IEEE Control Systems Society
Technical Committee on Discrete Event Systems

Newsletter **February 2023**

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Welcome to the 2023 February issue of the newsletter, also available online at
http://ieeecss.org/tc/discrete-event-systems/newsletters

Editorial

You are welcome to submit new items to the newsletter (topics including schools, workshops, sessions, conferences, journals, books, software, positions). Also please encourage relevant colleagues and students to subscribe to this newsletter.

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Contents

1 Selections of Journal Publications

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

1.1. IEEE Transactions on Automatic Control

Volume: 68, Issue: 2, February 2023

- **Observability Decomposition of Boolean Control Networks**
  Authors: Yifeng Li ; Jiandong Zhu
  Abstract: This article investigates the observability decomposition of Boolean control networks (BCNs) under the algebraic frame based on the semitensor product of matrices. First, the definition for the observability decomposition of BCNs is proposed, which is consistent with the observability decomposition of traditional linear control systems. Then, by using the vertex partition method, a necessary and sufficient vertex partition condition for the observability decomposition of BCNs is proposed. Next, an algorithm is designed for the analysis and realization of observability decomposition. Finally, a biological example and a counterexample are analyzed to illustrate the obtained results.
- **Distributed Markov Chain Redesign for Multiagent Decision-Making Problems**
  Authors: Gabriele Oliva ; Roberto Setola ; Andrea Gasparri
  Abstract: In this article, we consider the problem of modifying in a distributed way the transition probabilities of a Markov chain over an undirected graph in order to achieve a desired limiting distribution, while minimizing the variation from the current weights. This problem setting could be used to model a (graph-based) distributed decision-making process where static agents, e.g., elements of Internet of Things (IoT) networks, are required to achieve a common objective while adapting to different operational conditions, e.g., monitoring of time-varying and spatial-varying phenomena. This could be effectively used to describe several applications settings, ranging from sensor-network-based border patrolling to IoT-based environmental precision farming. In this context, our contribution is threefold: 1) we show that, under the assumption that a global optimal solution exists, then such a solution can be computed by solving a relaxed problem, where the irreducibility and aperiodicity constraints are lifted; 2) we derive an algebraic optimality condition for the relaxed problem; and 3) we design a distributed algorithm that provably converges towards this optimality condition.
- **Stabilization of Markovian Jump Boolean Control Networks via Event-Triggered Control**
  Authors: Bingquan Chen; Jinde Cao; Guoping Lu; Leszek Rutkowski
  Abstract: In this article, we investigate the stabilization of Markovian jump Boolean control networks by a kind of event-triggered control, which is essentially an intermittent control scheme. First, a novel condition for the stability of Markovian jump Boolean networks is obtained based on the recurrence of finite-state homogeneous Markov chains. After that, the necessary and sufficient conditions for the stabilization of a Markovian jump Boolean control network by an event-triggered control are proposed based on an associated digraph, and the design method of the corresponding event-triggered control is given. Furthermore, in order to save control costs, we construct an event-triggered control with a minimal event-triggering set for the stabilization of the Markovian jump Boolean control network by finding a minimum-weight spanning branching forest of the associated digraph. Finally, an example is given to illustrate the effectiveness of the obtained results.

Back to the contents

1.2. Automatica

Volume: 148, February 2023

- **Strong current-state and initial-state opacity of discrete-event systems**
  Authors: Xiaoguang Hana ; Kuize Zhang ; Jiahui Zhang ; Zhiwu Li ; Zengqiang Chen
  Abstract: Opacity, as an important property in information-flow security, characterizes the ability of a system to keep some secret information from an intruder. In discrete-event systems, based on a standard setting in which an intruder has the complete knowledge of the systems structure, the

standard versions of current-state opacity and initial-state opacity cannot perfectly characterize higher-level privacy requirements. To overcome such a limitation, in this paper we propose two stronger versions of opacity called strong current-state opacity and strong initial-state opacity for partially-observed nondeterministic finite-state automata. Strong current-state (resp., initial-state) opacity describes that for each run of a system ending (resp., starting) at a secret state, there exists a non-secret run whose observation is the same as that of the previous run. Then we propose an information structure using a novel concurrent-composition technique to verify strong current-state opacity and strong initial-state opacity, which has time complexity $\mathcal{O}((|\Sigma||X|^2 + |\Sigma_o||X\backslash X_S|^2(1+|\Sigma_{uo}|))2^{X\backslash X_S})$, where (resp., $|\Sigma|, |\Sigma_o|, |\Sigma_{uo}|, |X\backslash X_S|$) is the number of states (resp., events, observable events, unobservable events, non-secret states) of an automaton. Finally, the proposed information structure is also used to check strong infinite-step opacity, which has lower time complexity than the previous one in the literature.

