



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

PhD Student: Nunzia Solmonte

Cycle: XL

Training and Research Activities Report

Year: First

Tutor: prof. Nicola Pasquino

Date: October 31, 2025

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Author: Nunzia Solmonte

1. Information:

- **PhD student: Nunzia Solmonte**
- **DR number: DR999882**
- **Date of birth: 09/05/1999**
- **Master Science degree: Management Engineering**
University: University of Naples Federico II
- **Doctoral Cycle: XL**
- **Scholarship type: UNINA**
- **Tutor: Nicola Pasquino**

2. Study and training activities:

Activity	Type ¹	Hours	Credits	Dates	Organizer	Certificate ²
Bimonth 1						
Perché l'Intelligenza Artificiale crede di fare a meno della teoria linguistica, ma in realtà non potrà farlo.	Seminar	2	0.4	20/11/2024	Phil_AI Lab - prof. F. Cutugno	Y
AI and Enabling Technologies for Social Robots.	Seminar	1.5	0.3	03/12/2024	Phil_AI Lab - prof. F. Cutugno	Y
Time Window Assignment for Attended Home Delivery.	Seminar	2	0.4	05/12/2024	Proff. Claudio Sterle, Maurizio Boccia, Adriano Masone	Y
Kernel Search: a general-purpose method for MILP problems.	Seminar	2	0.4	06/12/2024	Proff. Claudio Sterle, Maurizio Boccia, Adriano Masone	Y
QUIC: the secure protocol shaping the future of real-time communication over the Internet (Part I).	Seminar	2	0.4	09/12/2024	Prof. Simon Pietro Romano	Y
QUIC: the secure protocol shaping the	Seminar	2	0.4	11/12/2024	Prof. Simon Pietro	Y

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future of real-time communication over the Internet (Part II).					Romano	
Bimonth 2						
Optimisation-based Control of Flexible Resources in Sustainable Energy Networks.	Seminar	1	0.2	05/02/2025	Prof. Luigi Glielmo	Y
Round Table: “Imprenditorialità e proprietà intellettuale”.	Seminar	2	0.4	06/02/2025	Scuola Nazionale per Dottorandi di Elettrotecnica “F. Gasparini”	Y
Using Deep Learning properly.	Course	12	4	03-06-10-14-17-19/02/2025	Dr. Andrea Apicella	Y
How to boost your PhD.	Course	18	5	08-15-22-29/01/2025	Dr. Antigone Marino	Y
Bimonth 3						
Automatic Control in the Era of Artificial Intelligence.	Seminar	1	0.2	24/03/2025	Proff. Luigi Glielmo, Bruno Siciliano	Y
Safety Assessment of Autonomous Vehicles: Approaches and Challenges.	Seminar	1	0.2	24/03/2025	Proff. Stefano Russo, Roberto Pietrantuono	Y
Safety of highly automated driving systems.	Seminar	1	0.2	23/04/2025	Prof. Marcello Cinque	Y
IEEE Xplore Webinar: “Search Strategies to Supercharge Your Research Experience”.	Seminar	1	0.2	28/04/2025	IEEE	Y
On the Security of Semantic Watermarking to	Seminar	1	0.2	29/04/2025	Prof. Luisa Verdoliva	Y

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Detect AI-Generated Content.						
I pilastri della trasformazione digitale.	Course	12	3	02-03-04-14-15-16/04/2025	Prof. Nicola Mazzocca	Y
Bimonth 4						
Methodologies and Tools for conducting Systematic Literature Reviews and Systematic Mapping Studies.	Course	14	3	28-29/04 – 05-06-09-12-14/05/2025	Prof. Domenico Amalfitano	Y
IEEE Xplore Webinar: “IEEE Authorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE Editors”.	Seminar	1.5	0.3	15/05/2025	IEEE	Y
How complex is to schedule the Italian Serie A? Problems and methods in sports timetabling.	Seminar	2	0.4	15/05/2025	Proff. Claudio Sterle, Maurizio Boccia, Adriano Masone	Y
Giornata Mondiale della Metrologia.	Seminar	3.5	0.2	20/05/2025	Ordini degli Ingegneri di Milano e di Napoli	Y
Sovranità digitale: cos'è e quali sono le principali minacce al cyberspazio nazionale.	Seminar	2	0.4	23/06/2025	Prof. Marcello Cinque	Y
Bimonth 6						
International Ph.D. School “Italo Gorini” 2025.	Doctoral School	20	4	01/09/2025 – 05/09/2025	Associazione Gruppo Misure Elettriche ed Elettroniche (GMEE)	Y
Practical Network Intrusion Detection	Course	14	4	1-2-7-8-9/10/	Dr. Giampaolo	Y

