IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... December 2017

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Contents:

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Editorial

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Welcome to the newsletter of the IEEE Control Systems Technical Committee on Discrete Event Systems! Happy Holidays!

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Activities

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2.1 Sponsored Activities
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2018 American Control Conference
Milwaukee, Wisconsin, United States, June 27–29, 2018
http://acc2018.a2c2.org/

2018 Conference on Control Technology and Applications
Copenhagen, Denmark, August 21-24, 2018
http://ccta2018.ieeecss.org/

2.2 TC meeting summary
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Contributed by: Kai Cai (kai.cai@eng.osaka-cu.ac.jp)

We held a TC meeting on Dec 13 during CDC 2017 in Melbourne.

Participants (15):
Stephane Laortune (University of Michigan)
Romub Meiva Goo (University of Michigan)
Yuling Ji (University of Michigan)
Joao Basilio (Federal University Rio De Janeiro)
Lilian K. Carvacho (Federal University Rio De Janeiro)
Majid Zamani (TU Munich)
Rong Su (NTU)
Rene Boel (Ghent University)
Christos Cassandras (Boston University)
Yorai Wardi (Georgia Tech)
Mariagraza Dotou (Politecnico Di Bari)
Chris Hadjicostis (University of Cyprus)
Ziyue Ma (Xidian University)
Alessandro Giua (University of Carliari)

Kai Cai (Osaka City University)

Topics discussed:

1. Promotion of DES applications by organizing invited sessions at incoming major conferences. Try to target "hot" applications
with emphasis on event-driven type of dynamics.

2. Promotion of any DES topics through organizing invited sessions, tutorial sessions, workshops at major conferences, including IEEE and
IFAC and also CS and CPS field. Make announcements through other TC's mailing lists, e.g. hybrid systems, formal methods, computer systems.

3. Promote DES field by considering a special issue on IEEE CSS Magazine.

4. Promote DES field by considering summer schools for students.

5. Need more collaboration with hybrid systems TC. In IFAC TC, hybrid systems and DES are together.

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Selections of Journal Publications

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Contributed by: Xiang Yin (xiangyin@umich.edu)

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SELECTIONS OF THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL
VOLUME: 62 ISSUE: 12
December 2017

(1) Stochastic Feedback Control With One-Dimensional Degenerate Diffusions and Nonsmooth Value Functions

Author: Xi-Ren Cao

Abstract

We study the stochastic control problems with degenerate semimartingales and nonsmooth value functions. We first derive the optimality conditions for finite horizon problems with nonsmooth value functions and singular control of infinite horizon discounted problems. Then, we show that the local time at the

degenerate point is zero, so if the value function has nonsmooth first-order derivatives at the degenerate points of all policies, the nonsmoothness can be ignored and the optimality equation for stochastic control, including optimal stopping, is simply the classical Hamilton–Jacobi–Bellman equation at the smooth points. Furthermore, we model the singular control by the reflecting force in the Skorokhod problem and show that there are two classes of degenerate points; in the first class, singular control at a degenerate point can be treated in the same way as regular control; and in the second class, the density of the singular control force may be of the order (dt1+γ, 0<γ<1, with γ=0 for nondegenerate points. We apply the direct-comparison-based approach to derive all the results. In all the analysis, viscosity solution is not needed.

Full-text available at: http://ieeexplore.ieee.org/document/7919255/

(2) Dimension Reduction and Feedback Stabilization for Max-Plus Linear Systems and Applications in VLSI Array Processors

Author: Cailu Wang ; Yuegang Tao ; Peng Yang ; Zuojun Liu

Abstract

This paper investigates the dimension reduction and feedback stabilization of max-plus linear systems and applies them to control and optimize the very large scale integration (VLSI) array processors. We introduce the weakly similar relation between max-plus matrices and the pseudoequivalent relation between autonomous max-plus linear systems, and point out that two systems are pseudoequivalent if and only if their state matrices are weakly similar. The reduced system is defined by using the pseudoequivalence, whose dimension is determined by the row rank of the original state matrix. We focus on obtaining a reduced system which maintains the stability and retains the steady-state period. An algorithm of polynomial complexity is developed to find such a reduced system. The reduced system is then used to design a state feedback controller to stabilize a max-plus linear system. Finally, we use the VLSI array processors as an example to demonstrate how the presented methods work in practical applications.

