UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DOTTORATO DI RICERCA / PHD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

Activities and Publications Report

PhD Student: Bianca Caiazzo

Student ID: DR993884

PhD Cycle: XXXV
PhD Cycle Chairman: Prof. Stefano Russo

PhD program student's start date: 01/11/2019
PhD program student's end date: 31/01/2023

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PhD scholarship funding entity: Università Federico II.

General information

Bianca Caiazzo received in year 2019 the Master Science degree in Management Engineering from the University of Napoli Federico II. She attended a curriculum in Automatic Control within the PhD program in Information Technology and Electrical Engineering. She received a grant from Università Federico II.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1st	Intelligenza artificiale ed etica: la ricerca in IA alla prova delle sfide etiche	Ad hoc course	1.6	Daniele Amoroso (Dipartimento di Giurisprudenza, Università di Cagliari); Pietro A. Bonatti (DIETI); Josè M. Galvan (Dipartimento di Teologia Morale, Pontificia Università della Santa Croce, Roma); Riccardo Guidotti (KDD-Lab – ISTI-CNR, Pisa); Paola Inverardi (DISIM, Università degli studi dell'Aquila); Roberto Prevete (DIETI); Luciano Serafini (ICT, Fondazione Bruno Kessler, Trento); Viola Schiaffonati (Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano)	ITEE
1st	Safety critical systems for railway traffic management	Ad hoc course	3.3	Dr. Mario Barbareschi (Rete Ferroviaria Italiana)	ITEE
1st	Matlab foundamentals	Ad hoc course	2	Prof. Agostino De Marco, with: Dr. Stefano Marrone, Dr. Francesco Orefice	DIETI and Scuola Politecnica e delle Scienze di Base - UNINA
1st	Scientific programming and visualization with python	Ad hoc course	2	Prof. Alessio Botta (DIETI)	DiSt department - Scuola Politecnica e delle Scienze di Base - UNINA
1st	Innovation management, entrepeneurship and	Ad hoc course	5	Prof. Pierluigi Rippa (Dipartimento di Ingegneria	Prof. Pierluigi Rippa - StartCup

	intellectual property			Industriale, Università di Napoli Federico II)	Campania 2020
1st	Big data analytics and business intelligence	MSc course	6	Prof. Antonio Picariello; Prof. Vincenzo Moscato	DIETI
1st	Machine Learning	Ad hoc course	3.6	Marco Aiello, Anna Corazza, Diego Gragnaniello, Francesco Isgrò, Roberto Prevete, Francesco Raimondi, Carlo Sansone	ITEE - ICTH
1st	Intelligenza Artificiale	MSc course	6	Prof. Flora Amato	DIETI
2nd	From observability to privacy and security in discrete event systems	Ad hoc course	5	Prof. Gianmaria De Tommasi; Prof. Francesco Basile; Prof. Claudio Sterle	ITEE
2nd	Control System for Autonomous Ground Vehicles	MSc course	6	Prof. Stefania Santini	Dipartimento di Ingegneria Industriale (DII)

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1st	Model predictive control	Online event	4.6	3/06/2020-10/06/2020	Scuola IMT Alti Studi di Lucca (Lecturer: Prof. Alberto Bemporad)
1st	Time-Delay and Sampled-data Systems	Online event	3	7/09/2020-11/09/2020	EECI 2020-International Graduate School on Control (Lecturers: Prof. Emilia Fridman and Prof. Pierdomenico Pepe)

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	A dynamic and probabilistic orienteering problem	0.2	Prof. Claudia Archetti	Department of Information Systems, Decision Sciences and Statistics, ESSEC Business School in Paris	ITEE
1st	Flexible two-echelon location-routing for supply networks	0.2	Prof. Claudia Archetti	Department of Information Systems, Decision Sciences and Statistics, ESSEC Business School in	ITEE