- **Disjunctive fault prediction of decentralized discrete event systems: Verification, predictor design and K-copredictability**
  Authors: Raphael Julio Barcelos ; João Carlos Basilio
  Abstract: This paper deals with the problem of fault predictability of discrete event systems (DES) modeled by automata. The predictability property is approached in a disjunctive decentralized architecture, where the verdict that a fault will inevitably occur is given when at least one local agent is sure about its future occurrence. We adapt previous results on diagnosability verification to develop two new strategies to verify disjunctive fault predictability (called copredictability): the first one is based on a diagnoser-like test automaton, and the second one on by using verifiers. Necessary and sufficient conditions for a regular language to be copredictable are provided, and also a strategy for designing local fault predictor systems, to be used in online fault prediction. We also address the problem of verifying if all fault occurrences can be predicted at least K events prior to their occurrences (K-copredictability) and provide both a necessary and sufficient conditions for a regular language to be K-copredictable and an automaton-based test to verify if a regular language is K-copredictable.

Back to the contents

1.3. Nonlinear Analysis: Hybrid Systems

Volume: 47, February 2023

- **Temporal logic guided safe model-based reinforcement learning: A hybrid systems approach**
  Authors: Max H.Cohen ; Zachary Serlin ; Kevin Leahy ; Calin Belta
  Abstract: This paper studies the problem of synthesizing control policies for uncertain continuous-time nonlinear systems from linear temporal logic (LTL) specifications using model-based reinforcement learning (MBRL). Rather than taking an abstraction-based approach, we view the interaction between the LTL formulas corresponding Büchi automaton and the nonlinear system as a hybrid automaton whose discrete dynamics match exactly those of the Büchi automaton. To find satisfying control policies, we pose a sequence of optimal control problems associated with states in the accepting run of the automaton and leverage control barrier functions (CBFs) to prevent specification violation. Since solving many optimal control problems for a nonlinear system is computationally intractable, we take a learning-based approach in which the value function of each problem is learned online in real-time. Specifically, we propose a novel off-policy MBRL algorithm that allows one to simultaneously learn the uncertain dynamics of the system and the value function of each optimal control problem online while adhering to CBF-based safety constraints. Unlike related approaches, the MBRL method presented herein decouples convergence, stability, and safety, allowing each aspect to be studied independently, leading to stronger safety guarantees than those developed in related works. Numerical results are presented to validate the efficacy of the proposed method.
- **Computing the average inter-sample time of event-triggered control using quantitative automata**
  Authors: Gabrielde Albuquerque Gleizer ; Manuel Mazo Jr
  Abstract: Event-triggered control (ETC) is a major recent development in cyberphysical systems

due to its capability of reducing resource utilization in networked devices. However, while most of the ETC literature reports simulations indicating massive reductions in the sampling required for control, no method so far has been capable of quantifying these results. In this work, we propose an approach through finite-state abstractions to do formal quantification of the traffic generated by ETC of linear systems, in particular aiming at computing its smallest average inter-sample time (SAIST). The method involves abstracting the traffic model through l-complete abstractions, finding the cycle of minimum average length in the graph associated to it, and verifying whether this cycle is an infinitely recurring traffic pattern. The method is proven to be robust to sufficiently small model uncertainties, which allows its application to compute the SAIST of ETC of nonlinear systems.