Full-text available at: http://ieeexplore.ieee.org/document/7934335/

(3) Thompson Sampling for Stochastic Control: The Finite Parameter Case

Author: Michael Jong Kim

Abstract

In this paper, we apply Thompson sampling to a class of average reward stochastic control problems with parameter uncertainty. Specifically, we study an average reward stochastic control problem over an infinite horizon in which both the reward and state transition distributions are parameterized by an unknown parameter taking values in a finite space. The main result of this paper is a proof showing that Thompson

sampling achieves a worst case average per period regret of O(T-1), which is asymptotically optimal.

Full-text available at: http://ieeexplore.ieee.org/document/7819546/

(4) Pinning Control for the Disturbance Decoupling Problem of Boolean Networks

Author: Yang Liu ; Bowen Li ; Jianquan Lu ; Jinde Cao

Abstract

This paper investigates the pinning control for the disturbance decoupling problem (DDP) of Boolean networks (BNs) with disturbances. First, the solvability of DDP in BCNs is defined. Then, rank-conditions-based pinning control is proposed. Moreover, rank-conditions-based pinning state feedback controllers are designed for the DDP of BNs and the range of controllers' number is obtained. In addition, rank-conditions-based pinning output feedback controllers for the DDP of BNs are also discussed. An example is given to show the effectiveness of the obtained results.

Full-text available at: http://ieeexplore.ieee.org/document/7949136/

(5) Dynamic Event-Based Control of Nonlinear Stochastic Systems

Author: Yingchun Wang ; Wei Xing Zheng ; Huaguang Zhang

Abstract

In this paper, the event-based control problems for nonlinear stochastic systems are investigated. First, a novel condition for stochastic input-to-state stability is established. Then, the dynamic event-triggered control approach is proposed and the stochastic stability of the resulting closed-loop system is also proved. Next, a new dynamic self-triggering mechanism is developed and the additional internal dynamic variable is designed according to the predicted value of the system state and error, which ensures that the closed-loop system is stochastically stable. It is shown that the lower bounds of interexecution times by the proposed dynamic event-triggered and self-triggered control approaches are all larger than zero, and the so-called Zeno phenomenon is avoided. Compared with the static event-triggering and self-triggering results, the interexecution times by the proposed dynamic approaches are prolonged on the whole. Two simulation examples are provided to show the efficiency of the proposed

approaches.

Full-text available at: http://ieeexplore.ieee.org/document/7932972/

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SELECTIONS OF AUTOMATICA
VOLUME: 86
December 2017

(1) Design of decentralized critical observers for networks of finite state machines: A formal method approach

Author: Giordano Pola, ElenaDe Santis, Maria Domenica Di Benedetto, Davide,Pezzuti

Abstract

Motivated by safety-critical applications in cyber–physical systems, in this paper we study the notion of critical observability and design of observers for networks of Finite State Machines (FSMs). Critical observability corresponds to the possibility of detecting if the current state of an FSM is in a given region of interest, called set of critical states. A critical observer detects on-line the occurrence of critical states. When a large-scale network of FSMs is considered, the construction of such an observer is prohibitive because of the large computational effort needed. We propose a decentralized architecture for critical observers of networks of FSMs, where on-line detection of critical states is performed by local critical observers, each associated with an FSM of the network, which do not need to interact. For the efficient design of decentralized critical observers we first extend on-the-fly algorithms traditionally used in the community of formal methods for the verification and control design of FSMs. We then extend to networks of FSMs, bisimulation theory traditionally given in the community of formal methods for single FSMs. The proposed techniques provide a remarkable computational complexity reduction, as discussed throughout the paper and also demonstrated by means of illustrative examples

