PhD in Information Technology and Electrical Engineering
Università degli Studi di Napoli Federico II

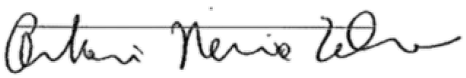
PhD Student:

Cycle: XXXIX

Training and Research Activities Report

Academic year: 2024-25 - PhD Year: Second

Tutor: prof. Antonia Maria Tulino



Co-Tutor: prof. Jaime Llorca

Date: October 31, 2025

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXIX **Author: Alessandro Mauro**

1. Information:

- **PhD student: Alessandro Mauro** **PhD Cycle: XXXIX**
- **DR number: DR997205**
- **Date of birth: 23/09/1998**
- **Master Science degree: Computer Science** **University: UNINA**
- **Scholarship type: PNRR**
- **Tutor: Prof. Antonia Maria Tulino**
- **Co-tutor: Prof. Jaime Llorca**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Can we Rely on AI? Reliability Issues in Artificial Neural Networks and Potential Solutions for Autonomous Vehicles	Seminar	1	0.2	16/01/2025	Dr. Edoardo Giusto	Y
Optimisation-based Control of Flexible Resources in Sustainable Energy Networks	Seminar	1	0.2	05/02/2025	Prof. Luigi Glielmo	Y
Corso di inglese B2 CLA	English Course		6	30/09/2024 to 9/12/2024	CLA	Y
How to boost your PhD	PhD Course		5	19/02/2025	Prof. Antigone Marino	Y
Emergent behaviors and collective decisions in cyber-physical-human systems	Seminar	1	0.2	13 February 2025	Karl H. Johansson	N
5G & DIGITAL TRANSFORMATION : A VIEW FROM AN UNCONVENTIONAL PERSPECTIVE	Seminar	4	0.8	14 March 2025	Prof. Antonia Tulino	Y
Robot Autonomy among Decision-	Seminar	1	0.2	15 April 2025	Prof. Fabio	Y

Making Agents					**Ruggiero**	
Robotic Manipulation @Vanvitelli Robotics Lab: A bird's eye view on the last 5 years	**Seminar**	**2**	**0.4**	**18 June 2025**	**Dr. Mario Selvaggio**	**Y**
Trusted Execution Environments for QPUs	**Seminar**	**1**	**0.2**	**27 June 2025**	**Prof. Edoardo Giusto**	**Y**
Game Engines and Interactive Experience	**MSc course**	**48**	**6**	**16 June 2025**	**Prof. Antonio Origlia**	**Y**
A Gentle and Incomplete Introduction to Bilevel Optimization	**Seminar**	**1**	**0.2**	**15 October 2025**	**prof. Maruzio Boccia, prof. Claudio Sterle, prof. Adriano Masone**	**Y**
Optimization in Transportation and Logistics	**Seminar**	**1**	**0.2**	**16 October 2025**	**prof. Maruzio Boccia, prof. Claudio Sterle, prof. Adriano Masone**	**Y**
Local Explainability in Machine Learning: A collective framework	**Seminar**	**1**	**0.2**	**16 October 2025**	**prof. Maruzio Boccia, prof. Claudio Sterle, prof. Adriano Masone**	**Y**
Exact and ML-guided Matheuristic approaches for a Truck-and-Drone delivery problem	**Seminar**	**1**	**0.2**	**17 October 2025**	**prof. Maruzio Boccia, prof. Claudio Sterle, prof. Adriano Masone**	**Y**

Quality of Experience in XR: Bridging Metrics and User Perception	**Seminar**	**1.5**	**0.3**	**16 October 2025**	**Fondazione RESTART (prof. Antonio Capone)**	**Y**
Guardians or Threats? AI at the Frontlines of Cybersecurity	**Seminar**	**4**	**0.8**	**17 October 2025**	**Prof. Antonia Maria Tulino**	**Y**
AI Powered User interface design	**Seminar**	**4**	**0.8**	**24 October 2025**	**Prof. Antonia Maria Tulino**	**Y**
Quality of Services	**Seminar**	**4**	**0.8**	**28 October 2025**	**Prof. Antonia Maria Tulino**	**Y**
NextComm	**Course**	**24**	**5 (TBD)**	**9 Oct -> 30 Oct**	**Prof. Daniele Riccio**	**Y**

1) Courses, Seminar, Doctoral School, Research, Tutorship
2) Choose: Y or N

2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1			5	0.4	
Bimonth 2	11	0.6	7		18.6
Bimonth 3		1	7		8
Bimonth 4	6	0.6	8		14.6
Bimonth 5			6		6
Bimonth 6	5	3.5	10		18.5
Total	22	5.7	43	0.4	71,1
Expected (2nd Year)	10 - 20	5 - 10	30 - 45	0 – 1.6	

3. Research activity:

During my second year, I continued the research line on the development of orchestration algorithms over distributed Edge–Cloud networks. Specifically, I continued the work conducted in my first year regarding the ***IDAGO (Information-Aware DAG Orchestration)*** *algorithm. IDAGO is an approximation algorithm for that provides probabilistic performance guarantees. However, it remains inherently stochastic, requiring repeated randomized rounding trials and lacking deterministic customization. To address these limitations, we introduced* ***DORIAN****, a deterministic extension of IDAGO that advances the state of approximation algorithms for AI service orchestration DORIAN contributes three key innovations: (i) an LP-driven probabilistic analysis that delivers tighter service-*

and network-aware bounds, (ii) a principled derandomization strategy that produces high-quality embeddings in a single deterministic step, and (iii) operatortunable mechanisms that align orchestration with customer-defined trade-offs across cost, throughput, and latency. Furthermore, DORIAN integrates the use of Behavior Trees that capture applications' runtime control logic to more faithfully characterize the functional relationships in the service graphs used as input for orchestration.