Back to the contents

1.4. IEEE Transactions on Systems, Man, and Cybernetics: Systems

Volume: 53, Issue: 2, February 2023

- **Petri Nets-Based Modeling Solution for Cyber-Physical Product Control Considering Scheduling, Deployment, and Data-Driven Monitoring**
  Authors: Zhenyu Liu ; Liang Hu ; Weifei Hu ; Jianrong Tan
  Abstract: For a complex electromechanical product that is a cyberphysical system (CPS), its dynamic behaviors are embodied in the closed-loop control between the logic process in its cyber component and actual actuators/sensors in its physical component, and thus, a well-defined model of the control is important to create a digital twin that acts as much like the real machine as possible. This article proposes a Petri nets (PNs)-based modeling solution that employs hybrid PNs (HPNs) for physics and system of sequential systems with shared resources (S4R) nets for logic in building a hierarchical control model. We also present PNs technologies for implementing a smooth transition and bidirectional mapping from the virtual prototype to the real machine. These technologies involve a PNs integration of a reinforcement learning (RL) method for generating a workflow scheduling agent in design, an extension of PNs definitions that is compatible with the microcontroller for easy deployment in manufacturing, and an architecture of PNs execution recording for data-driven monitoring in service. A software kit is provided for the solution that includes an integrated development environment of PNs, tools for quickly building a virtual prototype, and a monitor server for remote data-driven monitoring. This solution is successfully applied in the development of a typical cyberphysical product case, namely, the chemiluminescence immunoassay (CLIA) analyzer.
- **Formal Modeling and Discovery of Hierarchical Business Processes: A Petri Net-Based Approach**
  Authors: Cong Liu ; Long Cheng ; Qingtian Zeng ; Lijie Wen
  Abstract: Business processes are critical for information systems to control workflows and deliver services. Although existing process discovery techniques can generate flat process models from business event logs, few of them have investigated the notion of hierarchy (i.e., subprocesses) yet. To fill the gap, this article first defines the concept of hierarchical Petri nets (HPNs), which can support the formal modeling and correctness verification of processes with subprocesses. Followed by that, we propose an approach which can effectively discover HPNs from event logs with lifecycle information. Moreover, to quantify the quality of discovered HPNs, details on how to transform an HPN to a classical Petri net are given such that existing metrics can be applied. All proposed approaches have been fully implemented in ProM, and experiments over both synthetic and real-life event logs demonstrate that our approach can effectively discover hierarchical process models. Specifically, compared to exiting approaches on processes discovery, our approach can generally perform better in terms of model quality.
- **Reachability, Controllability, and Stabilization of Boolean Control Networks With Stochastic Function Perturbations**
  Authors: Xinrong Yang ; Haitao Li
  Abstract: Robust controllability and stabilization are two fundamental issues in modern control

theory. This article investigates the robust controllability and stabilization of Boolean control networks (BCNs) subject to stochastic function perturbations (SFPs). First, by defining the concept of the weighted path and constructing the perturbed position index matrix, the robustness analysis of reachability is divided into two cases. According to these two cases, several criteria are proposed for the robust reachability of BCNs with SFPs. Second, based on the robust reachability, the robust controllability and state-feedback stabilization of BCNs with SFPs are further studied. Finally, the validity of the obtained results is supported by examples.

Back to the contents

2 Call for Participants & Registrations

2.1 Virtual Workshop on Control Software Synthesis for CPS – On Harvesting Structural and Information-Flow Properties

When: January 18th 2023 and February 15th 2023 at 1pm UTC

Registration: free but required via https://css-workshop-23.mpi-sws.org/registration-2023/

More information: More information on the scope of the workshop, the speakers and the talks can be found here: https://css-workshop-23.mpi-sws.org/. The workshop consists of two sessions.

- **Session 1: Structural Properties in Controller Synthesis**
  January 18th 2023, 1pm UTC
  - "Compositional synthesis using the least-violating control framework" by Antoine Girard
  - "Unified bisimulation for compositional verification, synthesis and time optimization" by Bengt Lennartson
  - "Compositional verification and synthesis of interconnected control systems" by Majid Zamani
- **Session 2: Information-Flow Properties in Dynamic Systems**
  February 15th, 2023, 1pm UTC
  - "Probabilistic hyperproperties of Markov decision processes: information-flow properties and beyond" by Rayna Dimitrova
  - "A unified framework for verification of observational properties for partially-observed discrete-event systems" by Xiang Yin

2.2 2023 Virtual Talk Series on Discrete Event Systems

Dear members of the TC and previous participants,

We are excited to announce the 2023 edition of the Virtual Talk Series on Discrete Event Systems for which we invite everyone to register here:
https://tc-des.mpi-sws.org/registration-2023/

As in previous years, registration is free and only required for security reasons. Please feel free to forward this announcement to any interested person! We think that this year's series compasses an exciting and diverse program again.

