



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

PhD Student: Giacomo Basile

Cycle: XXXVII

Training and Research Activities Report

Year: First

student signature :

Tutor: Prof. Stefania Santini tutor signature :

Co-Tutor: Ing. Pietro Schipani

Date: October 21, 2022

Training and Research Activities Report

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Author: Giacomo Basile

1. Information:

- **PhD student:** Giacomo Basile
- **DR number:** DR995857
- **Date of birth:** 26/12/1995
- **Master Science degree:** Automation Engineering
- **University:** University of Naples Federico II
- **Doctoral Cycle:** XXXVII
- **Scholarship type:** INAF
- **Tutor:** Prof. Stefani Santini
- **Co-tutor:** Ing. Pietro Schipani

2. Study and training activities:

Activity	Type ¹	Hours	Credits	Dates	Organizer	Certificate ²
Complexity and the City: transitioning towards the smart cities of the future	Seminar	1.5	0.3	23/11/2021	Prof. Luis Bettencourt	Y
Graphos: a tool for the analysis of system on large networks	Seminar	1.5	0.3	24/11/2021	Prof. Paolo Fransca	Y
Data-Driven methods in engineering - Part I	Seminar	2	0.4	29/11/2021	Prof. Alessandro Talamelli	Y
Hyperuniform States of Matter and Their Novel Transport Properties	Seminar	1.5	0.3	02/12/2021	Prof. Salvatore Torquato	Y
Data-Driven methods in engineering - Part II	Seminar	2	0.4	03/12/2021	Prof. Alessandro Talamelli	Y
Advanced Controls Test bed for evaluation of rule-based, model predictive, and reinforcement learning building control	Seminar	1.5	0.3	09/12/2021	Prof. Gregor P.Henze	Y
Structure Process and Dynamics of	Seminar	1.5	0.3	09/12/2021	Prof. Stefano Boccaletti	Y

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Networks with higher Order Interaction						
Data-Driven methods for engineering – Part III	Seminar	2	0.4	06/12/2021	Prof. Alessandro Talamelli	Y
Data-Driven methods for engineering – Part IV	Seminar	2	0.4	13/12/2021	Prof. Alessandro Talamelli	Y
Social Network Dynamics leading to community formation and residential segregation	Seminar	1.5	0.3	16/12/2021	Prof. Massimo Franceschetti	Y
Data-Driven methods for engineering – Part V	Seminar	2	0.4	17/12/2021	Prof. Alessandro Talamelli	Y
Turbulent dynamics in viscous fluids: a complex phenomenon ubiquitous in nature	Seminar	1.5	0.3	18/11/2021	Prof. Vincenzo Carbone	Y
Climate meets complexity: exploring predictability of extreme climate events via complex	Seminar	1.5	0.3	13/01/2022	Prof. Jürgen Kurths	Y
The Challenge of gravitational wave detectors of the 3rd generation. Cultural and technological aspects	Seminar	1.5	0.3	20/01/2022	Prof. Ettore Majorana	Y
The Quest of Quantum advantage a photonics platform	Seminar	1.5	0.3	03/02/2022	Prof. Fabio Sciarrino	Y
Matrix Analysis for Signal	Course	8	2	22-23/03/2022	Proff. Antonio De	Y

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Processing with Matlab				5-7/04/2022	Maio, Augusto Aubry, Dr. Vincenzo Carotenuto, DIETI	
Using Delay for Control – Part I	Seminar	1	0.2	21/04/2022	Prof. Emilia Fridman	Y
Using Delay for Control – Part II	Seminar	1	0.2	28/04/2022	Prof. Emilia Fridman	Y
Big Data Architecture and Analytics	Course	20	5	6-08-22-27-29/04-06-11/05/2022	Prof. Giancarlo Sperli	Y
Operational Research: Mathematical Modelling, Methods and Software Tools for Optimization Problems	Course	10	4	14-21-28/09 - 05-12/10/2022.	Prof. Adriano Masone	Y
Sustainable Ship For Tue Energy Transitions of Maritime Transport	Course	10	4	22-29/09 06-13-20/10/2022	Prof.Ing. Tommaso COPPOLA	Y
Machine Learning for Science and Engineering Research	Course	20	5	20-21-22-23-24-27-28-29-30/06 - 01/07 2022	Proff. A. Corazza, F. Isgrò, R. Prevete, C. Sansone, G. Pezzulo	Y

1) Courses, Seminar, Doctoral School, Research, Tutorship

2) Choose: Y or N

○ Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0.0	4.1	5.9	0.0	10
Bimonth 2	0.0	0.9	9.1	0.0	10
Bimonth 3	2.0	0.4	7.6	0.0	10
Bimonth 4	5.0	0.0	4.8	0.2	10
Bimonth 5	0.0	0.0	10.0	0.0	10
Bimonth 6	13	0.0	2.0	0.0	10
Total	20.0	5.0	35.80	0.2	60
Expected	20 - 40	5 - 10	10 - 35	0 - 1.6	

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3. Research activity:

During my second years the following activity have been carried out:

- **ELT project:** during the first year, through the INAF, I attended to the ELT program, which aims to design and deploy a new extremely large telescope with the main mirror of almost 40m of diameter. In detail, my main role was the development of the Telemetry module and skeleton program of the adaptive optics control loops of the instrument called MAORY. Within this framework, I focus my study on the confidential technical report which have been reported in the following article [1], [2], [3]. During the study of the technical report I could learn how an adaptive optics control system works and is implemented in a scientific instrument.
- **Reinforcement Learning:** during my first year I focused my studies on the acquisition of the knowledge and skills regarding the new Reinforcement and Deep Reinforcement learning (RL/DRL)-based control strategy. In detail, I spent the first months in study the following article [4], [5], [6], [7], where I learned the difference between the different Reinforcement learning algorithms are adopted. Hence, I used this knowledge to design advanced RL-based control strategies for solving automotive control problem such as the cooperative adaptive cruise control for the virtual coupling control problem considering heterogeneous high-speed train [8]. Another products carried out by this studied is reported in [9], where, the Reinforcement learning has been adopted to deal the fault sensor measurement for an autonomous vehicle driving on a race track.

