# IEEE Control Systems Society
# Technical Committee on Discrete Event Systems

## Newsletter July 2021

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Welcome to the 2021 July 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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## Contents

# 1 Selections of Journal Publications

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

## 1.1. IEEE Transactions on Automatic Control

Volume: 66, Issue: 7, July 2021

- **Specification-Guided Verification and Abstraction Refinement of Mixed Monotone Stochastic Systems**
  **Authors:** Maxence Dutreix ; Samuel Coogan
  **Abstract:** This article addresses the problem of verifying discrete-time stochastic systems against omega-regular specifications using finite-state abstractions. Omega-regular properties allow specifying complex behavior and encompass, for example, linear temporal logic. We focus on a class of systems with mixed monotone dynamics. This class is shown to be amenable to efficient reachable set computation and models a wide range of physically relevant systems. In general, finite-state abstractions of continuous state stochastic systems give rise to augmented Markov chains wherein the probabilities of transition between states are restricted to an interval. We present a procedure to compute a finite-state interval-valued Markov chain (IMC) abstraction of discrete-time, mixed monotone stochastic systems subject to affine disturbances given a rectangular partition of the state space. Then, we suggest an algorithm for performing verification against omega-regular properties in IMCs. Specifically, we aim to compute bounds on the probability of satisfying a specification from any initial state in the IMC. This is achieved by solving a reachability problem on the sets of so-called winning and losing components in the Cartesian product between the IMC and a Rabin automaton representing the specification. Next, the verification of IMCs may yield a set of states whose acceptance status is undecided with respect to the specification, requiring a refinement of the abstraction. We describe a specification-guided approach that compares the best and worst case behaviors of accepting paths in the IMC and targets the appropriate states accordingly. Finally, we show a case study.
- **Formal Synthesis of Stochastic Systems via Control Barrier Certificates**
  **Authors:** Pushpak Jagtap ; Sadegh Soudjani ; Majid Zamani
  **Abstract:** This article focuses on synthesizing control policies for discrete-time stochastic control systems together with a lower bound on the probability that the systems satisfy the complex temporal properties. The desired properties of the system are expressed as linear temporal logic specifications over finite traces. In particular, our approach decomposes the given specification into simpler reachability tasks based on its automata representation. We, then, propose the use of so-called control barrier certificate to solve those simpler reachability tasks along with computing the corresponding controllers and probability bounds. Finally, we combine those controllers to obtain a hybrid control policy solving the considered problem. Under some assumptions, we also provide two systematic approaches for uncountable and finite input sets to search for control barrier certificates. We demonstrate the effectiveness of the proposed approach on a room temperature control and lane keeping of a vehicle modeled as a four-dimensional single-track kinematic model. We compare our results with the discretization-based methods in the literature.
- **Synthesis of Maximally Permissive Supervisors for Nondeterministic Discrete Event Systems With Nondeterministic Specifications**
  **Authors:** Shigemasa Takai
  **Abstract:** In this article, we consider the problem of synthesizing a nondeterministic supervisor for the plant and the specification modeled as nondeterministic automata. A similarity control problem requires us to synthesize a supervisor such that the supervised plant is simulated by the specification. Ideally, the synthesized supervisor should be as permissive as possible. We develop a method for synthesizing a maximally permissive supervisor that solves the similarity control problem.
- **Synthesis of Provably Correct Autonomy Protocols for Shared Control**
  **Authors:** Murat Cubuktepe ; Nils Jansen ; Mohammed Alshiekh ; Ufuk Topcu
  **Abstract:** We synthesize shared control protocols subject to probabilistic temporal logic specifica-

tions. Specifically, we develop a framework in which a human and an autonomy protocol can issue commands to carry out a certain task. We blend these commands into a joint input to a robot. We model the interaction between the human and the robot as a Markov decision process representing the shared control scenario. Using inverse reinforcement learning, we obtain an abstraction of the human's behavior. We use randomized strategies to account for randomness in human's decisions, caused by factors such as the complexity of the task specifications or imperfect interfaces. We design the autonomy protocol to ensure that the resulting robot behavior satisfies given safety and performance specifications in probabilistic temporal logic. Additionally, the resulting strategies generate behavior as similar to the behavior induced by the human's commands as possible. We solve the underlying problem efficiently using quasiconvex programming. Case studies involving autonomous wheelchair navigation and unmanned aerial vehicle mission planning showcase the applicability of our approach.