In January and February the VTS will feature a Virtual Workshop on Control Software Synthesis for CPS happening Wednesdays, January 18th 2023 and February 15th 2023 at 1pm UTC. From March to December the VTS will host two PhD forums and multiple 'classical' talks, happening, as usual, Thursdays 1pm UTC with confirmed speakers being:

- Laurent Hardouin, University of Angers, France
- Cristian Mahulea, University of Zaragoza, Spain
- Tomas Masopust, Faculty of Science, Palacky University in Olomouc, Czechia
- Anca Muscholl, LaBRI, Univ. of Bordeaux, France
- Sophie Pinchinat, Univ. Rennes, France

We are still in the process of finalizing the program of the VTS and will circulate the website with the final program when it is available.

One last remark: You will see that the virtual workshop mentioned above also has a separate registration site. If you register to the VTS, you do NOT need to register for the workshop separately. If you plan to ONLY attend the workshop, we kindly ask you to register on the workshop registration site.

We are looking forward to your active participation.

Kind regards,

Anne-Kathrin Schmuck on behalf of all TC co-chairs

3 Conferences

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

3.1 **2023 ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)**
San Antonio, USA, May 9-12, 2023
https://iccps.acm.org/2023/

3.2 **2023 IEEE International Conference on Robotics and Automation (ICRA)**
London, United Kingdom, May 29-June 02 2023, 2023
https://www.icra2023.org/

3.3 **2023 American Control Conference (ACC)**
San Diego, USA, May 31 - June 2, 2023
https://acc2023.a2c2.org/

3.4 **2023 IFAC World Congress (IFAC)**
Yokohama, Japan, July 9-14, 2023
https://www.ifac2023.org/

3.5 **2023 IEEE Conference on Control Technology and Applications (CCTA)**
Bridgetown, Barbados, August 16-18, 2023.
https://ieeeccta.org/

3.6 **2023 IEEE International Conference on Automation Science and Engineering (CASE)**
Auckland, New Zealand, August 26-29, 2023.
https://case2023.org/

3.7 **2023 IEEE International Conference on Systems, Man, and Cybernetics (SMC)**
Maui, Hawaii, October 14, 2023.
https://ieeesmc2023.org/

3.8 **2023 IEEE Conference on Decision and Control (CDC)**
Singapore, December 13-15, 2023.
https://cdc2023.ieeecss.org/

Back to the contents

4 Books

4.1 Analysis and Control for Resilience of Discrete Event Systems

Authors: Joao Carlos Basilio, Christoforos N. Hadjicostis and Rong Su

Description: System resilience captures the ability of the system to withstand a major disruption within acceptable performance degradation and to recover within an acceptable time frame. In this monograph we consider two possible sources of major disruptions, i.e., component faults and cyber intrusions. A component fault is an indigenous activity that renders unavailability or inaccessibility of certain functions within a component, either permanently or temporarily. It typically generates safety and performance concerns. Cyber intrusion on the other hand is an exogenous activity that tampers privacy, confidentiality, availability, or integrity of the system. These two sources are not always independent from each other. For example, a cyber intrusion may trigger a component fault, whereas a component fault may open a door for cyber intrusion, e.g., by keeping it undetected. For cyber intrusion, we will focus on opacity, which describes the systems ability to hide certain secrets from an external observer (or eavesdropper), and sensor and actuator attacks that exploit the systems existing controller to generate undesirable behaviours.

In this monograph, we provide a detailed account of most recent research outcomes on fault diagnosis, opacity analysis and enhancement, and cyber security analysis and enforcement, within suitable discrete event system modelling frameworks. In each case, we describe basic problem statements and key concepts, and then point out the key challenges in each research area. After that, we present a thorough review of state-of-the-art techniques, and discuss their advantages and disadvantages. Finally, we highlight key research directions for further exploration.

