IEEE CONTROL SYSTEMS SOCIETY
TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... November 2019

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1. Editorial

Welcome to the 2019 November 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 use the following website:
https://www.control.eng.osaka-cu.ac.jp/miscellaneous/css-tc-des/submission
or email to kai.cai@eng.osaka-cu.ac.jp.

To subscribe, please email to kai.cai@eng.osaka-cu.ac.jp.
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2. Selections of Journal Publications

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

2.1. Selections from Discrete Event Dynamic Systems Theory and Applications

VOLUME: 29, ISSUE: 3, 2019

(1) Energy-efficient thermal-aware multiprocessor scheduling for real-time tasks using TCPN

Authors: L. Rubio-Anguiano ; G. Desirena-Lopez ; A. Ramirez-Trevino, J.L. Briz

Abstract: We present an energy-efficient thermal-aware real-time global scheduler for a set of hard real-time (HRT) tasks running on a multiprocessor system. This global scheduler fulfills the thermal and temporal constraints by handling two independent variables, the task allocation time and the selection of clock frequency. To achieve its goal, the proposed scheduler is split into two stages. An off-line stage, based on a deadline partitioning scheme, computes the cycles that the HRT tasks must run per deadline interval at the minimum clock frequency to save energy while honoring the temporal and thermal constraints, and computes the maximum frequency at which the system can run below the maximum temperature. Then, an on-line, event-driven stage performs global task allocation applying a Fixed-Priority Zero-Laxity policy, reducing the overhead of quantum-based or interval-based global schedulers. The on-line stage embodies an

adaptive scheduler that accepts or rejects soft RT aperiodic tasks throttling CPU frequency to the upper lowest available one to minimize power consumption while meeting time and thermal constraints. This approach leverages the best of two worlds: the off-line stage computes an ideal discrete HRT multiprocessor schedule, while the on-line stage manage soft real-time aperiodic tasks with minimum power consumption and maximum CPU utilization.

Full-text available at: https://link.springer.com/article/10.1007/s10626-019-00285-x

(2) A discrete-event and hybrid traffic simulation model based on SimEvents for intelligent transportation system analysis in Mcity

Authors: Yue Zhang ; Christos G. Cassandras ; Wei Li ; Pieter J. Mosterman

Abstract: An intelligent transportation systems (ITS) is a typical cyber-physical system (CPS) in which physical components, for example, Connected Automated Vehicles (CAVs), are monitored and controlled through a network of cyber and physical components. Such systems, therefore, contain event-driven dynamics along with time-driven dynamics. The proposed discrete-event and hybrid simulation framework based on SimEvents facilitates testing for safety and performance evaluation of an ITS and has been used to build a traffic simulation model of the Mcity test facility. It is specifically designed for testing CAVs and contains various road/lane configurations and a complete instrumentation system. This enables users to study traffic at the microscopic level, including the effectiveness of new control algorithms for CAVs under different traffic scenarios, the event-driven aspects of transportation systems, and the effects of communication delays. The framework spans multiple toolboxes including MATLAB, Simulink, and SimEvents.

Full-text available at: https://link.springer.com/article/10.1007/s10626-019-00286-w

(3) A controller synthesis framework for automated service composition

Authors: Francis Atampore ; Juergen Dingel ; Karen Rudie

Abstract: Nowadays, Web services allow interoperability among distributed software applications deployed on different platforms and architectures which in effect plays a major role in electronic businesses. Web services allow organizations to carry out certain business activities automatically and in a distributed fashion. However, in some circumstances, a single service is not able to perform a certain task and it becomes imperative to compose two or more services in order to complete it. Thus, a key research challenge in this field is the problem of automatic service composition. Several approaches exist that tackle the problem of

