IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter August 2021

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Welcome to the 2021 August issue of the newsletter, also available online at
http://discrete-event-systems.ieeecss.org/tc-discrete/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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  or email to kai.cai@eng.osaka-cu.ac.jp.
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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: 66, Issue: 8, August 2021

- **Marking Predictability and Prediction in Labeled Petri Nets**
  Authors: Ziyue Ma ; Xiang Yin ; Zhiwu Li
  Abstract: This article studies the marking prediction problem in labeled Petri nets. Marking prediction aims to recognize a priori that the plant will inevitably reach a given set of alert markings in finite future steps. Specifically, we require that a marking prediction procedure should have the following properties: i) no missed alarm, i.e., an alarm can always be issued before reaching an alert marking; and ii) no false alarm, i.e., once an alarm is issued, the plant will eventually reach an alert marking in the future. To this end, the notion of marking predictability is proposed as a necessary and sufficient condition for the solvability of the marking prediction problem. A fundamental marking estimation problem in a labeled Petri net is first solved using minimal explanations and basis reachability graphs . Then, we propose two notions of basis markings called boundary basis markings and basis indicators , and prove that a plant is predictable with respect to a set of alert markings if all basis markings confusable with boundary basis markings are basis indicators. By properly selecting a set of explicit transitions, the set of basis indicators can be efficiently computed by structural analysis of the corresponding basis reachability graph. Our method has polynomial complexity in the number of basis markings. Finally, we present an effective algorithm for online marking prediction if the plant is predictable.
- **Noninterference Enforcement via Supervisory Control in Bounded Petri Nets**
  Authors: Francesco Basile ; Gianmaria De Tommasi ; Claudio Sterle
  Abstract: Security of distributed control systems is affected by the presence of information leaks, which permit to external intruders to infer the state of the system itself. Noninterference deals with the absence of such leak paths in a dynamic system modeled as discrete-event system. For a system that presents information leaks, a supervisory control strategy to enforce noninterference is proposed in this article. The approach is based on the solution of optimization problems on a Petri net model of the system under investigation. The effectiveness of the proposed enforcement strategy is shown by means of illustrative examples.
- **Multifidelity Modeling for Analysis and Optimization of Serial Production Lines**
  Authors: Yunyi Kang ; Logan Mathesen ; Giulia Pedrielli ; Feng Ju ; Loo Hay Lee
  Abstract: Recent advances in sensing, data analytics, and manufacturing technologies (e.g., 3-D printing, soft robotics, nanotechnologies, etc.) provide the potential to produce highly customized products by allowing flexible system design, endless device configurations, and unprecedented information flows. These opportunities also increase the complexity of controlling such systems optimally, which typically requires fast exploration of an increasingly large number of alternative operation strategies. Simulation and stochastic models have been particularly successful to support control and optimization of production systems, and methods have been developed to exploit them separately. Herein, we argue that the simultaneous use of these models can allow for better control and optimization by balancing the simulation accuracy, and related high computational costs, with the computational efficiency and lower accuracy of stochastic models. In this article, we assume that high fidelity models have higher accuracy and computational costs, and we present a novel multifidelity approach, which utilizes several models at different levels of fidelity to efficiently and effectively estimate and optimize the performance of asynchronous serial production lines with machines suffering from multiple failure types. Experimental results show that the multifidelity approach leads to better estimations, requiring less computational effort for optimization compared with the use of only high fidelity simulations.
- **A Necessary and Sufficient Graphic Condition for the Original Disturbance Decoupling of Boolean Networks**
  Authors: Yifeng Li ; Jiandong Zhu ; Bowen Li ; Yang Liu ; Jianquan Lu

Abstract: For a Boolean network with disturbances and outputs, a necessary and sufficient graphic condition for the original disturbance decoupling is proposed, and it reveals that the outputs are unaffected by the disturbances if and only if the vertex-colored state transition graph has a concolorous perfect vertex partition (CP-VP). In addition, if the CP-VP is an equal partition, a corresponding system decomposition is implemented. Furthermore, an algorithm is designed to check the existence of a CP-VP.