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### 1.2. Automatica

Volume: 129, July 2021

- **A general framework for diagnosis of discrete event systems subject to sensor failures**
  **Authors:** Shigemasa Takai
  **Abstract:** We consider a failure diagnosis problem for discrete event systems in the presence of sensor failures. In most existing works on failure diagnosis subject to sensor failures, intermittent sensor failures and permanent ones are dealt with separately. The case where any event in a subset of the observable event set possibly becomes unobservable intermittently or permanently can be modeled in the existing framework for intermittent sensor failures. However, for example, the case where at most $n'$ events in a set of $n(> n')$ observable events become unobservable cannot be dealt with. The purpose of this paper is to develop a general framework where the diagnosis problem can be addressed in the presence of both intermittent and permanent sensor failures. We introduce a new notion of diagnosability subject to sensor failures and present a procedure of online diagnosis in the general framework. Then, we present how to verify the diagnosability property. For a diagnosable system subject to sensor failures, we compute the delay bound within which the occurrence of any failure string can be detected.
- **Supervisor synthesis of POMDP via automata learning**
  **Authors:** Bo Wu ; Xiaobin Zhang ; Hai Lin
  **Abstract:** Partially observable Markov decision process (POMDP) is a comprehensive modeling framework that captures uncertainties from sensing noises, actuation errors, and environments. Traditional POMDP planning finds an optimal policy for reward maximization. However, for safety-critical applications, it is often necessary to guarantee system performance described by high-level temporal logic specifications. Hence, we are motivated to develop a supervisor synthesis framework for POMDP with respect to given formal specifications. We propose an iterative learning-based algorithm, which can learn a permissive policy in the form of a deterministic finite automaton. A humanrobot collaboration case study validates the proposed algorithm.
- **Risk-awareness in multi-level building evacuation with smoke: Burj Khalifa case study**
  **Authors:** Julian Barreiro-Gomez ; Salah Eddine Choutri ; Hamidou Tembine
  **Abstract:** We study a risk-aware multi-level evacuation control problem considering smoke propagation. We propose a continuous-time Markov-chain-based modeling for both population motion and smoke propagation while considering spatial/physical constraints such as walls and/or obstacles. Besides, we formally present some properties of the evacuation model. To do so, we design, in a semi explicit way, a mean-field-risk-aware control that reduces the evacuation time while avoiding the crowd and smoke. Finally, we present numerical examples for evacuation of single-level and multi-level buildings. The multi-level building is Burj Khalifa, the tallest building in the world with 164 floors.
- **Max-plus approximation for reinforcement learning**
  **Authors:** Vinicius Mariano Goncalves

**Abstract:** Max-Plus Algebra has been applied in several contexts, especially in the control of discrete events systems. In this article, we discuss another application closely related to control: the use of Max-Plus algebra concepts in the context of reinforcement learning. Max-Plus Algebra and reinforcement learning are strongly linked due to the latters dependence on the Bellman Equation which, in some cases, is a linear Max-Plus equation. This fact motivates the application of Max-Plus algebra to approximate the value function, central to the Bellman Equation and thus also to reinforcement learning. This article proposes conditions so that this approach can be done in a simple way and following the philosophy of reinforcement learning: explore the environment, receive the rewards and use this information to improve the knowledge of the value function. The proposed conditions are related to two matrices and impose on them a relationship that is analogous to the concept of weak inverses in traditional algebra.