Full-text available at: http://www.sciencedirect.com/science/article/pii/S0005109817304557

(2) Verification of detectability in Probabilistic Finite Automata

Author: Christoforos Kerogloua, Christoforos N.Hadjicostisb

Abstract

In this paper we analyze state estimation in stochastic discrete event systems (SDES) that can be modeled as probabilistic finite automata (PFAs). For a given PFA, we obtain the necessary and sufficient conditions that guarantee exact state estimation, at least asymptotically, with increasing certainty as more information is acquired from observing the behavior of the given PFA, by defining the notion of AA-detectability, and providing necessary and sufficient conditions that can be used to verify it. The characterization and analysis of AA-detectability is transformed to a problem of classification between two (or more) PFAs, which capture the recurrent behavior of an underlying Markov process that is obtained by ignoring output behavior and focusing on state transitions in the given PFA. Our approach combines techniques used in

classification between two (or more) PFAs with state estimation methods used in logical discrete event systems (DES). We prove that the proposed verification of AA-detectability is of polynomial complexity with respect to the size of the state space of the given PFA.

Full-text available at: http://www.sciencedirect.com/science/article/pii/S0005109817304570

(3) Stochastic stability of Markov jump hyperbolic systems with application to traffic flow contro

Author: Liguo Zhangab, Christophe Prieurc

Abstract

In this paper, we investigate the stochastic stability of linear hyperbolic conservation laws governed by a finite-state Markov chain. Both system matrices and boundary conditions are subject to the Markov switching. The existence and uniqueness of weak solutions are developed for the stochastic hyperbolic initial–boundary value problem. By means of Lyapunov techniques some sufficient conditions are obtained by seeking the balance between the boundary condition and the transition probability of the Markov process. Particularly, boundary feedback control of a stochastic traffic flow model is developed for the freeway transportation system by integrating the on-ramp metering with the speed limit control.

Full-text available at: http://www.sciencedirect.com/science/article/pii/S0005109817304284
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SELECTIONS OF DISCRETE EVENT DYNAMIC SYSTEMS: THEORY AND APPLICATIONS
VOLUME: 27 ISSUE: 4
December 2017

(1) Computation of controllable and coobservable sublanguages in decentralized supervisory control via communication

Author: Jan Komenda, Tomas Masopust

Abstract

In decentralized supervisory control, several local supervisors cooperate to accomplish a common goal (specification). Controllability and coobservability are the key conditions to achieve a specification in the controlled system. We construct a controllable and coobservable sublanguage of the specification by using additional communications between supervisors. Namely, we extend observable events of local supervisors via communication and apply a fully decentralized computation of local supervisors. Coobservability is then guaranteed by construction. Sufficient conditions to achieve the centralized optimal

solution are discussed. Our approach can be used for both prefix-closed and non-prefix-closed specifications.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0249-6

(2) Cellular adaptive Petri net based on learning automata and its application to the vertex coloring problem