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with Machine Learning and Generative AI.				2025	Bovenzi	
Optimization in Transportation and Logistics.	Seminar	1	0.2	16/10/2025	Proff. Maruzio Boccia, Claudio Sterle, Adriano Masone	Y
Local Explainability in Machine Learning: A collective framework.	Seminar	1	0.2	16/10/2025	Proff. Maruzio Boccia, Claudio Sterle, Adriano Masone	Y
Exact and ML-guided Matheuristic approaches for a Truck-and-Drone delivery problem.	Seminar	1	0.2	17/10/2025	Proff. Maruzio Boccia, Claudio Sterle, Adriano Masone	Y
Guardians or Threats? AI at the Frontlines of Cybersecurity.	Seminar	4	0.8	17/10/2025	Prof. Antonia Maria Tulino	Y
Boosting Your Citations: Maximizing the Impact of Your Publications.	Seminar	1	0.2	21/10/2025	Peeref	Y
AI Powered User interface design.	Seminar	4	0.8	24/10/2025	Prof. Antonia Maria Tulino	Y
2025 Spring School on Trasferable Skills.	Doctoral School	9	2	30-31/10/2025	Department of Pharmacy University of Naples Federico II	Y It will be uploaded after this 1 st year report

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

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2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	2.3	6	0	8.3
Bimonth 2	9	0.6	5.5	0	15.1
Bimonth 3	3	1	6	0	10
Bimonth 4	3	1.3	5.5	0	9.8
Bimonth 5	0	0	5.5	0	5.5
Bimonth 6	10	2.4	6.5	0.3	19.2
Total	25	7.6	35	0.3	67.9
Expected	30 - 70	10 - 30	80 - 140	0 - 4.8	

3. Research activity:

During my first year of PhD, I carried out my research activities within the field of modeling long-term electromagnetic field (EMF) exposure time series through Machine Learning methodologies, with particular attention to statistical analysis, clustering techniques, and 5G exposure assessment.

Electromagnetic field (EMF) exposure assessment for the general public is a major regulatory and societal concern, especially in the context of the rapid deployment of new telecommunication infrastructures such as 5G. In particular, the huge amount of data collected requires automated methodologies able to detect patterns, characterize variability, and support compliance evaluations.

Using continuous-monitoring datasets from sensitive environments, I analyzed temporal dynamics through averaging operators, distributional descriptors, weekday-weekend comparisons and multi-year trends. These analyses revealed stable diurnal cycles, systematic differences between workdays and weekends, and site-specific evolutions over time, providing a framework to interpret exposure levels in relation to regulatory reference limits.

Building on this, I extended the analysis with Machine Learning methodologies, in particular model-based clustering of daily exposure profiles. By applying log-normal mixture models, I was able to identify consistent temporal states that compactly represent the daily variability of EMF exposure, distinguishing, for example, characteristic regimes between working days and weekends. This integration of statistical descriptors and clustering techniques enabled both a more detailed interpretation of monitoring data and a compact data-driven representation suitable for further predictive and compliance-oriented applications.