				Paris	
1st	Lo spazio cibernetico nel dominio bellico	0.4	Dott. Gian Piero Siroli	Università di Bologna (Dipartimento di Fisica e Astronomia)	ITEE
1st	Deep learning onramp	0.4	Ing. Stefano Marrone	DIETI	ITEE
1st	L'ingegnere nel business dell'energia	1	Dr. Paolo Pietrogrande	Founder and managing partner of Netplan Management Consulting LLC (Delaware)	Dipartimento di Ingegneria Industriale (DII)
1st	Marked point processes for object detection and tracking in high resolution images: application to remote sensing data	0.3	Prof. Josiane Zerubia	INRIA Sophia-Antipolis Méditerranée	ITEE
1st	Cybersecurity and fuzzing for robots, blockchain, and more	0.2	Dott. Antonio Ken Iannillo	SnT - Université du Luxembourg	ITEE
1st	Computational Biology: large scale data analysis to understand the molecular bases of human diseases	0.2	Prof. Michele Ceccarelli	DIETI	ITEE - ICTH
1st	Elettromagnetismo e salute	0.2	Prof. Rita Massa	UNINA	UNINA
1st	Webinar: "How to get published with IEEE"	0.4	Dr.ssa Eszter Lukacs	IEEE Client Services Manager Europe	ITEE
1st	Access the eLearning library on IEEE Xplore	0.2	Dr.ssa Eszter Lukacs	IEEE Client Services Manager Europe	IEEE
1st	Large scale training of Deep Neural Network	0.4	Giuseppe Fiameni, PhD	NVIDIA	IEEE
1st	Design e nuove tecnologie. Possibili scenari per fronteggiare l'emergenza	0.2	Amleto Picerno Ceraso	INNOVATION VILLAGE 2020	UNINA
1st	La programmazione europea e la ricerca. Nuovi scenari della programmazione europea dopo il 2020	0.4	Filippo Ammirati	INNOVATION VILLAGE 2020	UNINA
1st	Health 4.0-La rapidità della medicina e la velocità del cambiamento del nostro	0.4	Paolo Netti	INNOVATION VILLAGE 2020	UNINA

	mondo organizzato da Università degli studi di Napoli Federico II				
1st	Realtà virtuale e salute reale. Health 4.0-Dal bit alla mente: spazi virtuali per la salute	0.5	Valentino Megale	TecUp - INNOVATION VILLAGE 2020	UNINA
1st	Planning 5G under EMF constraints: challenges and opportunities	0.4	Prof. Luca Chiaraviglio	University of Rome Tor Vergata, Rome, Italy	ITEE
1st	Joint design of optics and post-processing algorithms based on deep learning for generating advanced imaging features	0.4	Raja Giryes; Laura Waller; Michael Unser; Katie Bouman; Yoram Bresler; Orazio Gallo; Saiprasad Ravishankar	Tel Aviv University; UC Berkeley; EPFL; Caltech; UIUC; Nvidia; Michigan State University	IEEE SPS
1st	Virtual seminars on sensing	0.8	J. Wenger, C.;Rockstuhl, L. Baldassarre, M. Fleischer	Institute Fresnel, France; Karlsruher Institut fur Technologie, Germany; Sapienza University of Rome; Universitat Tubingen, Germany	DIETI
2nd	Telemedicina in Italia: casi di successo	0.3	Dott. Maurizio Nardi	NA	DIETI
2nd	Robot Manipulation and control	0.5	Prof. Bruno Siciliano	DIETI	ITEE
2nd	Digital Management: practices, techniques, tools, and scientific approach	0.4	Prof. Dario Carotenuto	Project Management Institute	DIETI
2nd	L'esperienza del progetto di teleriabilitazione NEUROLAB	0.3	Ing. D. Furno; L. Romanelli	NA	DIETI
2nd	Images, Texts, Emojis & Geodata in a Sentiment Analysis pipeline	0.3	Dr. Serena Pelosi	University of Salerno	DIETI
2nd	Telemedicina, e-health e mobile-health: si può davvero usare il digitale nel percorso assistenziale?	0.3	Dott.ssa Simonetta Scalvini	NA	DIETI
2nd	Patent Searching Best	0.2	Dr.ssa Eszter	IEEE Client Services	IEEE