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### 1.3. Control Engineering Practice

Volume: 112, July 2021

- **Planning on Discrete Event Systems using parallelism maximization**
  **Authors:** Lucas V.R. Alves ; Patrícia N. Pena ; Ricardo H.C. Takahashi
  **Abstract:** This work deals with the production planning problem in Discrete Event Systems, using the Supervisory Control Theory to establish the search space and developing two heuristics based on the maximization of the parallelism to find sequences that minimize makespan. The role of the Supervisory Control Theory is to provide the set of all safe production sequences, given by the closed-loop behavior. The two heuristics are based on the idea that controllable events should be executed as soon as they are allowed (maximizing parallelism) but only temporally feasible candidates are evaluated. The proposed methodology delivers solutions that are robust to uncertainties in the model parameters that represent time intervals required for plant operations. Although heuristic procedures are not guaranteed to reach exact optimal solutions in general, we present a case study where it happens for all batch sizes. The efficiency in terms of computation time is also illustrated by the case study.
- **Model properties for efficient synthesis of nonblocking modular supervisors**
  **Authors:** Martijn Goorden ; Joanna van de Mortel-Fronczak ; Michel Reniers ; Martin Fabian ; Wan Fokkink ; Jacobus Rooda
  **Abstract:** Supervisory control theory provides means to synthesize supervisors for systems with discrete-event behavior from models of the uncontrolled plant and of the control requirements. The applicability of supervisory control theory often fails due to a lack of scalability of the algorithms. This paper proposes a format for the requirements and a method to ensure that the crucial properties of controllability and nonblockingness directly hold, thus avoiding the most computationally expensive parts of synthesis. The method consists of creating a control problem dependency graph and verifying whether it is acyclic. Vertices of the graph are modular plant components, and edges are derived from the requirements. In case of a cyclic graph, potential blocking issues can be localized, so that the original control problem can be reduced to only synthesizing supervisors for smaller partial control problems. The strength of the method is illustrated on two case studies: a production line and a roadway tunnel.

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### 1.4. International Journal of Control

Volume: 94, Issue: 7, July 2021

- **Robust supervisory control of discrete event systems against intermittent loss of observations**
  **Authors:** Marcos V. S. Alves ; Antonio E. C. da Cunha ; Lilian Kawakami Carvalho ; Marcos Vicente Moreira ; João Carlos Basilio
  **Abstract:** We address in this paper the design of robust supervisors that are able to cope with intermittent loss of observations and also make the controlled system achieve the specification lan-

guage under nominal operation. In order to do so, we introduce a definition of robust observability that leverages possible observations of the events that are subject to intermittent loss of observations and address language permissiveness by extending the recently introduced definition of relative observability to robust relative observability. We present necessary and sufficient conditions for the existence of robust supervisors that make the controlled system achieve robustly controllable and observable or relatively observable languages and present a characterisation of all achievable languages. A running example illustrates all the results presented in the paper, and an example taken from the open literature is used to illustrate the efficiency of the robust design strategy proposed in the paper.

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### 1.5. IEEE Transactions on Automation Science and Engineering

