IEEE CONTROL SYSTEMS SOCIETY
TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... March 2019

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1. Editorial

Welcome to the 2019 February issue of the newsletter,
also available electronically at
http://discrete-event-systems.ieeecss.org/tc-discrete/newsletters

You are welcome to submit new items to the newsletter (topics including schools, workshops, sessions, conferences, journals, books, software, positions).
To submit a new item, please email to kai.cai@eng.osaka-cu.ac.jp.

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2. Positions

2.1. Postdocs: Nanyang Technological University, Singapore

Contributed by: Rong Su (rsu@ntu.edu.sg)

Two postdoc positions are available on DES-base modelling and performance optimisation for on-demand manufacturing, which aim for template-based modelling that facilitates a drag-and-play design, and real-time synthesis for behavioural correctness and performance optimality. All developed results are required to be demonstrated in a real flexible manufacturing system. Any candidate who has substantial knowledge on discrete event modelling, supervisory control and/or DES-based performance optimisation (in particular, on temporal metrics such as makespan) is welcome to apply.

The salary is competitive including a base salary and an annual performance bonus, plus a free group medical insurance and other benefits. The tax rate in Singapore is very low, and a postdoc salary is almost tax-free. The first contract will be 1 year, but can be renewed up to 2.5 years.

If you need more details about the position please do not hesitate to contact Dr. Rong Su (rsu@ntu.edu.sg).

2.2. Postdoc: Czech Academy of Sciences, Czech Republic

Contributed by: Jan Komenda (komenda@ipm.cz, komenda@math.cas.cz)

A postdoc position is available in Institute of Mathematics, Czech Academy of Sciences (Brno, Czech Republic) on Control of Concurrent Timed Discrete-Event Systems.

Position Description: A three year postdoc position is available for a candidate with background in discrete-event systems or similar area, and interest in modeling, analysis, and control of timed discrete-event systems. The successful candidate must hold a Ph.D. in a relevant area of engineering, computer science or applied mathematics, and will join a cooperation project (2019-2021)
between Czech Academy of Sciences and German Universities TU Berlin and FAU Erlangen that aims at developing novel and scalable methods for supervisory control of concurrent timed discrete-event systems.

Applications including a detailed CV should be emailed to Dr. Jan Komenda (komenda@ipm.cz or komenda@math.cas.cz). If you need more details about the position please do not hesitate to contact Dr. Jan Komenda (komenda@ipm.cz, komenda@math.cas.cz).

2.3 Postdoc: Queen's University, Canada

Contributed by: Karen Rudie (karen.rudie@queensu.ca)

Postdoctoral Fellowship Competition: Dr. Karen Rudie is seeking a candidate whose application can be put forth for a postdoctoral research opportunity. This is a competition at Queen's University and the successful candidate would receive funding for one year but with the expectation that they would aid in grant writing that would ideally lead to further funding for subsequent years.

Job Description: postdoctoral research in discrete-event systems with an emphasis on opacity and cyber-resilience problems.

Required skills:
· strong problem-solving skills
· a background in Control of Discrete-Event Systems (or something close enough that you could easily hit the ground running)
· good people skills and good communication skills
· an eagerness to write up our work into publications
· leadership skills and able to train more junior researchers (i.e., graduate students or undergraduate summer researchers).

3. Selections of Journal Publications

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

3.1. SELECTIONS OF THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL
VOLUME: 64, ISSUE: 3, March 2019

(1) Automatic Generation of Optimal Reductions of Distributions

Authors: Liyong Lin ; Tomas Masopust ; W. Murray Wonham ; Rong Su

Abstract: A reduction of a source distribution is a collection of smaller sized distributions that are collectively equivalent to the source distribution with respect to the property of decomposability. That is, an arbitrary language is decomposable with respect to the source distribution if and only if it is decomposable with respect to each smaller sized distribution (in the reduction). The notion of reduction of distributions has previously been proposed to improve the complexity of decomposability verification. In this paper, we address the problem of generating (optimal) reductions of distributions automatically. A (partial) solution to this problem is provided, which consists of an incremental algorithm for the production of candidate reductions and a reduction validation procedure. In the incremental production stage, backtracking is applied whenever a candidate reduction that cannot be validated is produced. A strengthened substitution-based proof technique is used for reduction validation, while a fixed template of candidate counter examples is used for reduction refutation; put together, they constitute our (partial) solution to the reduction verification problem. In addition, we show that a recursive approach for the generation of (small) reductions is easily supported.