automatic service composition, however, the task of generating provably correct Web service compositions still remains a challenging and complex task. In this paper, we develop a formal framework for modeling Web service compositions based on Supervisory Control Theory (SCT) of discrete-event systems. We model services that exchange messages and exhibit nondeterministic behaviours. The objective is to synthesize a supervisor which interacts with a given set of Web services through messages to guarantee that a given specification is satisfied. A key novelty of this work is the application of control theory to service-oriented computing and the incorporation of run-time input into the supervisor generation process. First, we describe a novel supervisory control framework for automated composition of Web services. The framework employs Labelled Transition Systems equipped with guards and data variables to model Web services and provides a technique to synthesize a controller. We model the interactions of services asynchronously and we use the guards and data variables to allow us to express certain preconditions which are then propagated from the system requirements through the overall composite service. Second, we develop a set of algorithms to generate a controller satisfying a given functional requirement also specified as a Labelled Transition System equipped with guards and data variables. Besides the standard disabling and enabling of events, the generated controller in our framework has the ability to enforce certain events based on run-time information to drive the system towards its goal. In addition, the controller is able to impose restrictions on the kind of data that can be sent or received by services. This includes the automatic generation of stronger guards or preconditions which impose restrictions on which path to take during execution. Lastly, we state a theorem capturing the existence of a controller and provide a proof to demonstrate the correctness of the proposed approach.

Full-text available at: https://link.springer.com/article/10.1007/s10626-019-00282-0

(4) Flexible Nets: a modeling formalism for dynamic systems with uncertain parameters

Authors: Jorge Julvez ; Stephen G. Oliver

Abstract: The modeling of dynamic systems is frequently hampered by a limited knowledge of the system to be modeled and by the difficulty of acquiring accurate data. This often results in a number of uncertain system parameters that are hard to incorporate into a mathematical model. Thus, there is a need for modeling formalisms that can accommodate all available data, even if uncertain, in order to employ them and build useful models. This paper shows how the Flexible Nets (FNs) formalism can be exploited to handle uncertain parameters while offering attractive analysis possibilities. FNs are composed of two nets, an event net and an intensity net, that model the relation between the state and the processes of the system. While the event net captures how the state of the system is updated by the processes in the system, the

intensity net models how the speed of such processes is determined by the state of the system. Uncertain parameters are accounted for by sets of inequalities associated with both the event net and the intensity net. FNs are not only demonstrated to be a valuable formalism to cope with system uncertainties, but also to be capable of modeling different system features, such as resource allocation and control actions, in a facile manner.

Full-text available at: https://link.springer.com/article/10.1007/s10626-019-00287-9

(5) Throughput maximization of complex resource allocation systems through timed-continuous-Petri-net modeling

Authors: Michael Ibrahim ; Spyros Reveliotis

Abstract: Fluid-relaxation-based scheduling is a powerful scheduling method for complex resource allocation systems and other stochastic networks. However, this method has been pursued through rather ad hoc representations and arguments in the past. This paper establishes that timed-continuous Petri nets provide a structured and natural framework for the implementation of this method in the context of complex resource allocation, and highlights the potential advantages of such a more structured approach.

Full-text available at: https://link.springer.com/article/10.1007/s10626-019-00289-7

(6) Time-optimal control of large-scale systems of systems using compositional optimization

Authors: Fredrik Hagebrin ; Bengt Lennartson

Abstract: Optimization of industrial processes such as manufacturing cells can have great impact on their performance. Finding optimal solutions to these large-scale systems is, however, a complex problem. They typically include multiple subsystems, and the search space generally grows exponentially with each subsystem. In previous work we proposed Compositional Optimization as a method to solve these type of problems. This integrates optimization with techniques from compositional supervisory control, dividing the optimization into separate sub-problems. The main purpose is to mitigate the state explosion problem, but a bonus is that the individual sub-problems can be solved using parallel computation, making the method even more scalable. This paper further improves on compositional optimization with a novel synchronization method, called partial time-weighted synchronization (PTWS), that is specifically designed for time-optimal control of asynchronous systems. The benefit is its ability to combine the behaviour of asynchronous subsystems without introducing additional states or transitions. The method also reduces the search space further by integrating an optimization heuristic that removes many non-optimal or redundant solutions

already during synchronization. Results in this paper show that compositional optimization efficiently generates global optimal solutions to large-scale realistic optimization problems, too big to solve when based on traditional monolithic models. It is also shown that the introduction of PTWS drastically decreases the total search space of the optimization compared to previous work.