Volume: 18, Issue: 3, July 2021

- **Detectability of Discrete-Event Systems Under Nondeterministic Observations**
  **Authors:** Lei Zhou ; Shaolong Shu ; Feng Lin
  **Abstract:** In practical systems, due to reasons such as sensor limitations, sensor faults, and packet losses in networks, the observation of events becomes nondeterministic. In this article, we extend strong detectability and weak detectability to the case of nondeterministic observations and denote them as A-$(k_1, k_2)$-detectability and O-$(k_1, k_2)$-detectability, respectively. A-$(k_1, k_2)$-detectability says that, for any string, we can distinguish state pairs in the specification for all possible observations of the string. O-$(k_1, k_2)$-detectability says that, for at least one string, we can distinguish state pairs in the specification for all possible observations of the string. For A-$(k_1, k_2)$-detectability, we construct a transformed automaton and then translate the A-$(k_1, k_2)$-detectability problem into the traditional detectability problem that has been solved. We show that A-$(k_1, k_2)$-detectability can be used to solve the deterministic supervisory control problem. For O-$(k_1, k_2)$-detectability, we construct an augmented automaton that includes all the information of the given automaton and its state estimates. Based on the augmented automaton, we propose a depth-first search (DFS)-based algorithm to check O-$(k_1, k_2)$-detectability.
  **Note to Practitioners:** Nowadays, practical engineering systems become more and more complex. In these systems, the observation of events often becomes nondeterministic due to reasons such as sensor limitations, sensor faults, and packet losses in networks. Consider a mobile robot as an example. The availability of a sensor output may depend on the current location of the mobile robot. If the mobile robot is in an area where the wireless network is unreliable, the sensor output may not be received by the supervisor. In this article, we investigate the state estimation problem for practical engineering systems under nondeterministic observations within a discrete-event system framework. The results in this article provide not only insights for engineers in the automatic control field to understand nondeterministic observations in practical systems but also the methodology to estimate the current discrete state that is always an important issue. Therefore, we believe that the engineers in the automatic control field should be interested in this article and can benefit from it.

- **RCTL: New Temporal Logic for Improved Formal Verification of Reconfigurable Discrete-Event Systems**
  **Authors:** Mohamed Ramdani ; Laid Kahloul ; Mohamed Khalgui ; Zhiwu Li ; MengChu Zhou
  **Abstract:** This article deals with improved formal verification of reconfigurable discrete-event systems (DESs) modeled by reconfigurable timed net condition event systems (R-TNCESs). An R-TNCES consists of a set of timed net condition event systems, each of which represents a particular behavior of a DES, and a reconfiguration scenario is a switching mode from a timed net condition event system to another. However, the verification with the classical computation tree logic (CTL) as well as the related extensions increases the number of properties for complete verification of a complex R-TNCES. We propose reconfigurable CTL as a new extension of CTL to reduce such a number. New connectors of reconfigurable CTL are proposed, with their formal syntax and semantics, and a set of new algorithms is proposed to control the complexity of model checking. We use a benchmark production system for the performance evaluation of the proposed approach. Reduction

in the number of properties to be checked is shown, and consequently, the related validation time is reduced.

**Note to Practitioners:** This research represents a new orientation for guiding efficiently the model checking of reconfigurable discrete-event systems. A classification of properties described in computation tree logic (CTL), according to their dominance and equivalence relations, allows one to conduct an efficient verification by avoiding inefficient calculation due to redundant properties. In this case, giving a verification order for these properties allows one to shorten their verification time. An extension named reconfigurable CTL describes the new syntax of the proposed classification. This approach can be applied in modeling and verification of advanced reconfigurable systems arising from smart grids, adaptive sensor networks, intelligent transportation, reconfigurable manufacturing, and embedded systems.

- **Reachability Tree-Based Optimization Algorithm for Cyclic Scheduling of Timed Petri Nets**

  **Authors:** Chulhan Kim ; Tae-Sun Yu ; Tae-Eog Lee

  **Abstract:** Timed Petri nets (TPNs) have been widely used for modeling discrete-event systems of diverse manufacturing and service industries. In this article, we introduce a reachability tree-based optimization algorithm to optimize cyclic schedules of TPNs. In particular, we focus on a special class of cyclic schedules that are referred to as one-cyclic schedules, i.e., the algorithm efficiently finds the optimal one-cyclic transition firing schedule of a TPN. The proposed scheduling method can be robustly applied and extended to a number of different scheduling models since the methodology is not bounded to a specific domain. To enhance the computational performance, we establish a set of transition ordering constraints that can reduce the tree size during the search procedure. We evaluate the computational efficiency of the suggested algorithm by examining robotized manufacturing systems where one-cyclic schedules are popularly being used. It is numerically shown that the proposed algorithm is computationally more efficient than the previously studied Petri net-based optimization methods.

