Workshop Proposal for IEEE CDC 2023

Rong Su and Xiang Yin

1 General Information

- **Title:**

  Formal Methods in System Resilience: From Analysis to Control

- **Length:**

  Full-Day Workshop from 9:00 am to 17:00 pm

- **Sponsorship:**

  This workshop will be sponsored by IEEE Control Systems Society Technical Committee on Discrete Event Systems.

2 Goals and Topics

Engineering systems that involve physical elements controlled by computational infrastructure are called Cyber-Physical Systems (CPS). CPS are present in almost every modern automated system, ranging from manufacturing and transportation systems over telecommunication networks to large-scale computer clusters. The ever-increasing demand for safety, security, performance, and certification of these – often safety-critical – CPS put stringent constraints on their design. This necessitates the use of formal, model-based approaches to analyze and design secure, reliable and performant systems.

Resilience has emerged as a property of major interest for the design and analysis of a complex system. It describes the system ability to continue providing its designed services or functions, even after disruptive changes in the system, caused either by faults, or other naturally occurring phenomena, or by malicious actions. Formal methods in resilience has been enjoying a spotlight in many different fields, including the Discrete Event Systems (DES) community, hybrid systems community and computer science community. This workshop aims to report recent research achievements related to formal analysis and control for resilience and to identify relevant challenges. It will focus on two main themes:

- *Formal Analysis for Resilience*, which include safety verficaition, diagnosability/detectability analysis of DES in networked environments under attacks, information-flow security analysis and efficient resilience verification for infinite systems.
- *Formal Control Synthesis for Resilience*, which include supervisory control theory of DES under attacks, resilient software synthesis by reactive synthesis and secure-by-construction synthesis of cyber-physical systems.

Overall, in this workshop, we intend to achieve the following two goals:

(1) To report and showcase recent technical developments related to formal methods in system resilience; and

(2) to identify challenges ahead which, although hindering the current research efforts, are critical for safety-critical CPS, in order to arouse more interests and efforts at a broader societal level to ensure R&D sustainability.

3 Intended Audience

This workshop consists of presentations, which report recent individual research progresses on specific topics, e.g., supervisory control of discrete-event systems, reactive synthesis for temporal logic, diagnosability and opacity analysis of discrete-event systems, formal analysis of hybrid systems and attacks on networked CPS. They require the audience to have some basic technical background in discrete-event systems, or the logic foundation of cyber-physical systems, thus, suitable for researchers and graduate students in relevant fields. To help the registered audience to better understand the presented materials, a printout of each presentation will be disseminated during the workshop.

4 List of Organizers

- **Rong Su** (rsu@ntu.edu.sg)

  Nanyang Technological University, Singapore.

  Bio: Su Rong obtained his Bachelor of Engineering degree from University of Science and Technology of China, and Master of Applied Science degree and PhD degree from University of Toronto, respectively. He was affiliated with University of Waterloo and Technical University of Eindhoven before he joined Nanyang Technological University in 2010. Dr Su's research interests include multi-agent systems, discrete-event system theory, model-based fault diagnosis, cyber security analysis and synthesis, control and optimization of complex networks with applications in flexible manufacturing, intelligent transportation, human-robot interface, power management and green buildinga. In the aforementioned areas he has more than 230 journal and conference publications, 1 monograph, 9 granted/filed patents. Dr Su is a senior member of IEEE, and an associate editor for Automatica (IFAC), Journal of Discrete Event Dynamic Systems: Theory and Applications, and Journal of Control and Decision. He was the Chair of the Technical Committee on Smart Cities in the IEEE Control Systems Society in 2016-2019. Currently, he is a co-chair of Technical Committee on Automation in Logistics in the IEEE Robotics and Automation Society, and chair of the Control Systems Chapter, Singapore. Dr Su is the recipient of 2021 Hsue-shen Tsien Paper Award from IEEE/CAA Journal of Automatica Sinica, a Distinguished Lecturer for 2020 Chinese Conference on Decision and Control (CCDC'20) and an IEEE Distinguished Lecturer for IEEE Robotics and Automation Society.

- **Xiang Yin** (yinxiang@sjtu.edu.cn)

  Shanghai Jiao Tong University, Shanghai, China.

