IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... August 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: 8
August 2018

(1) Ranking and Selection as Stochastic Control

Author: Yijie Peng ; Edwin K. P. Chong ; Chun-Hung Chen ; Michael C. Fu

Abstract

Under a Bayesian framework, we formulate the fully sequential sampling and selection decision in statistical ranking and selection as a stochastic control problem, and derive the associated Bellman equation. Using a value function approximation, we derive an approximately optimal allocation policy. We show that this policy is not only computationally efficient but also possesses both one-step-ahead and asymptotic optimality for independent normal sampling distributions. Moreover, the proposed allocation policy is easily generalizable in the approximate dynamic programming paradigm.

Full-text available at: https://ieeexplore.ieee.org/document/8267207/

(2) Performance Optimization for Timed Weighted Marked Graphs Under Infinite Server Semantics

Author: Zhou He ; Zhiwu Li ; Alessandro Giua

Abstract

This paper deals with the performance optimization of resource allocation systems with the aim of maximizing the system's throughput under a given budget for acquiring resources. Resources are assumed to be renewable, i.e., they are not consumed by the operations and become available again after they have been released. The systems under consideration are modeled by a subclass of timed Petri nets called deterministic timed weighted marked graphs. In addition, we take into account infinite server semantics, i.e., the degree of self-concurrency of each transition is infinite. We propose an approach that provides an optimal solution, but has a high computational cost. For this reason, we also present two different approaches that can find suboptimal solutions with a reduced computational cost. The performances of the proposed approaches are compared by means of numerical simulations.

Full-text available at: https://ieeexplore.ieee.org/document/8081749/

(3) Near-Optimal Scheduling for Petri Net Models With Forbidden Markings

Author: Dimitri Lefebvre

Abstract

This paper is about control design for discrete event systems modeled with Petri nets. It addresses the problems of reachability and of firing sequence design. The untimed and timed cases are successively studied by searching control sequences from an initial marking to a reference one with length or duration that approach the minimal value, avoiding forbidden states and nonpromising branches. The proposed algorithms are applicable to a large class of discrete event systems in particular in the domain of flexible manufacturing, engineering. To accelerate the computation and make robust the control strategy, only a small area of the reachability graph is worked out and an approach inspired from model predictive control is used. The approach is suitable for deadlock-free scheduling and fault-tolerant control problems.

Full-text available at: https://ieeexplore.ieee.org/document/8089434/

(4) Deadline Scheduling as Restless Bandits

Author: CZhe Yu ; Yunjian Xu ; Lang Tong

Abstract

The problem of stochastic deadline scheduling is considered. A constrained Markov decision process model is introduced in which jobs arrive randomly at a service center with stochastic job sizes, rewards, and completion deadlines. The service provider faces random processing costs, convex noncompletion penalties, and a capacity constraint that limits the simultaneous processing of jobs. Formulated as a restless multiarmed bandit problem, the stochastic deadline scheduling problem is shown to be indexable. A closed-form expression of the Whittle's index is obtained for the case when the processing costs are constant. An upper bound on the gap-to-optimality for the Whittle's index policy is obtained, and it is shown that the bound converges to zero as the job arrival rate and the number of available processors increase simultaneously to infinity.The problem of stochastic deadline scheduling is considered. A constrained Markov decision process model is introduced in which jobs arrive randomly at a service center with stochastic job sizes, rewards, and completion deadlines. The service provider faces random processing costs, convex noncompletion penalties, and a capacity constraint that limits the simultaneous processing of jobs. Formulated as a restless multiarmed bandit problem, the stochastic deadline scheduling problem is shown to be indexable. A closed-form expression of the Whittle's index is obtained for the case when the processing costs are constant. An upper bound on the gap-to-optimality for the Whittle's index policy is obtained, and it is shown that the bound converges to zero as the job arrival rate and the number of available processors increase simultaneously to infinity.

Full-text available at: https://ieeexplore.ieee.org/document/8295041/

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SELECTIONS OF AUTOMATICA
VOLUME: 93
July 2018

(1) Supervisor synthesis to thwart cyber attack with bounded sensor reading alterations

Author: Rong Su

Abstract

One of the major challenges about cyber–physical systems is how to protect system integrity from cyber attacks. There has been a large number of different types of attacks discussed in the literature. In this paper we aim to investigate one special type of attacks in the discrete-event system framework, where an attacker can arbitrarily alter sensor readings after

intercepting them from a target system, aiming to trick a given supervisor to issue improper control commands, which can drive the system to an undesirable state. We first consider the cyber attack problem from an attacker's point of view, and formulate an attack-with-bounded-sensor-reading-alterations (ABSRA) problem. We then show that the supremal (or least restrictive) ABSRA exists and can be computed, as long as the plant model and the supervisor model are regular, i.e., representable by finite-state automata. Upon the synthesis of the supremal ABSRA, we present a synthesis algorithm, which computes a supervisor that is ABSRA-robust in the sense that any ABSRA will either be detectable or inflict no damage to the system.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818301912

(2) Conditional reachability of uncertain Max Plus Linear systems

Author: Renato Markele Ferreir Cândido; Laurent Hardouin; Mehdi Lhommeau; Rafael Santos Mendes

Abstract

The reachability analysis problem of Max Plus Linear (MPL) systems has been properly solved using the Difference-Bound Matrices approach. In this work, the same approach is considered in order to solve the reachability analysis problem of MPL systems subjected to bounded noise, disturbances and/or modeling errors, called uncertain MPL (uMPL) systems. Moreover, using the results on the reachability analysis of uMPL systems, we solve the conditional reachability problem, herein defined as the support calculation of the probability density function involved in the stochastic filtering problem.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109817305721

