🎓 DAuSy Doctoral Research Seminars

The National Doctoral Program in Autonomous Systems (DAuSy) is pleased to announce a series of **research seminars** aimed at disseminating the doctoral activities carried out within the program. DAuSy Students will present their research to fellow postgraduate students and Professors, fostering scientific exchange and collaboration.

🗓 **Dates: May 7th, 14th, and 21st, 2025**

🕔 **Time: 5:00 PM – 7:30 PM (CET)**

💻 **Platform: Microsoft Teams (online)**

Each session includes **8 presentations**, with a **15-minute slot per speaker** (Q&A included).

Participation is **free of charge**, but **registration is mandatory** by **May 7th, 2025**, for all sessions, via the links below:

🔗 Register for May 7th, 2025:
https://events.teams.microsoft.com/event/5f2149aa-ee6d-4965-9b60-f26eb8b8d0ef@5b406aab-a1f1-4f13-a7aa-dd573da3d332

🔗 Register for May 14th, 2025:
https://events.teams.microsoft.com/event/b6df62bd-4bd2-447c-b5e4-6e879c0b0bb2@5b406aab-a1f1-4f13-a7aa-dd573da3d332

🔗 Register for May 21st, 2025:
https://events.teams.microsoft.com/event/e74bbd3d-7335-49c3-b3d7-f9a5cc56d940@5b406aab-a1f1-4f13-a7aa-dd573da3d332

🎓 Academic Credits

DAuSy and PoliBa PhD Students will receive 1 ECTS credit for the attendance

👥 Organising Committee

Prof. M. Dotoli, Prof. A. Cavallo, Prof. L. Giarrè, Prof. F. Pascucci, Prof. R. Carli

📧 Contact & Info

For inquiries, please contact Engr. Gaetano Pavone: gaetano.pavone@poliba.it

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🌓 Technical Sponsors

PROGRAM

May 7th, 2025 – Chair: Prof. Alberto Cavallo (Università degli Studi della Campania "L. Vanvitelli")

Speaker	***Title***
FRANCESCO CAMPREGHER (Università degli Studi di Brescia)	Advanced control strategies with applications to sustainable bioprocesses
DENIS TOGNOLO (*Università degli Studi di Verona*)	Autonomous Navigation in Orchard Rows: A Vision-Based Local Motion Planner Exploiting Smooth Transition Functions
ALESSANDRO DI BIASE (*Università Politecnica delle Marche*)	Development of methods for non-linear optimal control based on Riccati equation
ANTONIO DI PAOLA (*Università di Roma "La Sapienza"*)	Optimal routing strategies in satellite communication networks
GIORGIO MANCA (*Università degli Studi di Roma Tor Vergata*)	Enhancing the performance of extended Kalman filters through covariance estimation
SAJJAD MIRALIZADEH JALALAT (*Univ. degli Studi della Campania "L. Vanvitelli"*)	Machine Learning-based detection of fault type and location in electric distribution networks
NADIA NAZ (*Università degli Studi di Parma*)	Optimized Feedforward Control for the Coadministration of Propofol and Remifentanil for Induction of Hypnosis in General Anesthesia
VITTORIA SOCCI (*Università degli Studi di Siena*)	MAS - Mathematics in service to the city: Agent-Based Models for Sustainable Siena

May 14th, 2025 – Chair: Prof. Laura Giarrè (Università di Modena e Reggio Emilia)

Speaker	***Title***
AMARNATH VENKATACHALAM (*Università degli Studi di Catania*)	Control of Chimera States through Higher-Order Interactions
PIETRO BONSANTO (*Università degli Studi dell'Aquila*)	On the digital control for vehicular platoon exploiting macroscopic information
MAHSA GHAVAMI (*Università degli Studi del Sannio*)	Decentralized game solution for charging schedule of electric vehicles
MOHAMMAD JEDDI (*Università di Modena e Reggio Emilia*)	Safety-driven mixed model and learning-based motion planning and control of autonomous systems
MOHAMED MAHMOUD ABDELWAHAB MOHAMED (*Università degli Studi di Padova*)	Enhancing Computational Complexity of MC-PILCO
GABRIELE GEMIGNANI (*Università di Pisa*)	High-level Task Coordination and Decision-Making Loops through Single- and Multi-Agent Deep Reinforcement Learning
MOJTABA PORGHOVEH (*Politecnico di Bari*)	BCI frameworks with optimum EEG channels for drone-operator interface in logistics
DANIEL-COSTEL BOULEANU (*Università della Calabria*)	Multi-agent Systems Methodologies and Frameworks for Edge-AI in Smart Environments

May 21st, 2025 – Chair: Prof. Federica Pascucci (Università Roma Tre)