In parallel, i continued the activities for the Proof of Concepts within the RESTART program. Specifically:

- ***SUPER project**: the integration of the IDAGO algorithm into the SUPER Orchestrator was completed: IDAGO is being embedded into the Resource Allocation module of the SOCCER component through suitable APIs. This module computes service placement decisions by exploiting real-time resource and topology information, allowing IDAGO to deliver optimised placements while fitting naturally into the orchestrator's modular architecture, illustrated in Fig. 1.*
- ***Netwin Project:** IDAGO is used to determine the initial placement of a conversational AI application's modules across a nationwide network infrastructure provided by **Fastweb**.*

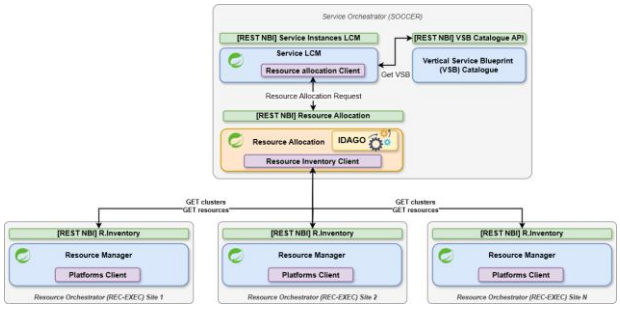


Figure 1: Integration between the Super Orchestrator and IDAGO

*Part of the PoC activities from the RESTART project were integrated into the project work developed within the **5G Academy**, where I served as academic coordinator responsible for the group of students.*

*Finally, I continued the development of **dual-time orchestration solutions**, aimed at combining long-term and short-term orchestration strategies. In particular, I pursued the collaboration with the **University of Catania** to integrate IDAGO (and its extensions) with a **Multi-Armed Bandit (MAB)** algorithm for dynamic resource autoscaling. In parallel, I continued working with my research group to integrate **IDAGO** with **reinforcement learning (RL)-based algorithms** for adaptive routing decisions.*

4. Research products:

4.1. Journal Papers

***Mauro, A.**, Tulino, A. M., & Llorca, J. (2025) End-to-End Orchestration of NextG Media Services over the Distributed Compute Continuum. IEEE Transaction on mobile computing. (**Early Access**).*

***Mauro, A.**, Origlia, A., Tulino, A. M., & Llorca, J. (2025). DORIAN: Deterministic Orchestration of AI-Centric Applications over Distributed Edge–Cloud Networks. Computer Networks (**Under Review**)*

4.2. Conferences Paper

***Mauro, A.**, Tulino, A. M., & Llorca, J. (2025) Robust and Predictable Orchestration of Distributed Multiuser AI-Powered Applications. ICC 2026 - IEEE International Conference on Communications: Next-Generation Networking & Internet (**Submitted**).*

*Di Bratto, M., Origlia, A., Llorca, J., Detti, A., **Mauro, A.**, Grazioso, M., Vitale, V. N., Russo, V., Mancini, A., Perrino, A., Napolitano, N., Della Corte, G., Tulino, A. M., Piane, S., & Tennirelli, M. (2025). Automatic positioning of AI microservices on NextG networks to support interactive holograms. Ital-IA 2025 (**Accepted**).*

5. Conferences and seminars attended

RESTART Plenary Dissemination Workshop, Poster presentation, Napoli 30 June 2025.
RESTART SUPER and NETWIN Workshop, Poster presentation, Rome 24 September 2025.
RESTART SUPER and NETWIN Workshop, Dissemination Talk, Rome 24 September 2025.
RESTART Spoke 4 Workshop, Dissemination Talk, Torino 30 October 2025.

6. Periods abroad and/or in international research institutions

N.A.

7. Tutorship

I performed tutorship and teaching activities, supervised by Prof. Antonia Tulino, in Information Theory course for a total of 10 hours from Jan–Feb 2025.

I performed tutorship and teaching activities within the 5G Academy for a total of 4 hours in date 3 June 2025

8. Plan for year three

In the third year, I plan to continue focusing on the design, development, and validation of the proposed E2E optimization algorithms. Specifically, I intend to expand on topics I have start exploring, including: (i) the use of Behavior Trees to capture applications' runtime control logic to more faithfully characterize the functional relationships in the service graphs used as input for orchestration algorithms, (ii) the development of dual-time orchestration solutions, and (iii) finalization of PoC activities in preparation for presentation at the final RESTART Plenary.
I plan to work on these activities also during the three months research period abroad, at the Centre Tecnologic de Telecomunicacions de Catalunya (CTTC/CERCA), Castelldefels, Spain, supervised by Prof. Jaime Llorca. I plan on staying in Castelldefels from January 2026, to April 2026.

Regarding my Ph.D. thesis, I plan to generalize the proposed E2E algorithms to focus on both AI for networks (using AI techniques to optimize network orchestration) and networks for AI (designing and testing orchestration solutions tailored for AI-centric applications).