IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... March 2018

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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!

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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/

2018 Conference on Decision and Control
Miami Beach, FL, USA, December 17-19, 2018
https://cdc2018.ieeecss.org/

2.2 Technically Co-Sponsored activities

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2018 SICE International Symposium on Control Systems
Tokyo, Japan, March 9-11, 2018
http://iscs2018.sice-ctrl.jp/

The 14th Workshop on Discrete Event Systems
Sorrento Coast, Italy, May 30 - June 1, 2018
http://wodes2018.unisa.it/

30th Chinese Control and Decision Conference (2018 CCDC)
Shenyang, China, June 9-11, 2018
http://www.ccdc.neu.edu.cn/

2018 International Conference on Unmanned Aircraft Systems
Dallas, TX, USA, June 12-15, 2018
http://www.uasconferences.com/

37th Chinese Control Conference (CCC2018)
Wuhan, China, July 25-27, 2018
http://ccc2018.cug.edu.cn/

23rd International Conference on Methods and Models in Automation and Robotics
Międzyzdroje, Poland, August 27-30, 2018
http://mmar.edu.pl/

22nd International Conference on System Theory, Control and Computing
Sinaia, Romania, October 10-12, 2018
http://www.icstcc.ugal.ro/2018/

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Selections of Journal Publications

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

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SELECTIONS OF THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL
VOLUME: 63 ISSUE: 3
March 2018

(1) Safety Verification and Control for Collision Avoidance at Road Intersections

Author: Heejin Ahn ; Domitilla Del Vecchio

Abstract

This paper presents a supervisory algorithm that prevents side collisions among vehicles at an intersection by taking control of vehicles when necessary. Based on the vehicles' current state and drivers' desired inputs, the supervisor verifies whether there exists an input signal with which vehicles can cross the intersection without collision. Instead of directly searching for the existence of such an input signal, we solve an equivalent jobshop scheduling problem, which leads to a more tractable solution. The jobshop scheduling problem determines the existence of a schedule, i.e., times at which vehicles can enter conflict areas within an intersection, such that vehicles do not meet in any conflict area. This problem is approximately solved via two mixed integer linear programming problems formulated for simplified vehicle dynamics. The solutions to these problems provide over- and underapproximations of the solution to the jobshop scheduling problem with quantified approximation bounds. We theoretically demonstrate that this supervisor keeps the intersection safe and is nonblocking. Computer simulations further validate that the

algorithm can run in real time for problems of realistic size.

Full-text available at: http://ieeexplore.ieee.org/document/7987071/

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SELECTIONS OF AUTOMATICA
VOLUME: 89
March 2018

(1) Stability structures of conjunctive Boolean networks

Author: Zuguang Gao, Xudong Chen, Tamer Başar

Abstract

A Boolean network is a finite dynamical system, whose variables take values from a binary set. The value update rule for each variable is a Boolean function, depending on a selected subset of variables. Boolean networks have been widely used in modeling gene regulatory networks. We focus in this paper on a special class of Boolean networks, termed as conjunctive Boolean networks. A Boolean network is conjunctive if the associated value update rule is comprised of only AND operations. It is known that any trajectory of a finite dynamical system will enter a periodic orbit. We characterize in this paper all periodic orbits of a conjunctive Boolean network whose underlying graph is strongly connected. In particular, we establish a bijection between the set of periodic orbits and the set of binary necklaces of a certain length. We further investigate the stability of a periodic orbit. Specifically, we perturb a state in the periodic orbit by changing the value of a single entry of the state. The trajectory, with the perturbed state being the initial condition, will enter another (possibly the same) periodic orbit in finite time steps. We then provide a complete characterization of all such transitions from one periodic orbit to another. In particular, we construct a digraph, with the vertices being the periodic orbits, and the (directed) edges representing the transitions among the orbits. We call such a digraph the stability structure of the conjunctive Boolean network.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109817305587