Speaker	***Title***
SIMONE GENTILE (*Università di Roma "La Sapienza"*)	Federated Data-Driven Control for Fault Recovery in Wireless Networks
CLAUDIA DELPRETE (*Politecnico di Bari*)	Unsupervised Deep Learning Methods for Polyp Detection and Segmentation in Colonoscopy Images
OLHA POHUDINA (*Politecnico di Bari*)	5G & UWB Integration with IMU Sensors: Advancing Precision Positioning
SARA GOMIERO (*Libera Università di Bolzano*)	Higher Order Sliding Mode Controllers and Observers for Cargo Drones
VALERIANA MANCAZZO (*Politecnico di Bari*)	A multimodal approach for multiple sclerosis disease: MRI lesion segmentation and motor evoked potentials classification with Transformers
PIETRO MARIA MARVULLI (*Politecnico di Bari*)	Multimodal Framework for Predicting TACE Response Using Clinical and CT Imaging Features
ZOHREH SHAHROUEI (*Università degli Studi di Cagliari*)	Management and automation systems for energy management in buildings and industrial processes
GIULIA D'ADDATO (*Università degli Studi di Trento*)	Socially-Aware Opinion-Based Navigation in Shared Human-Robot Spaces

ABSTRACTS – Session 1

May 7th 2025 – Chair: Prof. Alberto Cavallo (Università degli Studi della Campania "L. Vanvitelli")

FRANCESCO CAMPREGHER (*Università degli Studi di Brescia*)

Advanced control strategies with applications to sustainable bioprocesses

This PhD research focuses on wastewater treatment using microalgae, which simultaneously reduces CO_2 emissions and produces biofuel. The study aims to optimize plant performance through identification and control strategies. Additionally, the research explores the development and generalization of the Proportional-Integral-Derivative-Accelerative (PIDA) controller for broader industrial applications.

DENIS TOGNOLO (*Università degli Studi di Verona*)

Autonomous Navigation in Orchard Rows: A Vision-Based Local Motion Planner Exploiting Smooth Transition Functions

Autonomous navigation in agriculture is challenging due to environmental variability. Our system enables a rover to navigate orchard rows and execute precise turns at their ends. A unified control law, driven by a computer vision system, dynamically switches between these behaviors, using a smooth transition function inspired by bumpless transfer control techniques. This method ensures seamless and robust navigation, relying only on local data such as an RGB-D camera and odometry.

ALESSANDRO DI BIASE (*Università Politecnica delle Marche*)

Development of methods for non-linear optimal control based on Riccati equation

In the framework of Optimal Control methods, the Riccati Equation-based is promising due to its remarkable effectiveness. While the linear case provides analytical solutions, extending this methodology to non-linear systems is a significant challenge. The commonly adopted approach based on the numerical pointwise evaluation of the Riccati Equation solution is computationally intensive and suboptimal. We developed methods to decrease computational effort and increase performances.

ANTONIO DI PAOLA (*Università di Roma "La Sapienza"*)

Optimal routing strategies in satellite communication networks

In satellite communications, ensuring timely delivery of high-bandwidth data remains a persistent challenge. Conventional methods face limitations in adapting to dynamic network conditions, resulting in suboptimal performance and high end-to-end latency. This seminar presents an RL-based multipath routing strategy in satellite networks, aimed at minimizing video file delivery time in EO missions and some theoretical results on minimum-time optimal control of dynamical flow networks.

GIORGIO MANCA (*Università degli Studi di Roma Tor Vergata*)

Enhancing the performance of extended Kalman filters through covariance estimation

The extended Kalman filter is widely used for state estimation in (non)linear dynamic systems, and its performance critically depends on accurately choosing process and measurement noise covariance matrices. This work proposes a

systematic method for optimizing these matrices via numerical gradient descent, using Monte Carlo techniques to enhance noise robustness and Riemannian manifold optimization to ensure positive definiteness. Two numerical examples validate the improved filter performance.

SAJJAD MIRALIZADEH JALALAT (*Università degli Studi della Campania Luigi Vanvitelli*)

Machine Learning-based detection of fault type and location in electric distribution networks

Faults cause economic losses, equipment damage, and blackouts in distribution networks. They induce rapid voltage and current fluctuations. A machine learning-based detection method is proposed, using Wavelet Packet Transform on superimposed three-phase voltage signals for high accuracy and noise robustness. The approach identifies fault types and locations, considering Renewable Energy Source uncertainties. Monitoring Unit placement is also optimized via a Voltage Stability Index framework.