Full-text available at: https://link.springer.com/article/10.1007/s10626-019-00290-0
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2.2. Selections of the IEEE Transactions on Automatic Control
VOLUME: 64, ISSUE: 11, November 2019

(1) Hierarchical Decomposition of LTL Synthesis Problem for Nonlinear Control Systems

Authors: Pierre-Jean Meyer ; Dimos V. Dimarogonas

Abstract: This paper deals with the control synthesis problem for a continuous nonlinear dynamical system under a linear temporal logic (LTL) formula. The proposed solution is a top-down hierarchical decomposition of the control problem involving three abstraction layers of the problem, iteratively solved from the coarsest to the finest. The LTL planning is first solved on a small transition system only describing the regions of interest involved in the LTL formula. For each pair of consecutive regions of interest in the resulting accepting path satisfying the LTL formula, a discrete plan is then constructed in the partitioned workspace to connect these two regions while avoiding unsafe regions. Finally, an abstraction refinement approach is applied to synthesize a controller for the dynamical system to follow each discrete plan. The second main contribution, used in the third abstraction layer, is a new monotonicity-based method to overapproximate the finite-time reachable set of any continuously differentiable system. The proposed framework is demonstrated in simulation for a motion planning problem of a mobile robot modeled as a disturbed unicycle.

Full-text available at: https://ieeexplore.ieee.org/document/8657716

(2) Static and Dynamic Partitions of Inequalities: A Unified Methodology for Supervisor Simplification

Authors: Chen Chen ; Hesuan Hu

Abstract: In the context of automated manufacturing systems, supervisor simplification is drawing increasing attention. As a special class of state specifications, generalized mutual exclusion constraints (GMECs) are a typical kind of supervisory control of Petri nets. In this note, we first propose static and dynamic partitions to reduce the size of supervisor by partitioning inequalities, i.e., GMECs, into redundant and necessary ones. The former considers the specifications themselves and exhibits higher

efficiency; while the latter takes into account both specifications and reachable markings and achieves more economical supervisors. In an incremental manner, we develop Type I supervisor simplification method which has a compromised efficiency and complexity. In an integrated manner, we propose Type II supervisor simplification method that further improves efficiency and eases computational complexity. All techniques proposed in this note can be realized in an algebraic manner. Examples are presented for the sake of illustration as well as demonstration.

Full-text available at: https://ieeexplore.ieee.org/document/8667375
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2.3. Selections of Automatica
VOLUME: 109, November 2019

(1) Symbolic control design of nonlinear systems with outputs

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

Abstract: Formal methods have been recently used as the basis of a systematic framework to address control design of continuous or hybrid systems with specifications expressed in a logic form. However, results available in the literature assume full information of the state, or of its quantization. This information may not be available in relevant applications. In this paper, we consider the more realistic scenario where the controller cannot access the state of the plant but can only access a quantized measurement of its outputs where nonidealities of the sensing devices can be modeled. We focus on a control problem where the plant is described by a possibly unstable continuous-time nonlinear control system, the controller is dynamic, digital and quantized, and takes as input a (quantized) measurement of the output of the plant, and the specification is expressed in terms of regular languages. The solution to the control problem is based on formal methods. A finite-state system, also called symbolic model approximating the plant is first derived and then used to find the solution to the control problem. An illustrative example is provided and the symbolic control of a car-like robot is presented.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109819303723

(2) Decentralized optimal control of Connected Automated Vehicles at signal-free intersections including comfort-constrained turns and safety guarantees

Authors: YueZhang ; Christos G.Cassandras

Abstract: We extend earlier work for optimally controlling Connected Automated Vehicles (CAVs) crossing a signal-free intersection by including all possible turns taken so as to optimize a passenger

comfort metric along with energy and travel time minimization. We show that it is possible to achieve this goal in a decentralized manner with each CAV solving an optimal control problem, and derive explicit solutions that guarantee collision avoidance and safe distance constraints within a control zone. We investigate the associated tradeoffs between minimizing energy and vehicle travel time, as well as the passenger comfort metric and include extensive simulations to illustrate this framework.