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1.2. Automatica

Volume: 130, August 2021

- **Synthesis of covert actuator and sensor attackers**
  Authors: Liyong Lin ; Rong Su
  Abstract: In this work, we shall investigate the problem of covert attacker synthesis in the framework of supervisory control of discrete-event systems. Intuitively, the covertness property says that the attacker cannot reach a situation where its existence has been detected by the supervisor while no damage can be caused. We consider covert attackers that can exercise both actuator attacks (including enablement attacks and disablement attacks) and sensor attacks (restricted to sensor replacement attacks), where the (partial-observation) attackers may or may not eavesdrop the control commands issued by the supervisor. We shall develop an exponential time reduction from the covert attacker synthesis problem to the well studied RamadgeWonham supervisor synthesis problem, which generalizes our previous work on a reduction based approach for covert actuator attacker synthesis, for both the damage-reachable goal and the damage-nonblocking goal. We also provide discussions on conditions under which the exponential blowup in state sizes, due to the reduction construction, can be avoided.
- **Divergent stutter bisimulation abstraction for controller synthesis with linear temporal logic specifications**
  Authors: Sahar Mohajerani ; Robi Malik ; Andrew Wintenberg ; Stéphane Lafortune ; Necmiye Ozay
  Abstract: This paper proposes a method to synthesise controllers for systems with possibly infinite number of states that satisfy a specification given as an $LTL_{\setminus\circ}$ formula. A common approach to handle this problem is to first compute a finite-state abstraction of the original state space and then synthesise a controller for the abstraction. This paper proposes to use an abstraction method called divergent stutter bisimulation to abstract the state space of the system. As divergent stutter bisimulation factors out stuttering steps, it typically results in a coarser and therefore smaller abstraction, at the expense of not preserving the temporal next operator. The paper leverages results about divergent stutter bisimulation from model checking and shows that divergent stutter bisimulation is a sound and complete abstraction method when synthesising controllers subject to specifications in $LTL_{\setminus\circ}$.
- **Symbolic control design of incrementally stable nonlinear systems with dynamic regular language specifications**
  Authors: Tommaso Masciulli ; Giordano Pola
  Abstract: In this paper we consider a control problem where the plant is a continuous-time incrementally stable nonlinear system, the controller is modeled as a finite state machine and the specification is modeled as a regular language. In some applications of interest it can be the case that the system does not know the whole specification to be enforced, but only a first part of it; then, at some time the system will obtain a second specification for which the controller needs to reconfigure. We propose results for the efficient synthesis of controllers in this setting. An analysis of computational complexity of the proposed approach is included which is also compared to traditional ones. An illustrative example is also presented.

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1.3. IEEE Control Systems Letter

