



PhD program in Automatic Control, Bioengineering and Operations Research (ABRO)

## 2023 ABRO Course on Advances in Automatic Control

### Discrete-time and sampled-data control systems

March 2023

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#### Module 1. Problems and challenges in nonlinear discrete-time and sampled-data control

Salvatore Monaco, DIAG Sapienza ([monaco@diag.uniroma1.it](mailto:monaco@diag.uniroma1.it))

The analysis and control of nonlinear systems which evolve in discrete-time or come from the sampling of continuous-time ones fed by piecewise constant controls open toward problems still partially unsolved. Starting from known concepts and properties which are at the basis of the study in the linear context, the purpose of this short course is to introduce to ad hoc techniques and suitable restatements for solving the problems and face the challenges still open in the nonlinear context. The major question, such as the link between the structure of the dynamics and the geometry of the state space, its connection with the input-output behaviors, the characterization of the zero-dynamics, the peculiarities in the concept of passivity and in the definition of Hamiltonian dynamics, the new challenges in the multiagent context are introduced and investigated.

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#### Module 2. On the structure and the geometrical properties of discrete-time dynamical systems

Claudia Califano, DIAG Sapienza ([califano@diag.uniroma1.it](mailto:califano@diag.uniroma1.it))

The aim of this lecture is to show how the geometric techniques can be used to identify the equivalence (or feedback equivalence) of a given nonlinear system to one with a specific structure which can be used to address more powerfully control problems.

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#### Module 3. Computable sampled-data models in the analysis and control

Paolo Di Giamberardino, DIAG Sapienza ([digiamberardino@diag.uniroma1.it](mailto:digiamberardino@diag.uniroma1.it))

Sampling of nonlinear dynamics: the problem of integration of differential equations for nonlinearizable systems. Solutions for different classes of systems: exact and finite computable solutions. Existence of solutions under coordinates changes and/or state feedback: equivalence of dynamics. Kinematic systems, dynamic systems, the role of drift and equivalences. Discrete time control design for continuous time systems: planning and control. Examples.

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#### Module 4. Elements of analysis and design of multiagent discrete-time systems

Mattia Mattioni, DIAG Sapienza ([mattioni@diag.uniroma1.it](mailto:mattioni@diag.uniroma1.it))

Multi-agent systems typically involve numerous dynamical units exchanging information with the aim of cooperating toward a common goal. In general, typical problems in this context are recast in terms of consensus control: the idea is to define a control, local to each agent and based on the information gathered from the network, making all agents converge toward a common trajectory. In this



framework, several issues naturally arise that are involved with sampled-data and discrete-time systems. For instance, the dynamics of all agents are distinct and nonlinear and fed by piecewise constant signals with different sampling periods. Also, the information exchange is generally sporadic in time and asynchronous for all agents. In this sense, the effect of sampling over network of simple multi-agent systems will be presented emphasizing on the main differences with respect to classic (continuous-time networks) and the opening challenges in both modeling and control problems.

## Program at a glance

	When	Room	Who	Title
Module 1	March 23, 2023 14:00-18:00	A6	S. Monaco	<b>Problems and challenges in nonlinear discrete-time and sampled- data control.</b>
Module 2	March 27, 2023 14:00-18:00	Aula Magna	C. Califano	<b>On the structure and the geometrical properties of discrete-time dynamical systems</b>
Module 3	March 29, 2023 14:00-18:00	Aula Magna	P. Di Giamberardino	<b>Computable sampled-data models in the analysis and control</b>
Module 4	March 31, 2023 14:00-18:00	Aula Magna	M. Mattioni	<b>Elements of analysis and design of multiagent discrete-time systems</b>

All lectures will be given at **DIAG**, Via Ariosto 25, 00185 Rome Italy, and also streamed on **Zoom**  
<https://uniroma1.zoom.us/j/98204825675?pwd=RmRCUnEycHpHSFIYdkczMG9zTzFWdz09>  
ID riunione: 982 0482 5675  
Passcode: 727824

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