Full-text available at: https://ieeexplore.ieee.org/document/8340848/

(2) Controlled Markov Processes With Safety State Constraints

Authors: Mahmoud El Chamie ; Yue Yu ; Behcet Acikmese ; Masahiro Ono

Abstract: This paper considers a Markov decision process (MDP) model with safety state constraints, which specify polytopic invariance constraints on the state probability distribution (pd) for all time epochs. Typically, in the MDP framework, safety is addressed indirectly by penalizing failure states through the reward function. However, such an approach does not allow imposing hard constraints on the state pd , which could be an issue for practical applications where the chance of failure must be limited to prescribed bounds. In this paper, we explicitly separate state constraints from the reward function. We provide analysis and synthesis methods to impose generalized safety constraints at all time epochs, unlike current constrained MDP approaches where such constraints can only be imposed on the stationary distributions. We show that, contrary to the unconstrained MDP policies, optimal safe MDP policies depend on the initial state pd. We present novel algorithms for both finite- and infinite-horizon MDPs to synthesize feasible decision-making policies that satisfy safety constraints for all time epochs and ensure that the performance is above a computable lower bound. Linear programming implementations of the proposed algorithms are developed, which are formulated by using the duality theory of convex optimization. A swarm control simulation example is also provided to demonstrate the use of proposed algorithms.

Full-text available at: https://ieeexplore.ieee.org/document/8391697

(3) Design of Symbolic Controllers for Networked Control Systems

Authors: Alessandro Borri ; Giordano Pola ; Maria Domenica Di Benedetto

Abstract: Networked control systems (NCSs) are distributed systems where plants, sensors, actuators, and controllers communicate over shared networks. Nonideal behaviors of the communication network include variable sampling/transmission intervals and communication delays, packet losses, communication constraints, and quantization errors. NCSs have been the object of intensive study in the last few years. However, due to the inherent complexity of NCSs, the current literature focuses on a subset of these nonidealities and mostly considers stability and stabilizability problems. Recent technology advances need different and more complex control objectives to be considered. In this paper, we present first a general model of NCS, including most relevant nonidealities of the communication network; then, we propose a symbolic model approach to the control design with objectives expressed in terms of nondeterministic transition systems. The presented results are based on recent advances in symbolic control design of continuous and hybrid systems. An example in the context of robot motion planning with remote control is included, showing the effectiveness of the proposed approach.

Full-text available at: https://ieeexplore.ieee.org/document/8355500/

(4) Event-triggered Control With Self-triggered Sampling for Discrete-time Uncertain Systems

Author: Masako Kishida

Abstract: This paper proposes a resource-aware control approach for discrete-time linear uncertain systems. The approach uses a self-trigger condition to determine the sampling time to guarantee that the system is uniformly ultimately bounded and an event-trigger condition to determine control updates. The self-trigger condition is constructed using the skewed structured singular value to treat uncertainties in the prediction, and the event-trigger condition is constructed by considering the costs of sampling and control updates. A numerical example is provided to illustrate the approach.

Full-text available at: https://ieeexplore.ieee.org/document/8375736

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3.2. SELECTIONS OF AUTOMATICA

VOLUME: 101, March 2019

(1) Complexity of detectability, opacity and A-diagnosability for modular discrete event systems

Authors: Tomas Masopust ; Xiang Yin

Abstract: Modular discrete event systems are modeled as a parallel composition of finite automata. While deciding weak detectability, opacity, and A-diagnosability for monolithic systems is PSPACE-complete, the complexity for modular systems is unknown. We show that for modular systems the problems are EXPSPACE-complete, and hence there is neither a polynomial-time nor a polynomial-space algorithm solving them. While the upper bound is a natural modification of the PSPACE algorithms for monolithic systems, the lower bound requires a novel and nontrivial construction. We further discuss a case where the complexity drops to PSPACE-complete.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818306253