Volume: 5, Issue: 4, August 2021

- **Verification of Approximate Opacity via Barrier Certificates**
  Authors: Siyuan Liu ; Majid Zamani
  Abstract: This letter is motivated by the increasing security concerns of cyber-physical systems. Here, we develop a discretization-free verification scheme targeting an information-flow security property, called approximate initial-state opacity, for the class of discrete-time control systems. We propose notions of so-called augmented control barrier certificates in conjunction with specified regions of interest capturing the initial and secret sets of the system. Sufficient conditions for (the lack of) approximate initial-state opacity of discrete-time control systems are proposed based on the existence of the proposed barrier certificates. We further present an efficient computation method by casting the conditions for barrier certificates as sum-of-squares programming problems. The effectiveness of the proposed results is illustrated through two numerical examples.
- **Symbolic Observer-Based Controller for Uncertain Nonlinear Systems**
  Authors: W. A. Apaza-Perez ; A. Girard ; C. Combastel ; A. Zolghadri
  Abstract: Symbolic control is an approach to the control of continuous or hybrid systems with specifications expressed in a logic form. This approach is based on the use of symbolic models describing the dynamical system behavior with a finite description of the transition relation between its states. In the literature, many results using this approach assume the availability of full and exact information about the system states to compute the control actions. In this letter, we consider a more realistic scenario where only partial information about the plant states is available. This letter proposes an abstraction that makes it possible to synthesize output-feedback controllers. The presence of disturbances and output noise is also considered. A direct path between observer designs in the classical theory and control synthesis in formal methods is established and a numerical example is provided to illustrate the results.
- **Receding Horizon Control-Based Motion Planning With Partially Infeasible LTL Constraints**
  Authors: Mingyu Cai ; Hao Peng ; Zhijun Li ; Hongbo Gao ; Zhen Kan
  Abstract: This letter considers online optimal motion planning of an autonomous agent subject to linear temporal logic (LTL) constraints. Since user-specified tasks may not be fully realized (i.e., partially infeasible) in a complex environment, this letter considers hard and soft LTL constraints, where hard constraints enforce safety requirements (e.g., avoid obstacles) while soft constraints represent tasks that can be relaxed to not strictly follow user specifications. The motion planning of the agent is to generate trajectories, in decreasing order of priority, to 1) guarantee the satisfaction of safety constraints; 2) mostly fulfill soft constraints (i.e., minimize the violation cost if desired tasks are partially infeasible); 3) locally optimize rewards collection over a finite horizon. To achieve these objectives, receding horizon control is synthesized with an LTL formula to maximize the accumulated utilities over a finite horizon, while ensuring that safety constraints are fully satisfied and soft constraints are mostly satisfied. Simulation and experiment results are provided to demonstrate the effectiveness of the developed motion strategy.
- **Assessment of Bisimulation Non-Interference in Discrete Event Systems Modelled With Bounded Petri Nets**
  Authors: Francesco Basile ; Gianmaria De Tommasi
  Abstract: Non-interference in discrete event systems deals with the possibility by an intruder to infer the occurrences of private and non observable events, the so called high-level ones, by interacting with the system at a user level, i.e., by observing the occurrence of the so called low-level ones. When bisimulation non-interference is considered, the security objective is not only to avoid the detection of high-level event occurrences, but also to avoid the detection of their non occurrences; i.e., the secret includes also the non occurrences of some events. This letter deals with such a more restrictive security property in the framework of discrete event systems modelled as Petri nets. A necessary and sufficient condition is given to assess bisimulation non-interference in bounded Petri nets. Such a condition requires the solution of integer linear programming optimization

problems, whose solution can be used also to statically enforce bisimulation non-interference when this condition is not satisfied by the original system.

- **Absorption in Time-Varying Markov Chains: Graph-Based Conditions**
  Authors: Yasin Yazcolu
  Abstract: We investigate absorption, i.e., almost sure convergence to an absorbing state, in time-varying (non-homogeneous) discrete-time Markov chains with finite state space. We consider systems that can switch among a finite set of transition matrices, which we call the modes. Our analysis is focused on two properties: 1) almost sure convergence to an absorbing state under any switching, and 2) almost sure convergence to a desired set of absorbing states via a proper switching policy. We derive necessary and sufficient conditions based on the structures of the transition graphs of modes. More specifically, we show that a switching policy that ensures almost sure convergence to a desired set of absorbing states from any initial state exists if and only if those absorbing states are reachable from any state on the union of simplified transition graphs. We then show three sufficient conditions for absorption under arbitrary switching. While the first two conditions depend on the acyclicity (weak acyclicity) of the union (intersection) of simplified transition graphs, the third condition is based on the distances of each state to the absorbing states in all the modes. These graph theoretic conditions can verify the stability and stabilizability of absorbing states based only on the feasibility of transitions in each mode.