  **Note to Practitioners:** Resource scheduling is one of the most important managerial issues in diverse industrial systems. An optimal scheduling method for a certain industrial system is often locally developed by utilizing domain-specific operational properties. Although such domain-dependent knowledge can contribute to enhancing the computational efficiency of an optimization method, such an approach has a weak point that the method might not be applicable to scheduling problems of different industrial fields. Our motivation is to develop an algorithm for optimizing steady-state schedules that can be robustly applied for various types of discrete-event systems. The algorithm is developed on the basis of the Petri net modeling framework as it is widely being used for describing cyclic behaviors of diverse manufacturing systems, service systems, and social systems. It is experimentally shown that the proposed algorithm is computationally efficient compared with the existing cyclic scheduling methods.

- **Privacy-Preserving Behavioral Correctness Verification of Cross-Organizational Workflow With Task Synchronization Patterns**

  **Authors:** Cong Liu ; Qingtian Zeng ; Long Cheng ; Hua Duan ; Mengchu Zhou ; Jiujun Cheng

  **Abstract:** Workflow management technology has become a key means to improve enterprise productivity. More and more workflow systems are crossing organizational boundaries and may involve multiple interacting organizations. This article focuses on a type of loosely coupled workflow architecture with collaborative tasks, i.e., each business partner owns its private business process and is able to operate independently, and all involved organizations need to be synchronized at a certain point to complete certain public tasks. Because of each organizations privacy consideration, they are unwilling to share the business details with others. In this way, traditional correctness verification approaches via reachability analysis are not practical as a global business process model is unavailable for privacy preservation. To ensure its globally correct execution, this work establishes a correctness verification approach for the cross-organizational workflow with task synchronization patterns. Its core idea is to use local correctness of each suborganizational workflow process to guarantee its global correctness. We prove that the proposed approach can be used to investigate the behavioral property preservation when synthesizing suborganizational workflows via collabora-

tive tasks. A medical diagnosis running case is used to illustrate the applicability of the proposed approaches.

**Note to Practitioners:** Cross-organizational workflow verification techniques play an increasingly important role in ensuring the correct execution of collaborative enterprise businesses. This work addresses the issue of correctness verification for loosely coupled interactive workflows with collaborative tasks. To ensure the globally correct execution, a behavioral correctness verification approach is established. All proposed concepts and techniques are supported by open-source tools, and evaluation over a medical diagnosis process case has shown their applicability. The proposed methodology is readily applicable to industrial-size workflow correctness verification problems.

- **Online Partial Conditional Plan Synthesis for POMDPs With Safe-Reachability Objectives: Methods and Experiments**

**Authors:** Yue Wang ; Abdullah Al Redwan Newaz ; Juan David Hernández ; Swarat Chaudhuri ; Lydia E. Kavraki

**Abstract:** The framework of partially observable Markov decision processes (POMDPs) offers a standard approach to model uncertainty in many robot tasks. Traditionally, POMDPs are formulated with optimality objectives. In this article, we study a different formulation of POMDPs with Boolean objectives . For robotic domains that require a correctness guarantee of accomplishing tasks, Boolean objectives are natural formulations. We investigate the problem of POMDPs with a common Boolean objective: safe reachability , requiring that the robot eventually reaches a goal state with a probability above a threshold while keeping the probability of visiting unsafe states below a different threshold. Our approach builds upon the previous work that represents POMDPs with Boolean objectives using symbolic constraints. We employ a satisfiability modulo theories (SMTs) solver to efficiently search for solutions, i.e., policies or conditional plans that specify the action to take contingent on every possible event. A full policy or conditional plan is generally expensive to compute. To improve computational efficiency, we introduce the notion of partial conditional plans that cover sampled events to approximate a full conditional plan. Our approach constructs a partial conditional plan parameterized by a replanning probability . We prove that the failure rate of the constructed partial conditional plan is bounded by the replanning probability. Our approach allows users to specify an appropriate bound on the replanning probability to balance efficiency and correctness. Moreover, we update this bound properly to quickly detect whether the current partial conditional plan meets the bound and avoid unnecessary computation. In addition, to further improve the efficiency, we cache partial conditional plans for sampled belief states and reuse these cached plans if possible. We validate our approach in several robotic domains. The results show that our approach outperforms a previous policy synthesis approach for POMDPs with safe-reachability objectives in these domains.