  Bio: Xiang Yin was born in Anhui, China, in 1991. He received the B.Eng degree from Zhejiang University in 2012, the M.S. degree from the University of Michigan, Ann Arbor, in 2013, and the Ph.D degree from the University of Michigan, Ann Arbor, in 2017, all in electrical engineering. Since 2017, he has been with the Department of Automation,

Shanghai Jiao Tong University, where he is an Associate Professor. His research interests include formal methods, discrete-event systems and cyber-physical systems. He is serving as the chair of the *IEEE CSS Technical Committee on Discrete Event Systems*, an Associate Editor for the *Journal of Discrete Event Dynamic Systems: Theory & Applications*, and a member of the *IEEE CSS Conference Editorial Board*. Dr. Yin received the IEEE Conference on Decision and Control (CDC) Best Student Paper Award Finalist in 2016.

5 List of Speakers

- **Alessandro Abate** (alessandro .abate@cs.ox.ac.uk)
  University of Oxford
  Title: Logic Meets Learning - Formal Synthesis with Neural Templates
  Bio: Alessandro Abate is Professor of Verification and Control in the Department of Computer Science at the University of Oxford, where he is also Deputy Head of Department. Earlier, he did research at Stanford University and at SRI International, and was an Assistant Professor at the Delft Center for Systems and Control, TU Delft. He received an MS/PhD from the University of Padova and UC Berkeley. His research interests lie on the formal verification and control of stochastic hybrid systems, and in their applications in cyber-physical systems, particularly involving safety criticality and energy. He blends in techniques from machine learning and AI, such as Bayesian inference, reinforcement learning, and game theory.

- **Alessandro Giua** (giua@unica.it)
  University of Cagliari, Italy.
  Title: TBD
  Bio: Alessandro Giua is Professor of Automatic Control at the Department of Electrical and Electronic Engineering (DIEE) of the University of Cagliari, Italy. He has also held academic and visiting positions in several institutions worldwide, including Xidian University (China) and Aix-Marseille University (France). He received a Ph.D. degree in computer and systems engineering from Rensselaer Polytechnic Institute, Troy, NY, USA in 1992. His research interests include discrete event systems, hybrid systems, networked control systems, Petri nets and failure diagnosis. On these topics he has published extensively, given several talks and managed international and national research projects. He is currently the Editor in Chief of the IFAC journal Nonlinear Analysis: Hybrid Systems and a Senior Editor of the IEEE Trans. on Automatic Control. He is serving as Vice President for Conference Activities of the IEEE Control Systems Society (2000-21). He is a Fellow of the Institute of Electrical and Electronics Engineers and a Fellow of the International Federation of Automatic Control for contributions to discrete event and hybrid systems. He received in 2017 the People's Republic of China Friendship Award.

- **Christoforos Hadjicostis** (chadjic@ucy.ac.cy)
  University of Cyprus, Cyprus.
  Title: TBD
  Bio: Christoforos Hadjicostis is Professor of Electrical and Computer Engineering and Interim Director of the FOSS Research Center for Sustainable Energy at the University of Cyprus. He received S.B. degrees in Electrical Engineering, Computer Science and Engineering, and Mathematics, the M.Eng. degree in Electrical Engineering and Computer Science, and the Ph.D. degree in Electrical Engineering and Computer Science, all

from the Massachusetts Institute of Technology, Cambridge, MA. From 1999 to 2007, he was Assistant and then Associate Professor with the Department of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign. His research focuses on fault diagnosis and tolerance in distributed dynamic systems; error control coding; monitoring, diagnosis and control of large-scale discrete event systems; and related applications in energy distribution networks, embedded systems, distributed robotics, anomaly detection and network security. His research has been funded via several competitive grants from the National Science Foundation (including an NSF Career Award), the Air Force Office of Scientific Research, the European Commission (including a Marie Curie International Reintegration Grant), Qatar Foundation, the Cyprus Research Promotion Foundation, and others. Dr. Hadjicostis serves as Editor in Chief of the Journal of Discrete Event Systems and as Associate Editor of Automatica. In the past, he served as Associate Editor of IEEE Transactions on Automatic Control, the Journal of Nonlinear Analysis of Hybrid Systems, IEEE Transactions on Automation Science and Engineering, IEEE Transactions on Control Systems Technology, and IEEE Transactions on Circuits and Systems I.