ISBN: 978-1-68083-856-5
https://www.nowpublishers.com/article/Details/SYS-024

4.2 Introduction to Discrete Event Systems (Third Edition)

Authors: Christos Cassandras and Stéphane Lafortune

Description: Christos Cassandras and Stéphane Lafortune are happy to announce the publication of the third edition of their textbook, Introduction to Discrete Event Systems, by Springer in November 2021. The first two editions of this popular textbook were published in 1999 (Kluwer Academic Publishers) and 2008 (Springer), respectively. This unique textbook comprehensively introduces the field of discrete event systems, offering a breadth of coverage that makes the material accessible to readers of varied backgrounds. The book emphasizes a unified modeling framework that transcends specific application areas, linking the following topics in a coherent manner: language and automata theory, supervisory control, Petri net theory, Markov chains and queueing theory, discrete-event simulation, and perturbation analysis and concurrent estimation techniques. The third edition is a superset of the second one, with new material added based on our teaching of discrete event systems courses at Boston University and at the University of Michigan, and they reflect active research trends in discrete event systems since the publication of the second edition.

Topics and features:
- detailed treatment of automata and language theory in the context of discrete event systems, including application to state estimation and diagnosis
- comprehensive coverage of centralized and decentralized supervisory control
- timed models, including timed automata and hybrid automata - stochastic models for discrete event systems and controlled Markov chains
- discrete event simulation - an introduction to stochastic hybrid systems
- sensitivity analysis and optimization of discrete event and hybrid systems
- new in the third edition: opacity properties, enhanced coverage of event diagnosis and of supervisory control under partial observation, overview of latest software tools, updated treatment of Infinitesimal Perturbation Analysis and of concurrent estimation

This proven textbook is essential to students and researchers in a variety of disciplines where the study of discrete event systems is relevant: control, communications, computer engineering, computer science, manufacturing engineering, transportation networks, operations research, and industrial engineering. This book is available through SpringerLink as an e-book (PDF and EPUB formats) or as a print-on-demand hard cover at https://link.springer.com/book/10.1007/978-3-030-72274-6 The e-book is available for free download at Springer subscribing institutions.

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4.3 Hybrid Dynamical Systems – Fundamentals and Methods

Authors: Hai Lin and Panos Antsaklis

Description: This book is based on courses on hybrid systems, cyber-physical systems, and formal methods taught by the authors in the past years. It is a graduate level textbook and provides an accessible and comprehensive introduction to the theory of hybrid systems with a balanced treatment on fundamentals and methods from both control theory and computer science. It also serves as a reference book for researchers in the fields of hybrid dynamical systems, cyber-physical systems, formal methods and robotics.

More information may be found at the books Springer webpage:

https://link.springer.com/book/10.1007/978-3-030-78731-8

Back to the contents

5 Software Tools

5.1 DESpot 1.10.0 Released

DESpot is a discrete-event system (DES) software, research tool. It supports both flat projects (collection of plant and supervisor DES), and Hierarchical Interface-Based Supervisory Control (HISC) projects.

DESpot 1.10.0 supports a number of new Features:

- DESpot now targets version 4.8.7 of the Qt libraries, RedHat Enterprise Linux 7.x, and MS Windows 10 with MS Visual Studios 2019.
- Support for defining template DES, and then instantiating multiple copies for flat or HISC projects.
- Now includes curved transition arrows for DES diagrams, and the ability to export DES diagrams to EPS.
- Support for verification of timed controllability, including BDD-based algorithms.
- Support for Fault-Tolerant (FT) Supervisory Control, including both timed and untimed controllability and nonblocking BDD-based algorithms, for several fault scenarios.
- Support for specifying decentralized supervisory control structure for a project, and verifying co-observability.

To find out more information and to download a copy, see: http://www.cas.mcmaster.ca/~leduc/DESpot.html

DESpot is open source software, released under the GNU General Public license (GPL), version 2.

DESpot is written in C++ and uses the QT GUI libraries. At the moment, DESpot is available as source code and as a Windows' installer. It runs under Linux, and Windows.

5.2 Eclipse ESCET™ version 0.8 release

The Eclipse Supervisory Control Engineering Toolkit (Eclipse ESCET) project provides a model-based approach and toolkit for the development of supervisory controllers. It includes the languages CIF, Chi and ToolDef. ESCET, initially developed by Eindhoven University of Technology, is since January 2020 an Eclipse Foundation open-source project. More information can be found on the toolkits website at https://www.eclipse.org/escet/.

