



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

**PhD Student: Mario Noioso**

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**Cycle: XXXIX**

**Training and Research Activities Report**

**Academic year: 2024-25 - PhD Year: Second**

student signature

Mario Noioso

**Tutor: prof.ssa Stefania Santini**

tutor signature

**Co-Tutor**

Stefania Santini

**Date: October 28, 2025**

# Training and Research Activities Report

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Cycle:

Author:

## 1. Information:

- **PhD student:** Mario Noioso
  - **DR number:** DR997202
  - **Date of birth:** 17/11/1995
  - **Master Science degree:** Automation Engineering
  - **Scholarship type:** no scholarship
  - **Tutor:** Stefania Santini
  - **Co-tutor**
- PhD Cycle:** XXXIX
- University:** Federico II

## 2. Study and training activities:

| Activity                                                                            | Type <sup>1</sup> | Hours | Credits | Dates    | Organizer                 | Certificate <sup>2</sup> |
|-------------------------------------------------------------------------------------|-------------------|-------|---------|----------|---------------------------|--------------------------|
| The power of inhibition for collective decision making in minimalistic robot swarms | Seminar           | 1     | 0.2     | 14/11/24 | SSM Scientific Colloquium | Y                        |
| AI and Enabling Technologies for Social Robots                                      | Seminar           | 1.5   | 0.3     | 03/12/24 | Prof. Cutugno             | Y                        |
| Strutture basate su regole e strutture basate su approssimazioni                    | Seminar           | 1     | 0.2     | 10/12/24 | Prof. Cutugno             | Y                        |
| Solid State Transformers: Fundamentals, Insights and New Trends                     | Seminar           | 2     | 0.4     | 20/12/24 | Prof. Di Noia             | Y                        |
| Lunar Laser Retroreflectors for ESA-ASI's Moonlight, Farside & South Pole           | Seminar           | 1     | 0.2     | 16/01/25 | SSM Scientific Colloquium | Y                        |
| Bridging Physics to Biomedical Sciences                                             | Seminar           | 1     | 0.2     | 30/01/25 | SSM Scientific Colloquium | Y                        |
| Optimisation-based Control of Flexible Resources in Sustainable Energy Networks     | Seminar           | 1     | 0.2     | 05/02/25 | Prof. Luigi Glielmo       | Y                        |
| Emergent behaviors and collective decisions in cyber-physical-human systems         | Seminar           | 1     | 0.2     | 13/02/25 | SSM Scientific Colloquium | Y                        |
| How to boost your PhD                                                               | Course            | 18    | 5       | 19/02/25 | Prof. Antigo              | Y                        |

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|----------------------------------------------------------------------------------------------------------------|---------|-----|-----|----------|---------------------------|---|
|                                                                                                                |         |     |     |          | ne Marino                 |   |
| Explainable Scientific Machine Learning: Theoretical and Practical Perspectives                                | Seminar | 1   | 0.2 | 20/02/25 | SSM Scientific Colloquium | Y |
| Dynamic Risk Assessment in Industrial Applications: Leveraging Bayesian Inference for Enhanced Decision-Making | Seminar | 1   | 0.2 | 04/03/25 | Prof. Francesco Vitale    | Y |
| Numerical bifurcation analysis for delay equations                                                             | Seminar | 1   | 0.2 | 07/03/25 | Dr. Gabor Orosz           | Y |
| Bridging Local and Global Universe via gravitational astrometry: The Milky Way paradigm                        | Seminar | 1   | 0.2 | 20/03/25 | SSM Scientific Colloquium | Y |
| Safety Assessment of Autonomous Vehicles: Approaches and Challenges                                            | Seminar | 1.5 | 0.3 | 24/03/25 | Stefano Russo             | Y |
| Robot Autonomy among Decision-Making Agents                                                                    | Seminar | 1   | 0.2 | 15/04/25 | Prof. Fabio Ruggiero      | Y |
| TESTING AND VALIDATION OF AUTOMATED ROAD VEHICLES                                                              | Course  | 722 | 9   | 14/05/25 | Angelo Coppola            | Y |
| Time Delays, Hopf Bifurcation and Synchronization                                                              | Seminar | 1   | 0.2 | 13/06/25 | Dr. Gabor Orosz           | Y |
| Sovranità digitale cos'è e quali sono le principali minacce al cyberspazio nazionale                           | Seminar | 2   | 0.4 | 23/06/25 | Marcello Cinque           | Y |
| Superconducting Radio Frequency Cavities for Quantum Computing and Communication                               | Seminar | 1   | 0.2 | 24/06/25 | Dr. Edoardo Giusto        | Y |
| Trusted Execution Environments for QPUs                                                                        | Seminar | 1.5 | 0.3 | 27/06/25 | Dr. Edoardo Giusto        | Y |
| IEEE ITSS Italian Chapter Annual Meeting and PhD Award 2025                                                    | Seminar | 6   | 1   | 10/07/25 | IEEE ITSS Italian Chapter | Y |
| Control of multi-agent systems with time delays: theory and applications                                       | Seminar | 1.5 | 0.3 | 05/09/25 | Dr. Gabor Orosz           | Y |

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|-------------------------------------------------------------|---------|---|-----|----------|------------|---|
| Guardians or Threats? AI as the Frontlines of CyberSecurity | Seminar | 4 | 0.8 | 17/10/25 | 5G Academy | 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       | 0              | 1.1            | 8.9             | 0              | 10        |
| Bimonth 2       | 5              | 1              | 4               | 0              | 10        |
| Bimonth 3       | 0              | 1.1            | 8.9             | 0              | 10        |
| Bimonth 4       | 9              | 1.1            | 0               | 0              | 10.1      |
| Bimonth 5       | 0              | 1              | 9               | 0              | 10        |
| Bimonth 6       | 0              | 1.1            | 8.8             | 0              | 9.9       |
| <b>Total</b>    | <b>14</b>      | <b>6.4</b>     | <b>39.6</b>     | <b>0</b>       | <b>60</b> |
| <b>Expected</b> | <b>30 - 70</b> | <b>10 - 30</b> | <b>80 - 140</b> | <b>0 - 4.8</b> |           |