	Practices with IEEE Xplore		Lukacs	Manager Europe	
2nd	At the Nexus of Big Data, Machine Intelligence and Human Cognition	0.2	Prof. George S. Djorgovski	California Institute of Technology	DIETI
2nd	From Photometric redshifts to improved weather forecasts: an interdisciplinary view on machine learning	0.2	Kai Polsterer	Heidelberg Institute for Theoretical Studies - HITS	DIETI
2nd	Cybercrime and e-evidence: the criminal justice response	0.4	Matteo Lucchetti, PhD	Programme Manager Cybercrime – Council of Europe	DIETI
2nd	AI legal: Artificial intelligence for notary's sector- a case study	0.2	Salvatore Palange	CEO and Founder – FLUEL (Innovation for Business)	DIETI
2nd	Machine learning: causality lost in traslation	0.3	Edwin A. Valentijn	University of Groningen The Netherlands	DIETI
2nd	Approaches to graph machine learning	0.2	Miroslav Cepek	ORACLE LABS	DIETI
2nd	Visual Interaction and Communication in Data Science	0.4	Marco Quartulli	Vicomtech (Spagna)	DIETI
2nd	Robo Ludens: a game design taxonomy for human-robot interaction	0.2	Dr. John Edison Muñoz Cardona	University of Waterloo, Canada	ITEE
2nd	Parameter Sensitivity in Time Delay System	0.2	Prof. Gabor Stèpàn	Budapest University of Technology and Economics	IFAC working group on Time-Delay System
2nd	Artificial Intelligence and 5G combined with holographic technology: a new perspective for remote health monitoring	0.4	Dr. Pietro Ferraro; Dr. Pasquale Memmolo	Istituto di Scienze applicate e Sistemi Intelligenti "Eduardo Caianiello", Consiglio Nazionale delle Ricerche	DIETI
2nd	Delay-Adaptive Linear Control	0.2	Prof. Miroslav Krstic	Mechanical and Aerospace Engineering University of California, San Diego	IFAC working group on Time-Delay System
2nd	End-to-end optimization of augmented experience	0.8	Dr. Jaime Llorca	Tandon School of Engineering, New	DIETI

	services over cloud-integrated 5G networks			York University, NY, USA	
2nd	L'esposizione ai campi elettromagnetici generate dal Sistema 5G	0.8	Dr. Sara Adda; Dr. Daniele Franci; Eng. Sittimio Pavoncello	Agenzia Regionale per la Protezione Ambientale del Piedimonte – Dipartimento Rischi Fisici e Tecnologici; Agenzia Regionale per la Protezione Ambientale del Lazio	ITEE
2nd	Delays, dynamics and singularity tracking. A guided tour	0.2	Prof. Silviu – Iulian Niculescu	CNRS, Laboratory of Signals and Systems	IFAC working group on Time-Delay System
3rd	Complexity and the City: transitioning towards the smart cities of the future	0.3	Prof. Luis Bettencourt	University of Chicago	Modeling and Engineering Risk and Complexity research program of the Scuola Superiore Meridionale
3rd	Using delays for control	0.2	Prof. Emilia Fridman	Tel Aviv University (TAU)	IFAC working group on Time-Delay System
3rd	Input-to-State Stability of switched systems under dwell-time conditions	0.2	Aneel Tanwani	LAAS-CNRS, Toulouse, France	Part of Online Seminar on Input-to-State Stability and its Applications
3rd	Nonlinear Halanay's inequalities for ISS of Retarded Systems: the continuous and discrete time case	0.2	Prof. Pierdomenico Pepe	University of L'Aquila	Part of Online Seminar on Input-to-State Stability and its Applications
3rd	Dissipativity tools for convergence to Nash equilibria in population games	0.2	Prof. Murat Arcak	University of California Berkeley	IFAC/IEEE joint webinar series on Nonlinear Control Systems
3rd	Implementable event-triggered controllers for networked cyber-physical systems	0.2	Prof. Cameron Nowzari	George Mason University	Zoom Control and Optimization Seminar
3rd	Synchronization, networks, time-delays and more	0.2	Prof. Henk Nijmeijer	Department of Mechanical Engineering, Eindhoven University of	IFAC working group on Time-Delay System