Author: S. Mehdi Vahidipour, Mohammad Reza Meybodi, Mehdi Esnaashari

Abstract

In a Petri net, a decision point is raised when two or more transitions are simultaneously enabled in a given marking. The decision to be made at such a point is the selection of an enabled transition for firing. Decision making in Petri nets is accomplished by a so called controlling mechanism. Whenever a Petri net is used to represent an algorithm, the application of a different controlling mechanism results in a different instance of that algorithm. Recently, an adaptive controlling mechanism has been introduced for Petri nets in which several learning automata are used as decision makers during the evolution of the Petri nets. A Petri net with this adaptive controlling mechanism is referred to as APN-LA. Using APN-LA, one may be able to design adaptive algorithms to solve problems. There are problems for which designing a single APN-LA is tedious and results in a large and complex model. One class of such problems is the cellular problem, in which an identical algorithm must be executed in each cell and the solution to the problem is generated from the cooperation of these identical algorithms. To avoid having large and complex APN-LAs for cellular problems, a cellular adaptive Petri net called CAPN-LA is proposed in this paper, which consists of a cellular structure and a number of identical APN-LAs. In CAPN-LA, each APN-LA represents the algorithm which must be executed in each cell, and the required cooperation between the neighboring cells is handled by means of cooperation between the APN-LAs in those cells. The notation of expediency for this model is defined, and, using the steady-state analysis of the behavior of the CAPN-LA model, conditions under which this model is expedient are stated. A measure of expediency is defined for comparing different CAPN-LAs according to their expected reward; a CAPN-LA which receives a higher expected reward is regarded as more expedient. The proposed CAPN-LA is then used to design different algorithms for the classic problem of vertex coloring. The measure of expediency is calculated for these algorithms and results of using them for coloring vertices of different graphs are also included.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0251-z

(3) Predictability of fuzzy discrete event systems

Author: Bilal Benmessahel, Mohamed Touahria, Farid Nouioua

Abstract

This paper studies the problem of predictability in fuzzy discrete event systems (FDESs). FDESs combine fuzzy set theory with discrete events systems (DESs). They are proposed in Lin and Ying (2001) to cope

with vagueness, impreciseness, and subjectivity in real-world problems. In this work: (1) We propose a fuzzy approach for predictability by introducing fuzzy predictability functions to characterize the predictability degree of a prefix, a faulty trace as well as a faulty event in a fuzzy DES. These functions take values in the interval [0, 1]. The degree of predictability gives a valuable measure to refine the decision about fault predictability. (2) We show that the degree of predictability of a faulty event is always at most equal to its degree of diagnosability. This captures the idea that predictability is stronger than diagnosability. (3) For checking predictability in FDESs, we propose an approach based on the so-called verifier. This approach results in a polynomial (in the number of states) complexity test for the verification of predictability. Our results generalize those of predictability for crisp DESs and allow one to deal with the problem of predictability for both crisp DESs and FDESs.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0256-7

(4) The risk probability criterion for discounted continuous-time Markov decision processes

Author: Haifeng Huo, Xiaolong Zou, Xianping Guo

Abstract

In this paper, we consider the risk probability minimization problem for infinite discounted continuous-time Markov decision processes (CTMDPs) with unbounded transition rates. First, we introduce a class of policies depending on histories with the additional reward levels. Then, we construct the corresponding probability spaces, and also establish the non-explosion of the state process. Secondly, under suitable conditions we prove that the value function is a solution to the optimality equation for the probability criterion by an iteration technique, and obtain a value iteration algorithm to compute (at least approximate) the value function. Furthermore, under an additional condition we establish the uniqueness of the solution to the optimality equation and the existence of an optimal policy. Finally, we illustrate our results with two examples. The first one is used to verify our conditions for CTMDPs with unbounded transition rates, the second one for the numerical calculation of the value function and an optimal policy.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0257-6

(5) Empirical studies in the size of diagnosers and verifiers for diagnosability analysis

Author: Leonardo Bermeo Clavijo, Joao C. Basilio

Abstract

Diagnosability is an intrinsic property of the language generated by discrete event systems (DES) and the computational procedure to determine whether a language possesses or not this property is called diagnosability verification. For regular languages, diagnosability verification is carried out by building either diagnoser or verifier automata; the former is known to have worst-case exponential complexity whereas the latter has polynomial complexity in the size of state space of the automaton that generates the language. A question that has been asked for some time now is whether, in average, the state size of diagnosers is no

longer exponential. This claim has been supported by the size of diagnoser automata usually obtained in practical and classroom examples, having, in some cases, state space size much smaller than that of verifiers. In an effort to clarify this matter, in this paper we carry out an experimental study on the average state size of diagnosers and verifiers by means of two experiments: (i) an exhaustive experiment, in which ten sets of automata with moderate cardinality were generated and for these sets of automata, diagnosers and verifiers were built, being the exact average state size for these specific instances calculated; (ii)an experiment with sampling, which considers 1660 sets of different instance sizes and, for each one, sample sets of 10,000 automata are randomly generated with uniform distribution and we compute sets of diagnosers and verifiers for each set of randomly generated automata, which have been used to estimate an asymptotic model for the average state sizes of diagnosers and verifiers.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0260-y