NADIA NAZ (*Università degli Studi di Parma*)

Optimized Feedforward Control for the Coadministration of Propofol and Remifentanil for Induction of Hypnosis in General Anesthesia

General anesthesia is a crucial component of invasive medical procedures. Our main focus is the optimization of the simultaneous infusion of propofol and remifentanil during induction. In particular, we compute a feedforward infusion rate that allows bringing the BIS value below an assigned threshold in minimum time, while ensuring that the BIS remains above an assigned minimum value. We use a two-drug model, that takes into account the synergistic effect of the two drugs. Due to the expression of the Hill function, the constraint of maintaining the BIS in a given interval is non-convex. In this paper, we use a convex tightening of this constraint to formulate the overall optimal control task as a convex optimization problem. Through simulation experiments, we show that this hybrid feedforward-feedback strategy achieves faster BIS stabilization while maintaining safe and clinically acceptable infusion rates.

VITTORIA SOCCI (*Università degli Studi di Siena*)

MAS - Mathematics in service to the city: Agent-Based Models for Sustainable Siena

We built an Agent-Based Model to explore how cooperation related to sustainable behaviors spreads among citizens in Siena, using new data collected in 2024. The data reveal differences in environmental awareness by gender, age, education, and area of residence. ABM simulations on subgroups reflect these differences: groups with higher awareness show greater ability to sustain cooperation, even when individual incentives to defect increase.

ABSTRACTS – Session 2

May 14th 2025 – Chair: Prof. Laura Giarrè (Università di Modena e Reggio Emilia)

AMARNATH VENKATACHALAM (*Università degli Studi di Catania*)

Control of Chimera States through Higher-Order Interactions

Chimera states, where synchronized and desynchronized regions coexist, are well-studied with pairwise interactions. Recent studies show that higher-order interactions, involving multiple oscillators, significantly impact their emergence. We explore how these interactions shape and control chimera states in Stuart-Landau oscillators. Focusing on four-body interactions, we show they influence phase chimera states, allowing controlled coexistence of synchronized and desynchronized region.

PIETRO BONSANTO (*Università degli Studi dell'Aquila*)

On the digital control for vehicular platoon exploiting macroscopic information

In this talk, the use of macroscopic information to enforce performances of a vehicular platoon is investigated, aiming at ensuring string stability and disturbance string stability. Digital controllers are enforced to ensure the desired properties, while coping with nonidealities such as sampling and quantization. Numerical simulations validate the proposed controller for traffic oscillation mitigation.

MAHSA GHAVAMI (*Università degli Studi del Sannio*)

Decentralized game solution for charging schedule of electric vehicles

This paper presents a mixed-integer game-theoretic equilibrium analysis of a system involving Electric Vehicles (EVs) and the Generation Unit Operator (GUO) as players, with the Charging Station Operator (CSO) as the coordinator. EVs aim to optimize their charging profiles during the charging period by minimizing both battery degradation costs and deviations from their desired State-of-Charge (SoC). Meanwhile, GUO seeks to optimize the energy generation of the installed generator at the charging station, minimizing generation costs while satisfying capacity, supply, and demand constraints for the EVs. A decentralized learning approach is proposed to maintain the privacy of both EVs and GUO.

MOHAMMAD JEDDI (*Università di Modena e Reggio Emilia*)

Safety-driven mixed model and learning-based motion planning and control of autonomous systems

This research focuses on motion planning and control for autonomous driving at intersections, integrating model-based and learning-based approaches. The goal is to develop safe and adaptive algorithms that improve efficiency, adaptability, and performance guarantees. Learning-based methods enhance computational efficiency, while model-based techniques ensure safety and reliability, addressing current challenges and advancing state-of-the-art autonomous systems.

MOHAMED MAHMOUD ABDELWAHAB MOHAMED (*Università degli Studi di Padova*)

Enhancing Computational Complexity of MC-PILCO

Our method explores using Gaussian Process (GP) approximations to reduce the computational complexity of policy optimization in the MC-PILCO algorithm. By applying subset-of-regressor methods and careful inducing point selection, it enhances efficiency in model-based reinforcement learning for robotic systems.

GABRIELE GEMIGNANI (*Università di Pisa*)

High-level Task Coordination and Decision-Making Loops through Single- and Multi-Agent Deep Reinforcement Learning

The project explores various Reinforcement Learning frameworks for training high-level decision-making agents in scenarios with complex, dynamic, energetically and time-consuming tasks. It also extends to fleets of neural agents working together toward shared goals, addressing challenges related to communication and heterogeneity in robots' skills.

MOJTABA PORGHOVEH (*Politecnico di Bari*)

BCI frameworks with optimum EEG channels for drone-operator interface in logistics

Advances in tech enable EEG-based brain-computer interfaces (BCIs) which can have many applications from medical diagnosis to automate the order taking from the operators in logistics and other users. Due to EEG noise, optimal channel selection is key. This study presents four frameworks combining denoising, FSFS, ICA, and classifiers (SVM, neural nets). The best method uses Butterworth wavelet filtering, ICA for channel selection, and fuzzy MLP for classification. It improves BCI performance while reducing channels and computational cost, aiding real-time use for neuromuscular disability support.