				Technology	
3rd	Using Delays for control-part 1	0.2	Prof. Emilia Fridman	Tel Aviv University (TAU)	ITEE
3rd	Using Delays for control-part 2	0.2	Prof. Emilia Fridman	Tel Aviv University (TAU)	ITEE
3rd	Back and forth between the infinite and the finite: a numerical view of time delay systems	0.2	Prof. Dimitri Breda	University of Udine	IFAC working group on Time-Delay System

Research activities

Bianca Caiazzo participated in the research related on the design of distributed control strategies for Multi-Agent Systems (MASs) in a Networked Control Systems (NCS) perspective, with application in different research fields, such as autonomous driving and, in particular, smart power systems as Microgrids. During these three years, the focus of the research activities relies on two key points: 1) cooperative control of MASs; 2) time-delay systems and sampled-data control. Based on these latter, the following main contributions emerges from her research activities:

A. Designing of finite-time distributed cooperative control strategies able to cope with time-varying communication delays, as well as providing delay-dependent stability conditions with a gain-tuning rule;
B. Designing of a distributed cooperative control strategy which does not require any knowledge about global Microgrid information, such as communication graph topology, system dynamics and/or bound of external disturbances, thus counteracting any kind of unmodeled dynamics/unknown uncertainties/unbounded disturbances, while guaranteeing asymptotic stability;
C. Designing of distributed cooperative sampled-data controllers able to reduce communication network workload and save its limited re-sources, without compromising Microgrid control performance.

Moreover, during the period abroad, Bianca Caiazzo focuses her research activity on the stabilization of systems with fast-varying piecewise-continuous coefficients and non-small delays, whose input-to-state is analytically proven by leveraging Lyapunov-Krasovskii theory. Furthermore, these theoretical results are also applied for stabilization of delayed affine systems.

Tutoring and supplementary teaching activities

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1st	37.1	7.2	33.6	0
2nd	11	7	42	0
3rd	0	2.1	68.1	0

Note that, the slight surplus of credits in the research activity comes from 3 additional months in the third year due to the covid extension.

Iter formativo	corsi / scuole	seminari	attività ricerca	tutorato / did. int.
1 anno	min 20 - max 40	min 5 - max 10	min 10 - max 35	min 0 – max 1.6
2 anno	min 10 - max 20	min 5 - max 10	min 30 - max 45	min 0 – max 1.6
3 anno	min 0 - max 10	min 0 - max 10	min 40 - max 60	min 0 – max 1.6
TOTALE	min 30 – max 70	min 10 – max 30	min 80 – max 140	min 0 – max 4.8

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
2nd	Tel Aviv University (TAU), Israel	Prof. Emilia Fridman	13/10/2021-31/10/2021	Research on time delay approach to averaging for the stabilization of systems with fast-varying piecewise-continuous coefficients and non-small delays. Application to delayed switched affine system.
3rd	Tel Aviv University (TAU), Israel	Prof. Emilia Fridman	01/11/2021-12/04/2022	Research on time delay approach to averaging for the stabilization of systems with fast-varying piecewise-continuous coefficients and non-small delays. Application to delayed switched affine system. Preparation of the following papers: 1. Averaging of systems with fast-varying coefficients and non-small delays with application to stabilization of affine systems via time-dependent switching; 2. Synchronization of Multi-Agent Systems under Time-Varying Network via Time-Delay Approach to Averaging. Research on Distributed Dynamic Event-Triggered control for solving voltage regulation problem in islanded Microgrids by using artificial delays approach.