Full-text available at: https://www.sciencedirect.com/science/article/pii/S0005109819304248

3. Conferences

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

3.1. 2019 Conference on Decision and Control

Nice, France, December 11–13, 2019
https://cdc2019.ieeecss.org/

3.2. 2020 Workshop on Discrete Event Systems

Rio de Janeiro, Brazil, May 13–15, 2020
https://wodes2020.eventos.ufrj.br

3.3. 2020 American Control Conference

Denver, Colorado, USA, July 1–3, 2020
http://acc2020.a2c2.org

3.4. 2020 IFAC World Congress

Berlin, Germany, July 12–17, 2020
https://www.ifac2020.org

4. Call For Papers

4.1. Open Invited Tracks in IFAC WC'20 on "Supervisory Control Theory and Reactive Synthesis for Cyber Physical System Design"

Abstract: Supervisory Control Theory (SCT) and Reactive Synthesis (RS) are two techniques for the automatic design of a digital system from a given specification which are recently applied to Cyber Physical System (CPS) design. Both methods mostly evolved independently in two distinct research fields, namely control theory and computer science. It is the main purpose of this invited session to enhance the mutual understanding of benefits and limitations of SCT and RS methods in the context of CPS design and to motivate

collaborative efforts within their intersection.

Track proposed by: Schmuck, Anne-Kathrin; Cai, Kai

Code for submitting contributions: 853th

Submission deadline: November 11, 2019

4.2. Open Invited Tracks in IFAC WC'20 on "Control for Computing Systems"

Abstract: Computing systems, large (data centers in the Cloud or HPC for scientific applications) or small (embedded architectures), have a growing need to be dynamically flexible and reconfigurable w.r.t. their environments and workloads, and to be automated with control loops in order to be efficient, safe and responsive. Whereas computing for control is a well-established domain, the converse control for computing systems is a relatively novel approach, explored only in recent years. The aim of this open invited track is to propose a multi-disciplinary gathering around computing systems as a new application area for control theory, with challenges in the modeling of these unfamiliar systems, and identification of the relevant control techniques for problems where automation has not been introduced yet.

This track targets computing systems as an application domain of various approaches to control design, e.g. Control Design, Nonlinear Control, Optimal Control, Robust Control, Discrete Event and Hybrid Systems.

Track proposed by: Kerrigan, Eric C.; Rutten, Eric

Code for submitting contributions: 4w968

Submission deadline: November 11, 2019

4.3. Open Invited Tracks in IFAC WC'20 on "Control for Smart Cities"

Abstract: The modern societies have witnessed tremendous development and changing in cities in the past decades. Control has played critical component in this process. The purpose of this open invited track is to gather up-to-date models, methods, stories, and experiences in the field of Control for Smart Cities. There are indeed many exciting things going on in this field, from smart buildings to intelligent transportation, from mobility to healthcare, from water system to pollution control, from energy efficiency to cyber security, just to name a few. In order to make cities smart, a technological infrastructure is required to connect networks of sensors and actuators embedded throughout the urban terrain, and to interact with wireless mobile devices. Smart city is a great example for cyber-physical systems and internet of things. Development in these highly related fields are also welcome to this

track, with a focus on the application to Control for Smart City.

Track proposed by: Jia, Qing-Shan; Dotoli, Mariagrazia; Parisio, Alessandra; Cassandras, Christos G.; Malikopoulos, Andreas

Code for submitting contributions: aiead

Submission deadline: November 11, 2019

4.4. 2020 Workshop on Discrete Event Systems (WODES'20)

The interdisciplinary field of Discrete Event Systems (DES) combines different 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, etc.

The 15th Workshop on Discrete Event Systems aims at providing researchers from different fields (control theoreticians and control engineers, software engineers and computer scientists, operations research specialists) with an opportunity to exchange information and new ideas, and to discuss new developments in the field of DES theory and applications.
The workshop will cover all topics in DES theory and applications, including (but not limited to) the following:
- Formalisms and modeling methodologies: Petri nets, automata, state charts, process algebras, max-plus algebra, queueing networks;
- Control of discrete-event systems with emphasis on supervisory control and on real time control;
- Performance evaluation, optimization and scheduling;
- Diagnosis, fault detection, test, identification;
- Discrete approaches for hybrid systems;
- Event-driven methods in systems and control;
- Applications including manufacturing systems, transportation systems, power production, distributed systems,
  software engineering, home automation, workflow, telecommunication systems, biological systems;
- Automation methods and software tools enabling efficient handling of industrial-sized systems.