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1.4. Nonlinear Analysis: Hybrid Systems

Volume: 41, August 2021

- **Performance safety enforcement in stochastic event graphs against boost and slow attacks**
  Authors: Zhou He ; Ziyue Ma
  Abstract: This paper studies a performance safety enforcing problem in stochastic event graphs, a subclass of stochastic Petri net models. We assume that an intruder can attack part of the transitions to increase/decrease their firing rate such that the performance of the system violates a given safety interval. The difficulty in solving this problem is that the capability of the intruder, i.e., the number of transitions that can be simultaneously attacked, is limited. The control aim is to find a protecting policy such that the performance of the protected plant is guaranteed to be in a given safety interval. We show that this problem can be formulated as a two-player game between the intruder and the operator of the plant. By using mixed integer linear programming technique, we develop a heuristic method to compute a protecting policy that is locally optimal.
- **Polynomial-time optimal liveness enforcement for guidepath-based transport systems**
  Authors: Spyros Reveliotis ; Tomá Masopust ; Michael Ibrahim
  Abstract: Zone-controlled guidepath-based transport systems is a modeling abstraction representing the traffic dynamics of a set of agents circulating in a constricted medium. An important problem for the traffic coordinator of these systems is to preserve liveness, that is, the ability of each agent to successfully complete its current trip and to be engaged in similar trips in the future. We present a polynomial-time algorithm for enforcing liveness in a class of these systems, in a maximally permissive manner. Our result is surprising and applicable in the traffic control of various unit-load material handling systems and other robotic applications.
- **Stabilization and set stabilization of switched Boolean control networks via flipping mechanism**
  Authors: Qiliang Zhang ; Jun-e Feng ; Ying Zhao ; Jianli Zhao
  Abstract: Stabilization and set stabilization of switched Boolean control networks are investigated by using flipping mechanism in this paper. Firstly, with the help of Warshall algorithm, an explicit criterion for the stabilization of switched Boolean control networks is derived. Secondly, the necessary and sufficient condition for the solvability of stabilization of switched Boolean control networks, by flipping some elements of perturbation set once, is presented. Thirdly, a search algorithm is proposed to calculate the minimum number of stabilization flipped nodes and what exactly

they are. Furthermore, a necessary and sufficient condition is established for the solvability of set stabilization of switched Boolean control networks by flipping some elements of perturbation set once. Analogously, an algorithm is given to find the minimum number of set stabilization flipped nodes. Finally, examples are shown to demonstrate the feasibility of the above results.

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

Volume: 51, Issue: 8, August 2021

- **Pythagorean Fuzzy Petri Nets for Knowledge Representation and Reasoning in Large Group Context**

  Authors: Hu-Chen Liu ; Dong-Hui Xu ; Chun-Yan Duan ; Yun Xiong

  Abstract: Fuzzy Petri nets (FPNs) are a graphical-based knowledge representation and reasoning tool widely used in many fields for intelligent decision making. However, the traditional FPNs could not accurately represent domain experts uncertain and ambiguous knowledge with the increasing complexity of knowledge base systems. Additionally, the task of assessing the truth degrees of input places is limited to small-scale expert groups in current practices. In response to these problems, we develop a new type of FPN model, called Pythagorean FPNs (PFPNs), for knowledge representation and reasoning in the large group context. Pythagorean fuzzy sets are introduced to capture imprecise and ambiguous knowledge and a large group truth determination method is proposed to get the truth degrees of input places with massive data. Finally, an application example regarding security risk assessment is given to show the effectiveness and advantages of our proposed PFPNs.

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2 Conferences

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

2.1 **2021 IEEE Conference on Control Technology and Applications**
San Diego, August 8-11, 2021
https://ccta2021.ieeecss.org/

2.2 **2021 IEEE International Conference on Automation Science and Engineering**
Lyon Centre de Congres, Lyon, France, August 23-27, 2021
https://www.ieee-ras.org/component/rseventspro/event/1935-case-2021

2.3 **2021 IEEE International Conference on Systems, Man, and Cybernetics**
South Wharf, Victoria, Australia, October 17-20, 2021
http://ieeesmc2021.org/

2.4 **2021 IEEE Conference on Decision and Control**
Austin, Texas, USA. December 13-15, 2021
https://cdc2021.ieeecss.org

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3 Books

3.1 **Foundations of Average-Cost Nonhomogeneous Controlled Markov Chains**
Authors: Xi-Ren Cao
Description: This Springer brief addresses the challenges encountered in the study of the optimization of time-nonhomogeneous Markov chains. It develops new insights and new methodologies for systems in which concepts such as stationarity, ergodicity, periodicity and connectivity do not apply.