(3) Optimization in curbing risk contagion among financial institutes

Author: Xiang-Shen Ye; Ruo-Bing Xue; Jianjun Gao; Xi-RenCao

Abstract

Financial institutions are interconnected by holding debt claims against each other. A default bank may cause its creditors to default, and the risk may be further propagated to up-stream institutes (risk contagion). Such interconnection is a key contributing factor to the past worldwide financial crisis. We show that a good mechanism of default liquidation may improve the total wealth of the financial system and therefore may curb the risk contagion. We formulate this problem as a nonlinear optimization problem with constraints and propose an optimal liquidation policy to minimize the system's loss. We show that the problem resembles a Markov

decision problem (MDP) and therefore we can apply the direct-comparison based optimization approach to solve this problem. Higher order directional derivatives and some optimality properties are obtained. Furthermore, we derive an iterative algorithm which combines both the policy iteration and the gradient based approach to find a local optimal policy, and under some conditions, a global optimal policy. Our work provides a new direction in curbing the risk contagion in financial networks; and it illustrates the advantages of the direct-comparison based approach, originated in the field of discrete event dynamic system, in nonlinear optimization problems.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818302218

(4) On-line verification of current-state opacity by Petri nets and integer linear programming

Author: Xuya Conga; Maria Pia Fant; Agostino Marcello Mangini; Zhiwu Li

Abstract

Opacity is a security and privacy property that evaluates whether an external observer (intruder) can infer a secret of a system by observing its behavior. This paper proposes an on-line approach to address the problem of current-state opacity in discrete event systems (DESs) modeled in a labeled Petri Net (PN) framework and by observing its evolution. An observation of the system is said to be current-state opaque if the intruder is unable to determine whether the current state of the system is within a set of secret states, otherwise it is said to be not current-state opaque. The proposed approach to verify the current-state opacity works on-line: the verification algorithm waits for the occurrence of an observable event and uses Integer Linear Programming problem solutions to verify if the behavior of the system is current-state opaque to the intruder under the given observation. Moreover, the proposed method is applied in two different settings: (i) a centralized approach where the intruder has full knowledge of the system model but can partially observe the system behavior; (ii) a decentralized approach where a set of intruders can observe different event sets and collaborate with a coordinator to disclose the same secret. Finally, experimental results are presented to demonstrate the efficiency of the proposed method.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109818302061

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SELECTIONS OF IEEE IEEE Transactions on Systems, Man, and Cybernetics: Systems
VOLUME: 48 ISSUE: 8
August 2018

(1) A Decision Support System for User-Based Vehicle Relocation in Car Sharing Systems

Author: Monica Clemente ; Maria Pia Fanti ; Giorgio Iacobellis ; Massimiliano Nolich ; Walter Ukovich

Abstract

Car sharing (CS) services are promising solutions complementary to the classic public transport forms. In order to make CS effectively competitive, suitable planning and management strategies are required. This paper presents a decision support system (DSS) for handling the user-based vehicle relocation problem by applying economic incentives ruled by a threshold policy. Unlike the existing approaches, a methodology is proposed for determining the optimal threshold, which considers explicitly the stochastic reactions of the customers to the incentives. To this aim, the CS system is described in detail by unified modeling language diagrams and is modeled in a discrete event system framework. Moreover, a closed-loop control strategy is introduced to implement the vehicle relocation policy on the basis of the system state and the best threshold values, evaluated by discrete event simulation and particle swarm optimization. A case study simulation analysis shows that the proposed DSS management strategy can significantly improve the system performance.

Full-text available at: https://ieeexplore.ieee.org/document/7967633/

(2) Structural Decomposition and Decentralized Control of Petri Nets

Author: Jianhong Ye ; MengChu Zhou ; Zhiwu Li ; Abdulrahman Al-Ahmari

Abstract

Control of a large-scale automated manufacturing system is an important and challenging issue. Its discrete event system model represented by Petri nets tends to become highly complicated in structure, especially when there exist uncontrollable or unobservable events. The existing approaches are nontrivial to design both efficient and maximally permissive supervisors to impose constraints on an overall system. In this paper, instead of considering the control problem from an overall system perspective, we intend to transform an overall control problem into the one designing multiple controllers in parallel, each of which is much simpler in structure. A Petri net structure is decomposed via integer linear programming or a polynomial decomposition method to obtain multiple state-machine subnets that constitute a decentralized system. A necessary and sufficient condition for preserving the equivalence in terms of states and behaviors between the overall system and its decentralized version is reported. Constraints representing control requirements are further converted and enforced in the respective subnets. Then, supervisors are generated via a generalized mutual exclusion constraint method. By considering the deviations between the subnet control and overall control, this paper formulates a communication mechanism to guarantee that the decentralized system runs in an appropriate

manner. Finally, two examples are presented to demonstrate the proposed approach.

Full-text available at: https://ieeexplore.ieee.org/document/7987767/

(3) A Novel Approach for Constraint Transformation in Petri Nets With Uncontrollable Transitions

Author: Shouguang Wang ; Dan You ; Carla Seatzu

Abstract

The main contribution of this correspondence paper consists in a linear algebraic characterization of the admissible marking set relative to a Petri net with uncontrollable transitions, subject to a linear constraint. In more detail, given a linear constraint that limits the number of tokens in one place, an algorithm is proposed to compute an approximation of the admissible marking set in terms of a disjunction of transformed linear constraints. The optimality of the solution is guaranteed provided that certain conditions are satisfied during the intermediate steps of the iterative approach. In all the other cases, the set of markings described by the transformed constraints could be surely contained in the admissible marking set.

Full-text available at: https://ieeexplore.ieee.org/document/7866000/

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