PhD Thesis

In the PhD Thesis, Bianca Caiazzo focuses on the design of distributed control strategies for multi-agent systems with application to modern smart power systems. Recent advances in Information and Communication Technologies, along with the deployment of small-scale distributed generation sources, led to the current energy transition, mainly devoted to decarbonisation of energy sector and net zero greenhouse gas emissions. Microgrids (MGs) represent the conceptualization of this transition, where the combination of physical plants with novel bi-directional measurement and control loops entails the vision of MGs as cyber-physical energy systems in a networked control perspective. Hence, distributed control and multi-agent systems theory are the key enabling tools for MGs optimization and management.

However, the spread of distributed smart nodes within this modern power systems, endowed with sensing/actuation, control and communication capabilities, poses novel issues that cannot be neglected in control design phase to guarantee effective, resilient and reliable MGs operations.
From one side, different communication constraints arise due to the large amount of connected devices, such as: *i*) communication time-delays in information sharing process; *ii*) need of sampled-data formulation of distributed controllers to facilitate their implementation in digital control platform; *iii*) limited communication bandwidth with the need to avoid communication resources waste.

Besides, some fundamental control requirements are expected to be satisfied in MGs operations, namely: *iv*) short convergence time to timely accommodate their fast-changing operating conditions; *v*) resilience to unknown model mismatches, large disturbances/uncertainties affecting the entire MGs dynamics.
The purpose of the thesis is to answer these research questions by designing suitable distributed control protocols aiming at improving the MGs working operating conditions, thus promoting the current green energy revolution.

Publications

Research results appear in *8* papers published in international journals (2 further additional papers are currently under review), *9* contributions to international conferences.

List of scientific publications

International journal papers

1. B. Caiazzo, E. Fridman, X. Yang,
Averaging of systems with fast-varying coefficients and non-small delays with application to stabilization of affine systems via time-dependent switching, Nonlinear Analysis: Hybrid Systems 48 (2023): 101307, DOI: https://doi.org/10.1016/j.nahs.2022.101307.

2. B. Caiazzo, T. Murino, A. Petrillo, G. Piccirillo, S. Santini,
   An IoT-based and cloud-assisted AI-driven monitoring platform for smart manufacturing: design architecture and experimental validation,
   Journal of Manufacturing Technology Management, ahead-of-print (2022). DOI: https://doi.org/10.1108/JMTM-02-2022-0092

3. B. Caiazzo, M. Di Nardo, T. Murino, A. Petrillo, G. Piccirillo, S. Santini,
   Towards Zero Defect Manufacturing paradigm: A review of the state-of-the-art methods and open challenges,
   Computers in Industry 134 (2022): 103548. DOI: https://doi.org/10.1016/j.compind.2021.103548

4. B. Caiazzo, A. Coppola, A. Petrillo, S. Santini,
   Distributed nonlinear model predictive control for connected autonomous electric vehicles platoon with distance-dependent air drag formulation
   Energies 14.16 (2021): 5122. DOI: https://doi.org/10.3390/en14165122

5. B. Caiazzo, D. G. Lui, A. Petrillo, S. Santini,
   Distributed Double-Layer Control for Coordination of Multiplatoons Approaching Road Restriction in the Presence of IoV Communication Delays,
   IEEE Internet of Things Journal 9.6 (2021): 4090-4109. DOI: 10.1109/JIOT.2021.3102841

6. A. Andreotti, B. Caiazzo, A. Petrillo, S. Santini,
   Distributed Robust Finite-Time Secondary Control for Stand-Alone Microgrids With Time-Varying Communication Delays,
   IEEE Access 9 (2021): 59548-59563. DOI: 10.1109/ACCESS.2021.3073779

7. A. Andreotti, B. Caiazzo, A. Petrillo, S. Santini, A. Vaccaro,
   Hierarchical two-layer distributed control architecture for voltage regulation in multiple microgrids in the presence of time-varying delays,
   Energies 13.24 (2020): 6507. DOI: https://doi.org/10.3390/en13246507

8. A. Andreotti, B. Caiazzo, A. Petrillo, S. Santini, A. Vaccaro,
   Decentralized smart grid voltage control by synchronization of linear multiagent systems in the presence of time-varying latencies,
   Electronics 8.12 (2019): 1470. DOI: https://doi.org/10.3390/electronics8121470