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SELECTIONS OF IEEE Transactions on Systems, Man, and Cybernetics: Systems
VOLUME: 47 ISSUE: 12
December 2017

(1) FBMTP: An Automated Fault and Behavioral Anomaly Detection and Isolation Tool for PLC-Controlled Manufacturing Systems

Author: Arup Ghosh ; Shiming Qin ; Jooyeoun Lee ; Gi-Nam Wang

Abstract

The fault and behavioral anomaly detection and isolation (FBADI) in programmable logic controller (PLC) controlled systems has been under an active study for several decades. In this paper, we present a tool, called the fault and behavior monitoring tool for PLC (FBMTP) that can solve the FBADI problem in PLC-controlled manufacturing systems effectively. FBMTP first creates a nominal deterministic finite-state automaton-based model of the PLC control process, and then utilizes that model to detect and isolate the faults and the behavioral anomalies. The key idea is to check whether the observed behavior is consistent with the modeled behavior or not. The control signal data stored in the PLC memory is used for this whole procedure. With growing size of the manufacturing systems, it becomes difficult to obtain all the control signal data accurately because of the limited data acquisition time in each PLC scan cycle. The proposed control process modeling and the FBADI methodology of FBMTP can cope with such data inaccuracy problems associated with large manufacturing systems efficiently. Our experiments show that FBMTP provides highly accurate FBADI results for both small and large manufacturing systems.

Full-text available at: http://ieeexplore.ieee.org/document/7786853/

(2) Determining Truth Degrees of Input Places in Fuzzy Petri Nets

Author: Hu-Chen Liu ; Jian-Xin You ; Guangdong Tian

Abstract

Fuzzy Petri net (FPN), as one type of high-level Petri nets, has attracted a lot of attention over the recent decade due to its adequacy for knowledge representation and logic reasoning. However, in the FPN literature, the truth degrees of input places are usually given directly or supposed by researchers. No or little research has been performed on the determination of initial marking vector for a specific FPN. In this correspondence paper, we introduce a group decisionmaking model using hesitant 2-tuple linguistic term sets to obtain the initial truth values of FPNs based on domain experts' knowledge and gathered data. As is illustrated by the numerical example, the proposed framework can well capture domain experts' diversity judgements and derive initial truth degrees for an FPN under different types of uncertainties.

Full-text available at: http://ieeexplore.ieee.org/document/7484290/

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SELECTIONS OF International Journal of Control
VOLUME: 90 ISSUE: 12
December 2017

(1) Reconfigurability of behavioural specifications for manufacturing systems

Author: Klaus Werner Schmidt

Abstract

Reconfigurable manufacturing systems (RMS) support flexibility in the product variety and the configuration of the manufacturing system itself in order to enable quick adjustments to new products and production requirements. As a consequence, an essential feature of RMS is their ability to rapidly modify the control strategy during run-time. In this paper, the particular problem of changing the specified operation of a RMS, whose logical behaviour is modelled as a finite state automaton, is addressed. The notion of reconfigurability of specifications (RoS) is introduced and it is shown that the stated reconfiguration problem can be formulated as a controlled language convergence problem. In addition, algorithms for the verification of RoS and the construction of a reconfiguration supervisor are proposed. The supervisor is realised in a modular way which facilitates the extension by new configurations. Finally, it is shown that a supremal nonblocking and controllable strict subautomaton of the plant automaton that fulfils RoS exists in case RoS is violated for the plant automaton itself and an algorithm for the computation of this strict subautomaton is presented. The developed concepts and results are illustrated by a manufacturing cell example.

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