References:

- [1] Ciliegi, P., Agapito, G., Aliverti, M., Annibaldi, F., Arcidiacono, C., Azzaroli, N., ... & Xompero, M. (2022). MAORY/MORFEO at ELT: general overview up to the preliminary design and a look towards the final design. *Adaptive Optics Systems VIII*, 12185, 325-334.
- [2] Rigaut, F., McDermid, R., Cresci, G., Agapito, G., Aliverti, M., Antonucci, S., ... & Arsenault, R. (2021). MAVIS on the VLT: A Powerful, Synergistic ELT Complement in the Visible. *The Messenger*, 185, 7-11.
- [3] Baruffolo, A., Baronchelli, I., Savarese, S., Lampitelli, S., Foppiani, I., Capasso, G., ... & Ciliegi, P. (2022, August). MORFEO at ELT: preliminary design of the real-time computer. In *Adaptive Optics Systems VIII* (Vol. 12185, pp. 1719-1727). SPIE.
- [4] Sutton, R. S., & Barto, A. G. (2018). *Reinforcement learning: An introduction*. MIT press.
- [5] Lillicrap, T. P., Hunt, J. J., Pritzel, A., Heess, N., Erez, T., Tassa, Y., ... & Wierstra, D. (2015). Continuous control with deep reinforcement learning. *arXiv preprint arXiv:1509.02971*.
- [6] Iqbal, S., & Sha, F. (2019, May). Actor-attention-critic for multi-agent reinforcement learning. In *International conference on machine learning* (pp. 2961-2970). PMLR.

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- [7] Kiran, B. R., Sobh, I., Talpaert, V., Mannion, P., Al Sallab, A. A., Yogamani, S., & Pérez, P. (2021). Deep reinforcement learning for autonomous driving: A survey. *IEEE Transactions on Intelligent Transportation Systems*, 23(6), 4909-4926.
- [8] Basile, G., Lui, D. G., Petrillo, A., & Santini, S. (2022, December). Deep deterministic policy gradient-based virtual coupling control for high-speed train convoys. In 2022 IEEE International Conference on Networking, Sensing and Control (ICNSC) (pp. 1-6). IEEE. **(submitted)**.
- [9] Basile, G., Petrillo, A., & Santini, S. (2022, October). Ddpg based end-to-end driving enhanced with safe anomaly detection functionality for autonomous vehicles. In 2022 IEEE International Conference on Metrology for Extended Reality, Artificial Intelligence and Neural Engineering (MetroXRaine) (pp. 248-253). IEEE. **(published: October 5, 2023)**

4. Research products:

- Conference paper:
 - Basile, G., Lui, D. G., Petrillo, A., & Santini, S. (2022, September). Acc fuzzy-based control architecture for multi-body high-speed trains with active inter-cars couplers. In European Dependable Computing Conference (pp. 126-138). Cham: Springer International Publishing. **(published: September 5, 2022)**
 - Basile, G., Petrillo, A., & Santini, S. (2022, October). Ddpg based end-to-end driving enhanced with safe anomaly detection functionality for autonomous vehicles. In 2022 IEEE International Conference on Metrology for Extended Reality, Artificial Intelligence and Neural Engineering (MetroXRaine) (pp. 248-253). IEEE. **(published: October 5, 2023)**
- Journal Paper Published:
 - Savarese, S., Schipani, P., Fiorentino, G., Schreiber, L., Basile, G., Capasso, G., ... & Perrotta, F. (2022, August). Modeling wide-field telescopes in presence of misalignments: an application to the Vera C. Rubin Observatory. In *Modeling, Systems Engineering, and Project Management for Astronomy X* (Vol. 12187, pp. 557-565). SPIE. **(published: 25 August 2022)**
 - Basile, G., Napoletano, E., Petrillo, A., & Santini, S. (2022). Roadmap and challenges for reinforcement learning control in railway virtual coupling. *Discover Artificial Intelligence*, 2(1), 27. **(published: December 29, 2022)**

5. Conferences and seminars attended.

- 2022 18th European Dependable Computing Conference
 - Date: 12-15 September 2022. Zaragoza, Spain
 - Presentation made: Presentation of the paper “Acc fuzzy-based control architecture for multi-body high-speed trains with active inter-cars couplers” at European Dependable Computing Conference

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- 2022 IEEE International Conference on Metrology for Extended Reality, Artificial Intelligence and Neural Engineering (MetroXRINE)
 - Date: 26-28 October. Rome, Italy.
 - Presentation Made: Presentation of the paper “*Ddpq based end-to-end driving enhanced with safe anomaly detection functionality for autonomous vehicles*” at IEEE International Conference on Metrology for Extended Reality, Artificial Intelligence and Neural Engineering (MetroXRINE)

6. Activity abroad:

7. Tutorship:

During my first year I could teach lesson about the control systems for the course of “*Controlli automatici*” for the information engineering course. In detail, the main topics of the lessons were regarding the software “*Matlab&Simulink*”, what is and how to use it. Then, the lesson became more detailed on the control system. Indeed, the last lessons were regarding how to design and test a control system such as PID controller, Feedback state gain controller, and Frequency controller.