. A practical example, consisting of a plant simulated by using a 3D simulation software controlled by a Programmable Logic Controller, is used to illustrate the identification method and to show the efficiency of the fault detection algorithm based on the identified EBAM.

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1.4. International Journal of Control

Volume: 96, Issue: 5, May 2023

- **Approximately global optimal control for max-plus linear systems and its application on load distribution**
  Authors: Cailu Wang ; Yuanqing Xia ; Zhiwu Li ; Yuegang Tao
  Abstract: This paper considers the approximation problem of global optimal control of max-plus linear systems with real affine equality constrains. The approximate model that makes feasible

values closest to the greatest lower bound is set up by introducing the distance between max-plus vectors. The existence of approximately optimal solutions is proved, and a criterion for the uniqueness of such solutions is presented. A general formula with polynomial time complexity is given to compute all the approximately optimal solutions. Furthermore, the proposed approximation technique is used to minimise the overall completion time of a distributed system without accurate optimal solution. The examples and simulations are provided to demonstrate the applicability of the results.

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1.5. IEEE Transactions on Automation Science and Engineering

Volume: 20, Issue: 2, May 2022

- **An ETCEN-Based Motion Coordination Strategy Avoiding Active and Passive Deadlocks for Multi-AGV System**

  Authors: Xinyu Chen ; Zichao Xing ; Ligen Feng ; Tingqi Zhang ; Weimin Wu ; Ruifen Hu

  Abstract: In recent years, automated guided vehicles (AGV) are widely used to sort and transport parcels in logistics warehouses. The deployment of AGVs can improve storage efficiency and free human labour greatly. However, as the number of AGVs grows, the computational complexity and deadlock occurrence rate increase simultaneously, making it extremely difficult to coordinate AGVs movements in real time. In this paper, we first present a hierarchical motion coordination system based on event-triggered colored elementary net (ETCEN). The primary aim of the system is to coordinate AGVs in real time regardless of the systems scale. Then, we describe deadlocks by the ETCEN model and classify them into two categories - active deadlocks and passive deadlocks. Active deadlocks are prevented dynamically by controlling the movements of AGVs, while passive deadlocks are resolved by an improved path planning strategy. The entire system relies on a two-layer architecture, thereby improving flexibility and scalability. The proposed algorithms are validated by simulations and applications. Experiment results demonstrated that our approach can coordinate multi-AGV systems, avoid collisions and prevent deadlocks effectively.

  Note to Practitioners: This paper was motivated by the problem of coordinating multi-AGV system in warehouses, especially the tricky problem of preventing deadlocks in large-scale applications. Existing approaches mainly focused on collision-avoiding strategies, while paying less attention to the deadlock-preventing problem. As a result, the feasibility of current deadlock prevention methods strongly depends on the topology of the environment, and the computation time will surge exponentially as the scale of AGVs grows. This paper suggests a general approach towards solving two types of deadlocks (active deadlocks and passive deadlocks) based on Petri net theory. In this paper, a multi-AGV coordination model is presented and described thoroughly. Then we use the model to prove our theories and introduce our collision-avoiding and deadlock-preventing strategies. A two-layer architecture is designed to support the expansion of AGV fleet, making our system highly scalable. Both experiments and applications suggest that this approach is feasible and effective. In future research, we will focus on further optimizing the coordination and routing algorithm to improve the system throughput.

- **Robustness Analysis of Automated Manufacturing Systems With Uncontrollable Events Using Petri Nets**

  Authors: Benyuan Yang ; Hesuan Hu

  Abstract: In this paper, we address the robustness analysis problem of automated manufacturing systems with uncontrollable events in the paradigm of Petri nets (PNs). First, we formalize unreliable resource failures as the removal of all ingoing transitions of unreliable resource places (denoted by unreliable transitions hereafter). Second, we obtain a necessary and sufficient condition to check the robustness of markings, so called robustness controllability theorem (abbreviated as RCT hereafter) in the paradigm of reduced reachability graph (abbreviated as R2G hereafter). All markings involved in the R2G of a PN are equivalent to that of its reachability graph, except that all arcs associated to unreliable transitions are removed from R2G. Based on RCT, the robustness of all markings in an R2G can be determined. An example is proposed to illustrate the approach.

  Note to Practitioners: In reality, it is an urgent issue to analyze the behaviors of automated

manufacturing systems (AMSs) so as to guarantee their stable operation against resource failures, e.g., the missing of a signal or the failure of a sensor. In this connection, different methods are proposed to deal with the robustness analysis and control problem of AMSs with unreliable resources. The objective is to avoid any deadlock in the AMSs or to ensure the liveness of the subsystems that require only reliable resources when there exist resource failures. Due to limited actuating and sensing abilities, AMSs may be partially controlled, i.e., there exist events whose firing may not be inhibited by an external action. However, fewer research works consider this practical situation when handling robustness analysis and control issue, which renders the existing approaches impracticable. In this paper, we solve the robustness analysis problem of AMSs with uncontrollable events by using Petri nets. A necessary and sufficient condition is proposed to check the robustness of markings, called robustness controllability theorem (abbreviated as RCT hereafter) in the paradigm of reduced reachability graph. With the aid of RCT, the robustness of all markings can be determined so as to guarantee the flexibility of AMSs.