## 3. Research activity:

In recent years, the development of Highly Automated Vehicles (HAVs)—mainly made possible by the introduction and usage of AI-based algorithms for their key features (perception, decision-making and planning (DMP), and control systems)—has seen significant progress. Their usage, particularly when controlled cooperatively and properly organized in platoons, is promising for reducing accidents, pollution, and congestion, while increasing transport accessibility and saving fuel, as remarked in [1]. However, even if the technological challenges seem to be met, the numerous accidents involving HAVs are evidence that they are still far from reliable when operating in the cluttered, unstructured, or unseen environments where they are intended to function.

Indeed, this same technological complexity, given by the increasingly cutting-edge innovations introduced and the increasing number of devices interacting with each other, is progressively transforming AVs into complex systems. Their interaction with the arbitrarily complex, infinite-dimensional real environment necessitates the consideration of all possible traffic situations and influencing factors during their design and testing phases.

It is therefore clear that the resulting test space cannot be covered adequately using traditional distance-based statistical approaches [2], since the reduced variability of inputs encountered during "common" driving situations does not trigger all possible AV behaviours.

For this reason, a scenario-based mixed approach—focusing on the iterative search for safety-relevant scenarios, testing them in simulation, and, finally, their implementation on proving grounds—was first introduced with the European project PEGASUS [3].

Thus, with the focus on each individual scenario and on the explicit and implicit factors characterizing it, the challenge for properly validating an AV becomes that of finding the “corner-cases” that trigger an unexpected behaviour of the vehicle [2]. The validation problem, then, can be likened to an optimization problem, with the influencing factors (external and internal) as its possible dimensions.

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For this reason, in order to avoid proceeding with a brute-force approach on this resulting search space, and to highlight only the corner cases that an AV could encounter, the aim of research in the last years has been to develop test automation frameworks [6]. These frameworks must be capable of tackling the black-box, simulation-based problem deriving from the interconnection with a simulation environment.

However, although V2X sensors (with their communication protocols) represent a key factor for AV introduction, no test automation framework has yet considered the effects of their non-idealities—such as latency and reduced network bandwidth—as triggering factors, thus excluding important sources of SOTIF issues. SOTIF, which stands for Safety Of The Intended Functionality, is the safety standard (ISO 21448) dealing with this topic.

To tackle this point, while also examining the coupled interaction between these non-idealities (e.g., latency) and different weather conditions on an AV, a simulation environment based on Scenic and CARLA has been created to execute scenario-based simulations. This environment, externally connected to a test automation framework, was then used for executing scenario-based MIL (model-in-the-loop) tests on CACC (Cooperative Adaptive Cruise Control), finding the corner cases for vehicle safety by means of a population-based optimization process (Genetic Algorithm of the Global Optimization Toolbox). Sub-optimal solutions can then be tested in the real world to properly assess the ODD (Operational Design Domain) of the ADAS.

## References:

- [1] Y. Ma, C. Sun, J. Chen, D. Cao and L. Xiong, "Verification and Validation Methods for Decision-Making and Planning of Automated Vehicles: A Review," in *IEEE Transactions on Intelligent Vehicles*, vol. 7, no. 3, pp. 480-498, Sept. 2022, doi: 10.1109/TIV.2022.3196396.
- [2] F. Klück, M. Zimmermann, F. Wotawa and M. Nica, "Genetic Algorithm-Based Test Parameter Optimization for ADAS System Testing," *2019 IEEE 19th International Conference on Software Quality, Reliability and Security (QRS)*, Sofia, Bulgaria, 2019, pp. 418-425, doi: 10.1109/QRS.2019.00058.
- [3] Winner, H., Lemmer, K., Form, T., Mazzega, J. (2019). PEGASUS—First Steps for the Safe Introduction of Automated Driving. In: Meyer, G., Beiker, S. (eds) Road Vehicle Automation 5. Lecture Notes in Mobility. Springer, Cham. [https://doi.org/10.1007/978-3-319-94896-6\\_16](https://doi.org/10.1007/978-3-319-94896-6_16)
- [4] C. Neurohr, L. Westhofen, M. Butz, M. H. Bollmann, U. Eberle and R. Galbas, "Criticality Analysis for the Verification and Validation of Automated Vehicles," in *IEEE Access*, vol. 9, pp. 18016-18041, 2021, doi: 10.1109/ACCESS.2021.3053159.

## 4. Research products:

*A SOTIF-based simulation framework for evaluating the combined impact of V2X and weather conditions – Noioso M., et al. – Submitted*

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## 5. Conferences and seminars attended

## 6. Periods abroad and/or in international research institutions

## 7. Tutorship

## 8. Plan for year three

Planned Research Activities:

- Analyzing the “cut-out” scenario already considered (where a leading vehicle changes lanes due to the abrupt braking of a preceding hidden vehicle) within an augmented configuration space. This space will include new V2X and additional scenario-influencing factors enabling the analysis of the coupled effects of more than two factors.
- Employing surrogate models or different optimization algorithms specifically designed to handle the complexity that arises from considering continuous stochastic variables.
- Replacing the CARLA simulator's built-in physics (from UE4) with a fully controllable, custom white-box model. This customization will ensure greater transparency and manipulability of the underlying dynamics.