International conference papers

1. B. Caiazzo, E. Fridman, A. Petrillo, S. Santini,
   Synchronization of Multi-Agent Systems under Time-Varying Network via Time-Delay Approach to Averaging,
   17th IFAC Workshop on Time Delay Systems TDS 2022
   Montreal, Canada, September 27-30, 2022. IFAC-PapersOnLine, 55(36), 133-138.
   DOI: https://doi.org/10.1016/j.ifacol.2022.11.346

2. B. Caiazzo, D. G. Lui, A. Petrillo, S. Santini,
   Cooperative Finite-time Control for autonomous vehicles platoons with nonuniform V2V communication delays,
   17th IFAC Workshop on Time Delay Systems TDS 2022
   Montreal, Canada, September 27-30, 2022. IFAC-PapersOnLine 55.36 (2022): 145-150.
   DOI: https://doi.org/10.1016/j.ifacol.2022.11.348

3. A. Andreotti, B. Caiazzo, A. Di Pasquale, M. Pagano,
   On Comparing Regressive and Artificial Neural Network Methods for Power System Forecast
   2021 AEIT International Annual Conference (AEIT), (pp. 1-6). IEEE. 04-08 October 2021
   DOI: 10.23919/AEIT53387.2021.9626938

4. B. Caiazzo, D. G. Lui, A. Petrillo, S. Santini,
   Distributed Robust Finite-Time PID control for the leader-following consensus of uncertain Multi-Agent Systems with communication delay,
   2021 29th Mediterranean Conference on Control and Automation (MED),
   Online-event, 22-25 June 2021, (pp. 759-764). IEEE.
   DOI: 10.1109/MED51440.2021.9480293

5. B. Caiazzo, E. Fridman, A. Petrillo, S. Santini,
   Distributed Sampled-data PID Control for Voltage Regulation in Inverter-Based Islanded Microgrids Using Artificial Delays
   16th IFAC Workshop on Time Delay Systems TDS 2021
   Guangzhou, China, 29 September-1 October 2021. IFAC-PapersOnLine 54.18 (2021): 186-191.
   DOI: https://doi.org/10.1016/j.ifacol.2021.11.137

6. B. Caiazzo, D. G. Lui, A. Petrillo, S. Santini,
   On the exponential leader-tracking control for high-order multi-agent systems via distributed PI strategy in the presence of heterogeneous time-varying delays,
   16th IFAC Workshop on Time Delay Systems TDS 2021
   Guangzhou, China, 29 September-1 October 2021. IFAC-PapersOnLine 54.18 (2021): 139-144.
   DOI: https://doi.org/10.1016/j.ifacol.2021.11.129

7. B. Caiazzo, A. Coppola, A. Petrillo, S. Santini,
   Energy-Oriented Inter-Vehicle Distance Optimization for Heterogeneous E-Platoons,
   AIRO Workshop 2021
   Optimization and Data Science: Trends and Applications. Springer, Cham, 2021. 113-125.
   DOI: https://doi.org/10.1007/978-3-030-86286-2_9

8. A. Andreotti, B. Caiazzo, A. Petrillo, S. Santini, A. Vaccaro
   Robust Finite-time Voltage Restoration in Inverter-Based Microgrids via Distributed Cooperative Control in presence of communication time-varying delays
   2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe). IEEE, 2020.
   DOI: 10.1109/EEEIC/ICPSEurope49358.2020.9160502

9. G.N. Bifulco, B. Caiazzo, A. Coppola, S. Santini,
   Intersection crossing in mixed traffic flow environment leveraging v2x information,
   2019 IEEE International Conference on Connected Vehicles and Expo (ICCVE). IEEE, 2019.
   Graz, Austria, 04-08 November 2019
   DOI: 10.1109/ICCVE45908.2019.8965228

Patents and/or spin offs

Awards and Prizes

Date 13/01/2023

PhD student signature 

Supervisor signature