- **Optimal Task-Offloading Control for Edge Computing System With Tasks Offloaded and Computed in Sequence**
  Authors: Chen Hou ; Qianchuan Zhao
  Abstract: This paper considers the edge computing system (ECS) in which the tasks with dependencies are offloaded and computed in sequence. Different task-offloading orderings come with different ECS memory-cache execution latency (EMCEL) which is caused by writing and reading (WR) the computed results of earlier offloaded tasks between the ECS memory and cache. Therefore, the optimal ordering to offload all the tasks while leading to the minimum EMCEL arises as an interesting issue in practice. This requires to solve a hard exponential explosion optimization problem. To address this issue, this paper first formulates the tasks and their dependencies as a direct acyclic graph (DAG), then converts the exponential explosion problem into a discrete problem that can be solved in polynomial time, and finally develops some theoretical conditions to guide to determine the optimal task-offloading orderings. A novel algorithm called OTOOA to find the optimal task-offloading orderings in polynomial time is proposed. Field experiments show that OTOOA outperforms the existing algorithms. To our best knowledge, this is the initial work towards this issue.
  Note to Practitioners: For the edge computing system that operates in the application scenarios in which the ECS cache is small while the size of the tasks is relatively large such that it is not allowed for multiple tasks to be processed in the ECS cache parallelly or at the same time, e.g., the execution latency-sensitive and fast big data-processing scenarios in which the multiple tasks depending on the other are offloaded and computed in sequence, this paper helps such edge computing system to improve the operation efficiency with the minimum EMCEL by finding an optimal task-offloading ordering to guide the wireless devices to offload their tasks to the ECS server. Experimental investigations show that the solution proposed here outperforms existing ones.

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1.6. Systems & Control Letters

Volume: 175, May 2023

- **Abstractions of networks of stochastic hybrid systems under randomly switched topologies: A compositional approach**
  Authors: Asad Ullah Awan ; Majid Zamani
  Abstract: In this work, we derive conditions under which abstractions of networks of stochastic hybrid systems can be constructed compositionally. Proposed conditions leverage the interconnection topology, switching randomly between different interconnection topologies, and the joint dissipativity-type properties of subsystems and their abstractions. The random switching of the interconnection is modelled by a Markov chain. In the proposed framework, the abstraction, itself a stochastic hybrid system (possibly with a lower dimension), can be used as a substitute of the original system in the controller design process. In addition, we provide a weaker compositionality result under which compositional abstractions can still be constructed even if some of the compositionality conditions are violated for some of the interconnection topologies, provided that an

additional condition on the Markov chain parameters is satisfied. Finally, we provide an example illustrating the effectiveness of the proposed results by designing a controller enforcing some complex properties over the interconnected abstraction and then refining it back to the original interconnected system.out to illustrate the obtained results.

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2 Call for Participants & Registrations

2.1 ECC23 Workshop on Formal Methods for Data-Driven Control Systems

Dear colleagues,

We would like to bring your attention to the workshop on the topic of Formal methods for data-driven control systems at ECC 2023, to take place in Bucharest (Romania), June 13, 2013, organized by Antoine Girard (CNRS), Raphael Jüngers (UCLouvain), and Manuel Mazo Jr (TU Delft).

The workshop will feature invited talks from Alessandro Abate (U. Oxford), Pierre-Jean Meyer (Univ. Gustave Eiffel), Adnane Saoud (CentraleSupélec), Sofie Haesaert (TU Eindhoven), Raphael Jungers (UCLouvain), Maryam Kamgarpour (EPFL), and Calin Belta (Boston Univ.); as well as a panel discussion.

For more details on the talks, and registration please look at
https://sites.google.com/site/antoinesgirard/miscellaneous/ecc-2023-workshop.

We hope to see many of you in Bucharest on June 13th.

Antoine, Raphael, and Manuel

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3 Conferences

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

3.1 **2023 ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)**
San Antonio, USA, May 9-12, 2023
https://iccps.acm.org/2023/

3.2 **2023 IEEE International Conference on Robotics and Automation (ICRA)**
London, United Kingdom, May 29-June 02 2023, 2023
https://www.icra2023.org/

3.3 **2023 American Control Conference (ACC)**
San Diego, USA, May 31 - June 2, 2023
https://acc2023.a2c2.org/

3.4 **2023 IFAC World Congress (IFAC)**
Yokohama, Japan, July 9-14, 2023
https://www.ifac2023.org/

3.5 **2023 IEEE Conference on Control Technology and Applications (CCTA)**
Bridgetown, Barbados, August 16-18, 2023.
https://ieeeccta.org/

3.6 **2023 IEEE International Conference on Automation Science and Engineering (CASE)**
Auckland, New Zealand, August 26-29, 2023.
https://case2023.org/

3.7 **2023 IEEE International Conference on Systems, Man, and Cybernetics (SMC)**
Maui, Hawaii, October 14, 2023.
https://ieeesmc2023.org/

3.8 **2023 IEEE Conference on Decision and Control (CDC)**
Singapore, December 13-15, 2023.
https://cdc2023.ieeecss.org/

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4 Books

4.1 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

4.2 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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4.3 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

4.4 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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5 Software Tools

5.1 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.

5.2 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.

5.3 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.

5.4 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.

5.5 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.

5.6 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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6 Open Positions

6.1 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.

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