(2) Codiagnosability of discrete event systems revisited: A new necessary and sufficient condition and its applications

Authors: Gustavo S.Viana ; Joao C.Basilio

Abstract: It has been argued for some time now, based on classroom, textbook and practical examples that the size of verifiers and diagnosers is comparable. This belief has been corroborated by a recent paper, where it is conjectured, based on a rigorous statistical analysis, that the size of the states of diagnosers is , on the average, where (resp. n) is the number of events (resp. states) of the plant automaton. However, there is another difficulty that hampers the use of diagnosers in diagnosability verification: the search for cycle, which has been proved to be factorial. We present, in this paper, a necessary and sufficient condition for a language codiagnosability of DES and, based on this condition, we propose a new test for its verification that is based on a diagnoser-like automaton that has following advantages: (i) the diagnosability verification test is based on the search for strongly connected components, which is linear in the state size; (ii) it has both observable and unobservable events of the plant in its event set, and so the usual assumptions on language liveness and nonexistence of unobservable cycles of states connected with unobservable events only are no longer required, and; (iii) T-codiagnosability can be computed by adding weights associated with transitions of the plant automaton, and, as a consequence K-codiagnosability, since it is a particular case of T-codiagnosability when all weights are set equal to 1.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818306198

(3) Robust control for signal temporal logic specifications using discrete average space robustness

Authors: Lars Lindemann ; Dimos V.Dimarogonas

Abstract: Control systems that satisfy temporal logic specifications have become increasingly popular due to their applicability to robotic systems. Existing control methods, however, are computationally demanding, especially when the problem size becomes too large. In this paper, a robust and computationally efficient model predictive control framework for signal temporal logic specifications is proposed. We introduce discrete average space robustness, a novel quantitative semantic for signal temporal logic, that is directly incorporated into the cost function of the model predictive controller. The optimization problem entailed in this framework can be written as a convex quadratic program when no disjunctions are considered and results in a robust satisfaction of the specification. Furthermore, we define the predicate robustness degree as a new robustness notion. Simulations of a multi-agent system subject to complex specifications demonstrate the efficacy of the proposed method.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818306289

(4) Event-triggered and self-triggered control for linear systems based on reachable sets

Authors: Florian David Brunner ; W.P.M.H.Heemels ; Frank Allgower

Abstract: We propose novel aperiodic control schemes for additively perturbed discrete-time linear systems based on the evaluation of set-membership conditions related to disturbance reachable sets. The goal is to reduce the rate of communication between the sensor and the actuator, while guaranteeing that a certain set in the state space is asymptotically stabilized. In particular, we prescribe this set to be the minimal robust positively invariant set under a given feedback law updated at every time, multiplied by a factor that acts as a tuning parameter. This way, we achieve a trade-off between the communication rate and the worst-case asymptotic bound on the system state in the closed-loop system. We employ a novel stability concept that captures how much the system dynamics are explicitly dependent on past system states. This allows us to quantitatively compare the stability properties guaranteed by an all-time updated (static) feedback controller with those guaranteed by a (dynamic) aperiodic controller. We use the proposed framework to design both event-triggered and self-triggered controllers under the assumption of state feedback or output feedback.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818305697

(5) Towards demand side management control using household specific Markovian models

Authors: Ebby Thomas ; Rahul Sharma ; Yoni Nazarathy

Abstract: We devise a real-time control mechanism to aid electricity network operators facilitate effective residential Demand Side Management. Contrary to existing algorithms where individual customer behavior patterns are required or estimated, we propose a novel load management scheme for highly stochastic loads where each household possesses individually suited parameters. If the actual demand in a feeder is found to exceed its rating, selected customers are requested by the operator to lower their loads. The benefit of the proposed approach is to maximize the certainty of meeting Demand Response targets whilst minimizing the overall cost associated with the Demand Response control actions. Our contribution is a model that takes customer behavior patterns into consideration while selecting customers. We model load behavior of individual households using Markov chains and by treating the problem as a Markov Decision Process optimal control problem, we deduce an easily implementable strategy for load reduction. This strategy is then incorporated in an aggregate model that utilizes household specific transition probabilities. The practical application is explained based on real data. Our numerical results illustrate the virtue of the strategy, showing potential for the use of household specific Markovian models for Demand Side Management applications.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818306290