WODES 2020 will be held at Military Institute of Engineering (IME), which, together with Polytechnic School of the Federal Universtiy of Rio de Janeiro, is the oldest engineering school of all Americas. It is located at the pleasant neighborhood of Urca, opposite to Praia Vermelha (Red Beach) and next to the Cable Station to Sugar Loaf. It stays a few minutes away from the famous beaches of Copacabana, Ipanema and Leblon.

Important Dates
- Special Session Proposals Due: October, 31st 2019
- Submission Site Opens: November, 10th 2019
- Initial Paper Submission Due: December, 16th 2019

- Decision Notification: February, 17th 2020
- Registration Site Opens: February, 24th 2020
- Final Submissions Due: March, 9th 2020

4.5. Special Sesson in WODES'20 on "Applications of Discrete Event Systems"

Description and Aim:
Since the seminal work of Ramadge and Wonham in 1987, the control of discrete-event systems (DES) has been an active research area in the controls community in the past 30 years. Many systematic methods, tools and algorithms have been developed for DES analysis, verifications, and control synthesis. Leveraging the developed tools, many potential applications of DES control have been proposed in the literature; relatively few, however, have been demonstrated on actual hardware or software implementation in a lab or commercial environment.

The principal objective of this special session is, therefore, to present the state of the art DES control applications, with special emphasis on ‘real demonstrations’. By ‘real demonstration’ we mean to include actual hardware demonstration, software implementation, and elaborated case studies demonstrated with simulation; toy examples are excluded. Our aim is to show that DES analysis, verification, and control methods are not only theoretically sound, but also practically useful. We welcome contributions that demonstrate the impact of DES verification and control on any aspects of (engineering) practice.

Organizers: Kai Cai and Eric Rutten

Submission deadline: December 16, 2019

5. International Graduate School on Control

Introduction to Discrete Event Systems

Instructors: Stephane Lafortune, Christos Cassandras

Marseille, France, June 8-12, 2020

Registration:
http://www.eeci-igsc.eu/

Course summary:
Discrete event systems are dynamic systems with discrete state spaces and event-driven dynamics. They arise when modeling the high-level behavior of cyber-physical systems or when modeling computing and software systems. Discrete event models can be purely logical,

or they may include timing and stochastic information. This course will have two parts.
In the first half, we will study logical discrete event systems, focusing primarily on automata models. We will consider estimation, diagnosability, and opacity analysis for partially-observed systems, then supervisory control under full and partial observation. In the second half, we will study the performance analysis, control, and optimization of timed DES, using stochastic timed automata models. We will describe the use of discrete event simulation and review elementary queueing theory and Markov Decision Processes used to study stochastic timed DES. We with then present Perturbation Analysis (PA) theory as a method to control and optimize common performance metrics for DES. Finally, we will explain how to extend DES into Hybrid Systems, limiting ourselves to basic modeling and simple extensions of PA theory.
No prior knowledge of discrete event systems will be assumed. The course will rely on the textbook co- authored by the instructors.

Course outline:
0. Overview of DES and contrast to time-driven systems
1. Introduction to discrete event modeling formalisms
2. Analysis of logical discrete event systems
3. Supervisory control under full and partial observation
4. Timed Models of DES
5. DES (Monte Carlo) computer simulation
6. Review of queueing theory and Markov Decision Processes
7. Perturbation Analysis and Rapid Learning methods
8. From DES to Hybrid Systems

6. Technical Committee Meeting at CDC 2019

Technical Committee on Discrete Event Systems will hold a meeting at IEEE Conference on Decision and Control 2019, Nice, France.

Time: 12:00--13:30, December 11, Wednesday, 2019.
Location: TBD

All TC members who are going to attend CDC'19 are welcome to come to this meeting. Lunch is supplied (first come first served, limited amount).