- **Zhiwu Li** (systemscontrol@gmail.com)
  Macau University of Science and Technology, Macau.
  Title: TBD
  Bio: Zhiwu Li received the B.S. degree in mechanical engineering, the M.S. degree in automatic control, and the Ph.D. degree in manufacturing engineering from Xidian University, Xi'an, China, in 1989, 1992, and 1995, respectively.,In 1992, he joined Xidian University as Research Assistant. Over the past decade, he was a Visiting Professor with the University of Toronto, Toronto, ON, Canada, Technion Israel Institute of Technology, Haifa, Israel, Martin Luther University, Halle, Germany, the Conservatoire National des Arts et Metiers, Paris, France, Meliksah University, Talas, Turkey, King Saud University, Riyadh, Saudi Arabia, and the University of Cagliari, Cagliari, Italy. He is currently with the Institute of Systems Engineering, Macau University of Science and Technology, Taipa, Macau. His current research interests include Petri net theory and application, the supervisory control of discrete event systems, work flow modeling and analysis, system reconfiguration, game theory, and data and process mining.,Prof. Li was a recipient of the Alexander von Humboldt Research Grant, Alexander von Humboldt Foundation, Germany, and Research in Paris, France. He is the Founding Chair of the Xi'an Chapter of the IEEE Systems, Man, and Cybernetics Society. He is a member of the Discrete Event Systems Technical Committee of the IEEE Systems, Man, and Cybernetics Society, and a member of IFAC Technical Committee on Discrete Event and Hybrid Systems, from 2011 to 2014.

- **Rong Su** (rsu@ntu.edu.sg)
  Nanyang Technological University, Singapore.
  Title: A retrospective view of sensor-actuator attack frameworks for event driven systems
  Bio: See in Section 4.

- **Xiang Yin** (yinxiang@sjtu.edu.cn)
  Shanghai Jiao Tong University, Shanghai, China.
  Title: Scalable online monitoring and reactive control for temporal logic specifications
  Bio: See in Section 4.

- **Majid Zamani** (Majid.Zamani@Colorado.EDU)

University of Colorado, Boulder, United States.
Title: Secure-by-construction synthesis of cyber-physical systems
Bio: Majid Zamani is an Associate Professor in the Computer Science Department at University of Colorado Boulder and leading Hybrid Control Systems Lab. Between May 2014 and January 2019, he was an assistant professor (W2 grade) in the Department of Electrical Engineering at Technical University of Munich. He received a Ph.D. degree in Electrical Engineering and an MA degree in Mathematics both from University of California, Los Angeles in 2012, an M.Sc. degree in Electrical Engineering from Sharif University of Technology in 2007, and a B.Sc. degree in Electrical Engineering from Isfahan University of Technology in 2005. He received the NSF Career award in 2022 and ERC starting grant award from the European Research Council in 2018. His research interests include verification and control of cyber-physical systems, hybrid systems, embedded control software synthesis, networked control systems, and incremental properties of nonlinear control systems.

6 Program Schedule

The program schedule of the workshop is shown in the following table. We will have seven invited talks and a panel discussion among all speakers and audiences.

Event	**Speaker**	**Time Slot**
Opening Speech	Rong Su Xiang Yin	9:00-9:05
Morning Session		
Talk 1	Alessandro Giua	9:05-9:50
Talk 2	Christoforos Hadjicostis	9:50-10:35
Tea Break	/	10:35-10:50
Talk 3	Alessandro Abate	10:50-11:35
Talk 4	Rong Su	11:35-12:20
Lunch Breack	/	12:20-13:30
Afternoon Session		
Talk 4	Zhiwu Li	13:30-14:15
Talk 5	Majid Zamani	14:15-15:00
Tea Break	/	15:00-15:15
Talk 6	Xiang Yin	15:15-16:00
Panel Discussion	All Speakers/Audiences	16:00-17:00

7 Diversity Statement

- **Geography Diversity:**

  The organizers and the speakers of the workshop are from seven different countries/regions in three continents, including China, Cyprus, Macau, Italy, Singapore, UK and US. We believe that the proposed workshop will also attract more researchers from different countries.

- **Background Diversity:** The speakers of the workshop are active in both the discrete-event systems community and the hyrbid systems community. We believe that the proposed workshop will attract attentions from both communities.