In December 2022, ESCET version 0.8 has been released and can be downloaded from https://www.eclipse.org/escet/download.html. The main changes in this version are

- This release is based on Eclipse 2022-06, rather than Eclipse 2021-06. Eclipse 2022-06 may show for all projects in your existing workspace a warning that they dont have an explicit encoding set. The solution is described in the full release notes.
- Eclipse 2022-06 may automatically use a dark theme if your operating system is configured to use a dark theme. The Console view, Application view, and CIF simulator windows now support dark mode as well (in addition to the ones from version 0.7).
- Eclipse ESCET now bundles Java 17 rather than Java 11.
- Very long lines in the Console view and text editors now render correctly on Windows.
- CIF has improved type checking for the = and != binary expressions to support more expressions. For example, both expressions x = 1 and 1 = x are now supported, with x a real-valued variable.
- The CIF data-based synthesis tool now has a second hyper-edge creator, the linearized hyper-edge creator, which may improve performance. The legacy hyper-edge creator is still used by default.
- A new CIF example model and a new CIF benchmark model have been added. Furthermore, the CIF benchmarking models now come with scripts to easily benchmark data-based synthesis.
- he CIF to Supremica transformation, the CIF to UPPAAL transformation, and CIF PLC code precondition checks have improved output. The preconditions themselves have not changed.

The full ESCET release notes, including links to the language specific release notes and release notes from previous versions, are available from https://www.eclipse.org/escet/release-notes.html.

5.3 IDES: An Open-Source Software Tool

IDES, the discrete-event systems software tool in Karen Rudie's lab is now available as open-source software at https://github.com/krudie/IDES. More information on IDES can also be found at https://www.ece.queensu.ca/people/K-Rudie/qdes.html#fndtn-software.

5.4 MDESops

MDESops is an open-source tool written in Python for analysis and control of discrete event systems modeled as finite-state automata. It includes a growing set of operations on automata, including: (i) manipulation of models (e.g., parallel composition, observer); (ii) diagnosis and opacity verification; (iii) common supervisory control functions (e.g., computation of supremal controllable and normal sublanguages); and (iv) more advanced functions on synthesis of attackers and of resilient supervisors in the presence of sensor deception attacks. The repository is a Git server maintained by the EECS Department at the University of Michigan, USA. Download from https://gitlab.eecs.umich.edu/M-DES-tools/desops.

5.5 Supremica 2.7, New Version

The development team has just released a new version of Supremica, Waters/Supremica IDE 2.7.

Supremica is a DES and SCT drawing and calculation tool, that includes a multitude of efficient algorithms for modeling, verification, and synthesis of maximally permissive supervisors. In addition there are general algorithms for standard operations like synchronization, minimization, determinization, etc. Supremica also handles finite automata extended with bounded discrete variables. A feature-full simulation tool is also included.

New in this version:

- Conditional blocks or IF statements can now be created in the components list or on label blocks to allow conditional compilation of automata or events. They can also be used as an alternative to guard/action blocks.
- Update to Log4j 2.17.1 to avoid the Log4shell vulnerability.

Supremica is free to use for education and research; for commercial use, please contact fabian@chalmers.se. Download from www.supremica.org.

5.6 UltraDES 2.2 Release

UltraDES is an open-source library to the modeling, analysis and control of DES, written using C# in .NET Standard 2.0, which allows its use in multiple platforms, such as Windows, Linux, Mac, IOS, Android, so on. The library is under development at LACSED (Laboratory of Analysis and Control of Discrete Event Systems, at the Universidade Federal de Minas Gerais, Brazil) and has basic operations with automata as long as the monolithic, modular and local modular supervisory control (Alves et. al., 2017).

The main improvements of the UltraDES 2.2 version are:

- Supervisor Reduction Algorithm (Su and Wonham, 2004)
- Supervisor Localization (Cai and Wonham, 2010)
- Basic Petri Nets Functions (incidence matrix, coverability/reachability graph, Petri Net marking simulation, etc.)

Knowing that many researchers/students are not familiar with the C# language, we created an experimental python wrapper, that is less object oriented and easier to use.

Another initiative to improve the usability of UltraDES was the creation of a Web Application, developed using Blazor/WebAssembly, that allows the use of UltraDES online. This version is more limited in processing power and memory but it is useful for small examples and teaching.

We invite the community to download and contribute. Algorithms implemented may be integrated to the main distribution. Just let us know. Contact Lucas Alves lucasvra@ufmg.br or Patricia Pena ppena@ufmg.br for more information. Bugs should be informed using the UltraDES GitHub page.
Link: `https://github.com/lacsed/UltraDES`.

Back to the contents