DANIEL-COSTEL BOULEANU (*Università della Calabria*)

Multi-agent Systems Methodologies and Frameworks for Edge-AI in Smart Environments

We aim to develop an architectural model for simulating our agent-based IoT system as an optimal control problem—defining states, dynamics, control goals, and constraints. By agentifying IoT devices, we enhance autonomy and decision-making. The model will support a simulation environment for experiments, insights, and data collection, contributing to academic work and my thesis.

ABSTRACTS – Session 3

May 21st 2025 – Chair: Prof. Federica Pascucci (Università Roma Tre)

SIMONE GENTILE (*Università di Roma "La Sapienza"*)

Federated Data-Driven Control for Fault Recovery in Wireless Networks

The adoption of data-driven control methods offers an effective solution for cell outage detection and compensation in next-generation wireless networks. This seminar explores advanced techniques based on federated learning models to strengthen network resilience. The proposed approaches enhance reliability and service continuity in 5G and beyond, enabling dynamic adaptation to evolving network conditions.

CLAUDIA DELPRETE (*Politecnico di Bari*)

Unsupervised Deep Learning Methods for Polyp Detection and Segmentation in Colonoscopy Images

The research explored unsupervised Deep Learning methods for polyp detection and segmentation in colonoscopy images, using the HyperKvasir dataset for evaluation. F-AnoGAN, a reconstruction-based model, achieved an Area Under the Curve of 0.98. MemSeg, a memory-based model, yielded promising results. Experiments focused on further enhancing segmentation performance and a comparison with state-of-the-art methods are ongoing. Future work will aim to improve generalization using multi-center data.

OLHA POHUDINA (*Politecnico di Bari*)

5G & UWB Integration with IMU Sensors: Advancing Precision Positioning

This work presents the results of a localization system simulation for smart warehouse applications. A simulation model was developed to analyze the scalability of object localization, considering the application of UWB technology in indoor environments. This model incorporates various signal exchange protocols between anchors and tags, as well as the integration of inertial sensor data to determine the frequency of coordinate estimation. The model was developed in the Omnet++ system.

SARA GOMIERO (*Libera Università di Bolzano*)

Higher Order Sliding Mode Controllers and Observers for Cargo Drones

Cargo drones are opening new possibilities in the field of transportation, search and rescue and delivery. To allow their inclusion in cluttered environments, it is necessary to implement controllers and observers which are robust against disturbances and uncertainties. In contrast with PID controllers, usually employed in UAV companies, this talk proposes higher order sliding mode controllers and observers to solve the trajectory tracking problem of quadrotors with cable-suspended loads.

VALERIANA MANCAZZO (*Politecnico di Bari*)

A multimodal approach for multiple sclerosis disease: MRI lesion segmentation and motor evoked potentials classification with Transformers

As part of a Digital Twin framework, this project combines two tasks on multiple sclerosis using Transformer-based models. First, magnetic resonance imaging scans from six datasets are analyzed and preprocessed for the automatic lesion segmentation, employing a UNETR-based model; second, motor evoked potentials data are collected and

classified by a Vision Transformer for the prediction of motor disability progression, exploring the potential of multimodal integration in clinical modeling.

PIETRO MARIA MARVULLI (*Politecnico di Bari*)

Multimodal Framework for Predicting TACE Response Using Clinical and CT Imaging Features

My project focuses on developing a framework that utilizes multimodal data to predict the response to Trans Arterial Chemoembolization treatment. It integrates clinical data and pre-treatment CT scans from 105 patients. Images are used for radiomic feature extraction and processed by deep learning models to extract deep features using a pretrained Vision Transformer. Various combinations of clinical, radiomics, and deep features are used as input data to train machine learning models to assess prediction accuracy.

ZOHREH SHAHROUEI (*Università degli Studi di Cagliari*)

Management and automation systems for energy management in buildings and industrial processes

This research aims to develop a flexible energy management approach for residential and industrial buildings. It focuses on analyzing the impact of a building's thermal characteristics on optimization results, assessing the sensitivity of optimization to thermal parameters. Additionally, it examines the effect of varying the prediction horizon in the MPC approach. Optimization performance indexes will be defined, and the proposed method will be validated through a real case study.

GIULIA D'ADDATO (*Università degli Studi di Trento*)

Socially-Aware Opinion-Based Navigation in Shared Human-Robot Spaces

Robots in shared human spaces need to navigate safely while respecting social norms. Our method supports both collision avoidance and active influence to ensure smooth and socially acceptable paths. Using opinion dynamics and vortex fields, robots dynamically negotiate motion and generate human-like trajectories. In scenarios requiring influence instead, robot opinion dynamics can be modified to shape human decisions, while Lyapunov-based control ensures stability and predictable interactions.