(2) A peak-over-threshold search method for global optimization

Author: Siyang Gao, Leyuan Shi, Zhengjun Zhang

Abstract

In this paper, we propose a random search method, called peak-over-threshold search (POTS), for solving global optimization problems. An important feature of POTS is that it combines the existing partition-based

random search framework (e.g., Shi and Ólafsson 2000a; Chen et al. 2011) with the peak-over-threshold statistical reference (Coles, 2001) in order to achieve high search efficiency. In each iteration, POTS partitions the solution space into several subregions, evaluates the quality of each subregion and moves to promising subregions for more partitioning and sampling. To effectively assess the quality of a subregion, an extreme value type of inference in statistics is used to develop a new promising index which reflects the optimal objective value of a subregion and biases the search to regions that are likely to contain the optimal or near-optimal solutions. Under assumptions on the depth of partitioning and the probability of correct movement, POTS is shown to converge with probability one to the optimal region. The higher efficiency of the proposed method is illustrated by numerical examples. The application of POTS to beam angle selection, an important optimization problem in radiation treatment, is also presented in this paper.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109817305794

(3) State-feedback control of Markov jump linear systems with hidden-Markov mode observation

Author: Masaki Ogura, Ahmet Cetinkaya, Tomohisa Hayakawa, Victor M.Preciado

Abstract

In this paper, we study state-feedback control of Markov jump linear systems with partial information about the mode signal responsible for switching between dynamic modes. We assume that the controller can only access random samples of the mode signal according to a hidden-Markov observation process. Our formulation provides a novel framework to analyze and design feedback control laws for various Markov jump linear systems previously studied in the literature, such as the cases of (i) clustered observations, (ii) detector-based observations, and (iii) periodic observations. We present a procedure to transform the closed-loop system with hidden-Markov observations into a standard Markov jump linear system while preserving stability, norm, and norm. Furthermore, based on this transformation, we propose a set of Linear Matrix Inequalities (LMI) to design feedback control laws for stabilization, suboptimal control, and suboptimal control of discrete-time Markov jump linear systems under hidden-Markov observations of the mode signals. We conclude by illustrating our results with some numerical examples.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109817305630

(4) Priority-free conditionally-preemptive scheduling of modular sporadic real-time systems

Author: Xi Wang, Zhiwu Li, W.M. Wonham

Abstract

For a real-time system (RTS) processing both sporadic and (multiple-period) periodic tasks, this study presents a novel modular modeling framework to describe the parameters of tasks, conforming to the pertinent concepts and techniques of discrete-event systems (DES). A task is represented by an automaton

synchronized by the modular models corresponding to its parameters. As a consequence, a DES model depicting the RTS is synchronized by the DES representing these tasks. Based on supervisory control theory, priority-free conditionally-preemptive (PFCP) real-time scheduling is solved by finding all the safe execution sequences. Finally, the PFCP scheduling is illustrated by real-world examples.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109817305873

(5) Stochastic thresholds in event-triggered control: A consistent policy for quadratic control

Author: Florian David Brunner, Duarte Antunes, Frank Allgöwer

Abstract

We propose an event-triggered control scheme for discrete-time linear systems subject to Gaussian white noise disturbances. The event-conditions are given in terms of the deviation between the actual system state and the state of a nominal undisturbed system whose state is identical to the real system state at the event times. In order to ensure that the conditional distribution of the deviation between the two systems, under the condition that no event occurs, remains a normal distribution, we employ thresholds that are themselves random variables. This allows us to: (i) provide expressions for the probability mass function of the times between events and, in turn, arbitrarily select this function; (ii) synthesize controllers associated with the proposed transmissions scheduler that are optimal in terms of an average quadratic cost. In particular, these two properties allow us to show that our event-triggered scheme is consistent in the sense that it outperforms (in a quadratic cost sense) traditional periodic control for the same average transmission rate and does not generate transmissions in the absence of disturbances. We demonstrate the effectiveness of our scheme in a numerical example and describe a way to solve the non-convex optimization problem arising in the approach.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109817306301

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SELECTIONS OF DISCRETE EVENT DYNAMIC SYSTEMS: THEORY AND APPLICATIONS
VOLUME: 28 ISSUE: 1
March 2018