**Note to Practitioners:** This article was motivated by two observations. On the one hand, in robotics applications where uncertainty in sensing and actions is present, the solution to the classical partially observable Markov decision process (POMDP) formulation is expensive to compute in general. On the other hand, in certain practical scenarios, formulations other than the classical POMDP make a lot of sense and can provide flexibility in balancing efficiency and correctness. This article considers a modified POMDP formulation that includes a Boolean objective, namely safe reachability. This article uses the notion of a partial conditional plan. Rather than explicitly enumerating all possible observations to construct a full conditional plan, this work samples a subset of all observations to ensure bounded replanning probability. Our theoretical and empirical results show that the failure rate of the constructed partial conditional plan is bounded by the replanning probability. Moreover, these partial conditional plans can be cached to further improve the performance. Our results suggest that for domains where replanning is easy, increasing the replanning probability bound usually leads to better scalability, and for domains where replanning is difficult or impossible in some states, we can decrease the bound and allocate more computation time to achieve a higher success rate. Hence, in certain cases, the practitioner can take advantage of their knowledge of the problem domain to scale to larger problems. Preliminary physical experiments suggest that this approach is applicable to real-world robotic domains, but it requires a discrete representation of the workspace. How to deal with continuous workspace directly is an interesting future direction.

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

Volume: 51, Issue: 7, July 2021

- **Decision on Maximal Permissiveness of Linear Constraints via Structural Analysis of a Subclass of Petri Nets**

  **Authors:** HeFeng Chen ; NaiQi Wu ; ZhiWu Li ; Ting Qu

  **Abstract:** A maximally permissive (or optimal) supervisory control of an automated manufacturing system (AMS) modeled by Petri nets (PNs) can be usually implemented by imposing constraints in the form of a set of linear inequalities. To find such a set of linear constraints, in the existing work, an integer linear programming (ILP) problem is generally formulated and solved for some dominant markings obtained by reachability analysis and vector covering theory, which is computationally inefficient due to the combinatorial nature of solving ILPs to decide the coefficients of optimal linear constraints. This paper addresses the deadlock prevention problem for AMSs by developing efficient methods to reduce the computational overhead through the establishment of conditions on deciding the maximal permissiveness of linear constraints imposed on a system. By taking the advantage of structural properties of a PN model under consideration, we identify the most part of minimal covered illegal markings that can be optimally controlled via policies obtained by specific linear inequality constraints. Also, algorithms are developed to implement the proposed policies. The proposed approach can verify the optimality of a linear constraint efficiently without solving ILP problems. A linear programming method is developed to deal with the markings that cannot be processed by the proposed structural analysis. It is shown that for the considered class of PNs, called system of simple sequential processes with resources (S3PR), no mixed ILP problem needs to solve and the computational burden is dramatically reduced. Two examples are employed to demonstrate the efficiency of the developed method.

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## 2 Conferences

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

2.1 **2021 Chinese Control Conference**
Shanghai, China, July 26-28, 2021
https://conf2021.shu.edu.cn/index.htm

2.2 **2021 IEEE Conference on Control Technology and Applications**
San Diego, August 8-11, 2021
https://ccta2021.ieeecss.org/

2.3 **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

2.4 **2021 IEEE International Conference on Systems, Man, and Cybernetics**
South Wharf, Victoria, Australia, October 17-20, 2021
http://ieeesmc2021.org/

2.5 **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 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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