This brief introduces the novel concept of confluencity and applies a relative optimization approach. It develops a comprehensive theory for optimization of the long-run average of time-nonhomogeneous Markov chains. The book shows that confluencity is the most fundamental concept in optimization, and that relative optimization is more suitable for treating the systems under consideration than standard ideas of dynamic programming. Using confluencity and relative optimization, the author classifies states as confluent or branching and shows how the under-selectivity issue of the long-run average can be easily addressed, multi-class optimization implemented, and Nth biases and Blackwell optimality conditions derived. These results are presented in a book for the first time and so may enhance the understanding of optimization and motivate new research ideas in the area.

ISBN: 978-3-030-56678-4
https://www.springer.com/gp/book/9783030566777

3.2 **Discrete-Time and Discrete-Space Dynamical Systems**
Authors: Kuize Zhang, Lijun Zhang, Lihua Xie
ISBN: 978-3-030-25971-6, Springer
https://link.springer.com/book/10.1007/978-3-030-25972-3

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4 Positions

4.1 PhD Position at the University of Salerno

The Department of Information and Electric Engineering and Applied Mathematics at the University of Salerno has openings for fully-funded PhD researchers. The Automatic Control Group at the University of Salerno is looking for outstanding candidates in the area

"Resilient control against cyber-attack"

We are looking for a talented, outstanding PhD researcher with a Master degree (or close to completion) in Systems and Control, or Computer Science, Complex Systems, or related field, with interests in distributed control of cyber-physical systems (CPSs).

General project description: the candidate will conduct theoretical and algorithmic research on enforcing safety specifications on spatially distributed control systems. Specifically, there is a great potential in this area for developing novel approaches using methodologies that pertain to discrete event systems (DESs). Indeed, cyber-attacks act essentially at the higher levels of the control architecture, where the discrete event view of the system is the most effective description of the system dynamics. The project aims not only at extending the current state of the art from a systems theory point of view with novel contributions, but also to apply and validate the proposed methodologies in the context of CPSs using case studies that emphasize the social and economic impact.

Additional information: while knowledge of the Italian language is not mandatory (all doctorate courses are in English), to facilitate international students in settling down, an introductory Italian language course will be offered. Moreover, based on the outcome of the interviews students might be offered a free accommodation at the University of Salerno Campus and a free meal per day at University canteen. Other benefits include:

- funding for 3.000,00 euros to support his/her research needs;
- financial support to spend research periods at other international institutions.

The main referent for each project is Prof. Francesco Basile (see https://docenti.unisa.it/005630/en/home).

To apply, please email to fbasile@unisa.it with subject line PHD positions and attach:

- curriculum vitae;
- statement of motivation and research interests (1-page max);
- transcripts of all exams taken and obtained degrees (in English);
- names and contact information of up to two references.

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5 Call for Papers

5.1 Advanced Robotics: Special Issue on Control Technology for Networked and Distributed Robotics

Guest Editors:

- Prof. Masaaki Nagahara (The University of Kitakyushu, Japan)
- Prof. Kai Cai (Osaka City University, Japan)
- Prof. Takeshi Hatanaka (Tokyo Institute of Technology, Japan)
- Prof. Yutaka Hori (Keio University, Japan)
- Prof. Hideaki Ishii (Tokyo Institute of Technology, Japan)
- Prof. Debasish Chatterjee (Indian Institute of Technology Bombay, India)
- Prof. Nikhil Chopra (The University of Maryland, USA)
- Prof. Daniel E. Quevedo (Queensland University of Technology, Australia)
- Prof. Michel Reniers (Eindhoven University of Technology, Netherlands)