(1) Ranking nodes in general networks: a Markov multi-chain approach

Author: Joost Berkhout, Bernd F. Heidergott

Abstract

The basis of Google's acclaimed PageRank is an artificial mixing of the Markov chain representing the connectivity structure of the network under study with a maximally connected network where every node is connected to every other node. The rate with which the original network is mixed with the strongly connected one is called damping factor. The choice of the damping factor can influence the ranking of the nodes. As we show in this paper, the ranks of transient nodes, i.e., nodes not belonging to a strongly connected component without outgoing links in the original network, tend to zero as the damping factor increases. In this paper we develop a new methodology for obtaining a meaningful ranking of nodes without having to resort to mixing the network with an artificial one. Our new ranking relies on an adjusted definition of the ergodic projector of the Markov chain representing the original network. We will show how the new ergodic projector leads to a more structural way of ranking (transient) nodes. Numerical examples are provided to illustrate the impact of this new ranking approach.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0248-7

(2) Solving a class of simulation-based optimization problems using "optimality in probability"

Author: Jianfeng Mao, Christos G. Cassandras

Abstract

We consider a class of simulation-based optimization problems using optimality in probability, an approach which yields what is termed a "champion solution". Compared to the traditional optimality in expectation, this approach favors the solution whose actual performance is more likely better than that of any other solution; this is an alternative complementary approach to the traditional optimality sense, especially when facing a dynamic and nonstationary environment. Moreover, using optimality in probability is computationally promising for a class of simulation-based optimization problems, since it can reduce computational complexity by orders of magnitude compared to general simulation-based optimization methods using optimality in expectation. Accordingly, we have developed an "Omega Median Algorithm" in order to effectively obtain the champion solution and to fully utilize the efficiency of well-developed off-line algorithms to further facilitate timely decision making. An inventory control problem with nonstationary demand is included to illustrate and interpret the use of the Omega Median Algorithm, whose performance is tested using simulations.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0261-x

(3) Variance minimization of parameterized Markov decision processes

Author: Xia Li

Abstract

In this paper, we study the variance minimization problem of Markov decision processes (MDPs) in which the policy is parameterized by action selection probabilities or other general parameters. Different from the average or discounted criterion mostly used in the traditional MDP theory, the variance criterion is difficult to handle because of the non-Markovian property caused by the nonlinear (quadratic) structure of variance function. With the basic idea of sensitivity-based optimization, we derive a difference formula of the reward variance under any two parametric policies. A variance derivative formula is also obtained. With these sensitivity formulas, we obtain a necessary condition of the optimal policy with the minimal variance. We also prove that the optimal policy with the minimal variance can be found in the deterministic policy space. An iterative algorithm is further developed to efficiently reduce the reward variance and this algorithm can converge to the local optimal policy. Finally, we conduct some numerical experiments to demonstrate the main results of this paper.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0258-5

(4) Opacity for linear constraint Markov chains

Author: Béatrice Bérard, Olga Kouchnarenko, John Mullins, Mathieu Sassolas

Abstract

On a partially observed system, a secret φ is opaque if an observer cannot ascertain that its trace belongs to φ. We consider specifications given as Constraint Markov Chains (CMC), which are underspecified Markov chains where probabilities on edges are required to belong to some set. The nondeterminism is resolved by a scheduler, and opacity on this model is defined as a worst case measure over all implementations obtained by scheduling. This measures the information obtained by a passive observer when the system is controlled by the smartest scheduler in coalition with the observer. When restricting to the subclass of Linear CMC, we compute (or approximate) this measure and prove that refinement of a specification can only improve opacity.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0259-4

(5) Applications of generalized likelihood ratio method to distribution sensitivities and steady-state simulation

Author: Lei Lei, Yijie Peng, Michael C. Fu, Jian-Qiang Hu

Abstract

We provide applications of the generalized likelihood ratio (GLR) method proposed in Peng et al. (2016c) to distribution sensitivity estimation for both finite-horizon and steady-state simulation. Applications on sensitivity of distortion risk measure, gradient-based maximum likelihood estimation, and quantile sensitivity in both finite-horizon and steady-state settings are put together under a single umbrella, and

addressed uniformly by the proposed estimator. Empirical comparison of the performance of different methods is presented.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0247-8