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3.3. IEEE Control Systems Letters
VOLUME: 3, ISSUE: 1, January 2019

(1) Control Barrier Functions for Signal Temporal Logic Tasks

Authors: Lars Lindemann ; Dimos V. Dimarogonas

Abstract: The need for computationally-efficient control methods of dynamical systems under temporal logic tasks has recently

become more apparent. Existing methods are computationally demanding and hence often not applicable in practice. Especially with respect to multi-robot systems, these methods do not scale computationally. In this letter, we propose a framework that is based on control barrier functions and signal temporal logic. In particular, timevarying control barrier functions are considered where the temporal properties are used to satisfy signal temporal logic tasks. The resulting controller is given by a switching strategy between a computationally-efficient convex quadratic program and a local feedback control law.

Full-text available at: https://ieeexplore.ieee.org/document/8404080

(2) Output Feedback Control via Bisimulation of Stochastic Linear Systems

Authors: Giordano Pola ; Costanzo Manes ; Maria Domenica Di Benedetto

Abstract: The characterization of the behavior that can be achieved by a plant when interconnected with a controller is a topic widely investigated in mathematical systems theory. In this regard, many results have been obtained for several classes of continuous systems, and also for discrete-event and hybrid systems. However, current literature is rather scant in stochastic settings. In this letter we aim to start filling this gap and provide some necessary and some sufficient checkable conditions for enforcing desired stochastic behavior, in terms of stochastic bisimulation equivalence, on discrete-time stochastic linear systems through output feedback interconnection with deterministic linear controller systems.

Full-text available at: https://ieeexplore.ieee.org/document/8398482

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3.4. Systems & Control Letters
VOLUME: 125, March 2019

(1) Mean-semivariance optimality for continuous-time Markov decision processes

Author: Qingda Wei

Abstract: In this paper we study the mean-semivariance problem for continuous-time Markov decision processes with Borel state and action spaces and unbounded cost and transition rates. The optimality criterion is to minimize the semivariance of the discounted total cost over the set of all policies satisfying the constraint that the mean of the discounted total cost is equal to a given function. Under reasonable conditions, we show that the semivariance optimal value function is a solution to the optimality equation of the mean-semivariance criterion by an iteration approach. Moreover, we obtain the existence of mean-semivariance optimal policies from the optimality equation. Furthermore, we give a value iteration algorithm to compute approximately an optimal policy and the optimal value, and analyze the convergence of the algorithm.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0167691119300180

4. Conferences

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

4.1 2019 European Control Conference
Naples, Italy, Jun 25 - Jun 28, 2019
https://ecc19.eu/

4.2 27th Mediterranean Conference on Control and Automation
Akko, Israel, Jul 1 - Jul 4, 2019
https://med19.net.technion.ac.il/

4.3 2019 American Control Conference
Philadelphia, Pennsylvania, United States, Jul 10 - Jul 12, 2019
http://acc2019.a2c2.org/

4.4 38th Chinese Control Conference (CCC 2019)
Guangzhou, China, Jul 27 - Jul 30, 2019
http://www.ccc2019.cn/en/index.html

4.5 2019 Conference on Control Technology and Applications
Hong Kong, China, Aug 19 - Aug 21, 2019
http://ccta2019.ieeecss.org/

4.6 15th International Conference on Automation Science and Engineering
Vancouver, British Columbia, Canada, Aug 22 - Aug 26, 2019
http://case2019.hust.edu.cn/index.htm

4.7 2019 Conference on Decision and Control
Nice, France, December 11-13, 2019
https://cdc2019.ieeecss.org/