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International Graduate School on Control

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M13 – MARSEILLE
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Introduction to Discrete Event Systems

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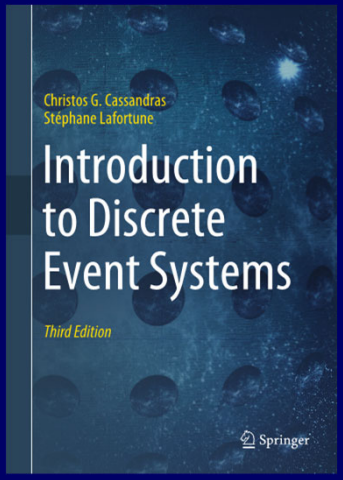
Course summary:

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: *Introduction to Discrete Event Systems – Third edition, Springer, 2021*
https://www.springer.com/gp/book/9783030722722

Course outline:

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