(6) Instruction-throughput regulation in computer processors with data-center applications

Author: Xinwei Chen, Yorai Wardi, Sudhakar Yalamanchili

Abstract

This paper tests a recently-proposed technique for regulating output performance of Discrete Event Dynamic Systems and Stochastic Hybrid Systems. The controller is based on an integrator with a variable gain, adjusted so as to guarantee wide stability margins of the closed-loop system. The gain is adjusted by estimating, in real time, the derivative of the plant function via approximations to its IPA derivative. The technique is robust to computational errors in the loop, and hence these approximations are designed for fast computation rather than precision. The development of the regulation technique has been motivated by applications in computer processors, and extensively tested in the past on a cycle-level, full system simulator. In this paper we describe implementations of the regulator on an Intel machine based on the Haswell processor, and apply it to control the instructions' throughput of various industry program-benchmarks as well as data-center applications.

Full-text available at: https://link.springer.com/article/10.1007/s10626-017-0254-9

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SELECTIONS OF SYSTEMS & CONTROL LETTERS
VOLUME: 113
March 2018

(1) Q-learning for Markov decision processes with a satisfiability criterion

Author: Suhail M. Shah, Vivek S. Borkar

Abstract

A reinforcement learning algorithm is proposed in order to solve a multi-criterion Markov decision process, i.e., an MDP with a vector running cost. Specifically, it combines a Q-learning scheme for a weighted linear combination of the prescribed running costs with an incremental version of replicator dynamics that updates the weights. The objective is that the time averaged vector cost meets prescribed asymptotic bounds. Under mild assumptions, it is shown that the scheme achieves the desired objective.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0167691118300045

(2) Constrained minimum variance control for discrete-time stochastic linear systems

Author: E. Bakolas

Abstract

We propose a computational scheme for the solution of the so-called minimum variance control problem for discrete-time stochastic linear systems subject to an explicit constraint on the 2-norm of the input (random) sequence. In our approach, we utilize a state space framework in which the minimum variance control problem is interpreted as a finite-horizon stochastic optimal control problem with incomplete state information. We show that if the set of admissible control policies for the stochastic optimal control problem consists exclusively of sequences of causal (non-anticipative) control laws that can be expressed as linear combinations of all the past and present outputs of the system together with its past inputs, then the stochastic optimal control problem can be reduced to a deterministic, finite-dimensional optimization problem. Subsequently, we show that the latter optimization problem can be associated with an equivalent convex program and in particular, a quadratically constrained quadratic program (QCQP), by means of a bilinear transformation. Finally, we present numerical simulations that illustrate the key ideas of this work.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0167691118300227

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SELECTIONS OF THE IEEE TRANSACTIONS ON SYSTEMS, MAN AND CYBERNETICS: SYSTEMS
VOLUME: 48 ISSUE: 3
March 2018

(1) Petri Net Modeling and Scheduling of a Close-Down Process for Time-Constrained Single-Arm Cluster Tools

Author: QingHua Zhu ; MengChu Zhou ; Yan Qiao ; NaiQi Wu

Abstract

In wafer fabrication, a robotic cluster tool is required to be closed down in order for engineers to perform its on-demand and preventive maintenance and switch between different wafer lots. They often deal with a close-down process subject to wafer residency time constraints, i.e., a wafer must exit from a processing chamber before its quality degradation within a certain time limit. To obtain higher yield, it is very important to optimize a close-down process for a cluster tool. Yet the existing literature pays no or little attention to

this issue. By focusing on a time-constrained single-arm cluster tool, this paper intends: 1) to build its Petri net model to analyze its schedulability and 2) to develop computationally efficient algorithms to find an optimal and feasible schedule for its closing-down process under different workloads at its steps. Industrial examples are used to illustrate the application of the proposed method.

Full-text available at: http://ieeexplore.ieee.org/document/7572224/

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