Scheduled Publication in Vol. 37, Issue 1 (January 2023)

Submission deadline: 28 February 2022

Control technology is one of the fundamental disciplines of robotics. The technology has been developed for more than 100 years and expanded in many research areas. In particular, control technology for networked and distributed robotics has been recently emerging thanks to the development of embedded systems and wireless communications. An example of networked and distributed robotics is a drone light show, which was presented in the opening ceremony of Tokyo Olympic Games 2020, where multiple drones are operated from the main computer located on the ground that controls multiple drones through wireless networks. The purpose of this special issue is to present recent theory and practice of control technology that can be effectively applied to networked and distributed robotics. It aims at collecting a representative body of innovative theoretical contributions that have potential applications to networked and distributed robotics as well as applicative robotics researches that show successful implementation of recent theory of networked and distributed control. Prospective contributed papers are invited to cover, but are not limited to, theoretical and applicative researches on the following topics

- control of multi-agent systems (e.g. consensus control, coverage control, formation)
- networked control systems
- **discrete-event systems and hybrid systems**
- resource-aware control (e.g. event-triggered control, sparse control)
- secure, resilient, and safe control
- machine learning and data driven methods for networked robotics
- human-in-the-loop and human-machine interaction

The full-length manuscript (either PDF or Microsoft Word file) should be sent to the office of Advanced Robotics, Robotics Society of Japan, through its homepage at: https://www.rsj.or.jp/pub/ar/submission.html. Templates for the manuscript as well as instructions for the Authors are available at the homepage.

Further information will be provided via the following website: https://ct4ndr.wordpress.com

5.2 ACC'22: Safety and Security of Discrete Event Systems

Organizers:

- Ziyue Ma, Associate Professor, Xidian University, E-mail: maziyue@xidian.edu.cn
- Kai Cai, Professor, Osaka City University, E-mail: kai.cai@eng.osaka-cu.ac.jp
- Yin Tong, Assistant Professor, Southwest Jiaotong University, E-mail: yintong@swjtu.edu.cn

Sponsors: This session will be sponsored by IEEE CSS Technical Committee on Discrete Event Systems, where organizer Kai Cai is the Chair.

Summary Statement: The interdisciplinary field of Discrete Event Systems (DES) combines various formalisms, methodologies and tools from control, computer science and operations research. The research activity in this field is driven by the needs of many different applications domains: manufacturing, process control, supervisory systems, software engineering, transportation, information security, access certification, and so on. It is now a mature field and many interesting applications have been developed in the past few years with ever-increasing demands due to the development of Cyber-Physical Systems.

The main objective of this invited session is that of gathering recently developed novel approaches devoted to analysis and enforcement of Security, Safety and Resilience using DES models. We seek submissions including but not limited to the following topics:

- Modeling, analysis, and enhancement of cyber-security of discrete event systems
- Cyber-attack and defense strategies in discrete event systems
- Fault analysis, detection, and fault-tolerant control in discrete event systems
- Resilient control design in discrete event systems
- Information integrity analysis and enhancement in networked discrete event systems
- Performance evaluation, optimization, and scheduling techniques in discrete event systems
- Automation methods, applications, and software tools enabling efficient handling of industrial-sized systems.

If you are interested and considering submitting a paper, please contact Dr. Ziyue Ma (maziyue@xidian.edu.cn) with the tentative title of the paper.

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6 Software Tool

6.1 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.

6.2 Supremica 2.6, New Version

The development team has just released a new version of Supremica, Waters/Supremica IDE 2.6.

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:

- Scaling of the GUI
- Revamped configuration dialog
- New analyzer user interface
- Logging can now be done directly to file, in addition to the log output pane
- Automaton variables have been introduced, so that guards and actions can refer to the state of an automaton
- The normalizing compiler is now the default
- Plenty of bug fixes, including more graceful termination when out of memory

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

6.3 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.

6.4 **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 coobservability.

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.

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