The results of these activities are documented in the papers *Time Variability Analysis of RF-EMF Data from Continuous Monitoring Systems* (ELECOM 2024), *An approach for annual analysis of EMF exposure in highly sensitive areas of kindergartens and schools* (Radiation Protection Dosimetry), and *Cluster Analysis of RF-EMF Exposure to Detect Time Patterns in Urban Environment: A Model-Based*

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Approach (IEEE Access). Together, they lay the methodological foundation for my PhD, establishing a combined framework of statistical and Machine Learning tools for long-term EMF exposure assessment.

In parallel, I analyzed the evolution of telecommunication infrastructures as potential drivers of EMF exposure. Using national datasets on base station deployment and power, I found evidence of network densification and reinforcement in Italy over the last decade, rather than pure expansion. These findings contextualize long-term monitoring trends and highlight the relevance of infrastructure evolution in exposure modeling. This work was presented in the poster “*Spatio-temporal Analysis of Telecommunication Infrastructure Evolution*” (MetroGREENST 2025).

Finally, I explored the challenges introduced by 5G active antenna systems (AAS) and beamforming. In a dedicated measurement campaign, I compared IEC 62232-compliant extrapolation methods (SSB-based, with correction factors) with frequency- and code-selective spectrogram analysis. While IEC methods remain the compliance backbone, spectrogram techniques proved more effective in capturing time-varying, traffic-dependent beams, thus reducing uncertainty in realistic scenarios. This work was presented in the poster “*Exposure in FR1 with IEC 62232 in Realistic 5G Deployment Scenarios*” (MetroGREENST 2025).

Overall, the first year of research resulted in several scientific outputs, including journal and conference papers on time variability analysis, model-based clustering of RF-EMF monitoring data, and 5G FR1 exposure methodologies. These contributions establish the methodological foundation for my PhD, with future work aimed at supervised ML forecasting, spatio-temporal modeling, and quantification of beamforming effects in real deployments.

4. Research products:

N. Djuric, D. Kljajic, N. Pasquino, N. Solmonte and S. Djuric, “Time Variability Analysis of RF-EMF Data from Continuous Monitoring Systems,” *2024 5th International Conference on Emerging Trends in Electrical, Electronic and Communications Engineering (ELECOM)*, Balaclava, Mauritius, 2024, pp. 1-6, doi: 10.1109/ELECOM63163.2024.10892174 (PUBLISHED).

D. Kljajic, N. Djuric, N. Pasquino, N. Solmonte, and S. Djuric, “An approach for annual analysis of EMF exposure in highly sensitive areas of kindergartens and schools,” *Radiation Protection Dosimetry*, p. ncaf047, 05 2025. [Online]. Available: <https://doi.org/10.1093/rpd/ncf047> (PUBLISHED).

N. Pasquino, N. Solmonte, N. Djuric, D. Kljajic, and S. Djuric, “Cluster Analysis of RF-EMF Exposure to Detect Time Patterns in Urban Environment: A Model-Based Approach,” in *IEEE Access*, vol. 13, pp. 118724-118732, 2025, doi: 10.1109/ACCESS.2025.3586905 (PUBLISHED).

D. Suka, N. Solmonte, M. Ruttner, N. Pasquino, and N. Djuric, “Evaluation of RF-EMF Exposure in 5G FR1 Band Using IEC 62232 Assessment Methodologies,” *2025 IEEE INTERNATIONAL WORKSHOP ON Metrology for Green technologies, RENEWABLE ENERGY AND ECOLOGICAL SUSTAINABILITY (METROGREENST)*, Giardini Naxos (ME), Italy, 2025, pp. 1-6 (PUBLISHED).

N. Solmonte, D. Franci, G. Marsico, and N. Pasquino, “Mobile Network Penetration in Italy: A Preliminary Space and Time Analysis,” *2025 IEEE INTERNATIONAL WORKSHOP ON Metrology*

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for Green technologies, Renewable ENergy and ecological SusTainability (METROGREENST), Giardini Naxos (ME), Italy, 2025, pp. 1-6 (PUBLISHED).

5. Conferences and seminars attended

Ph.D. School Italo Gorini, IGO, Aversa (CE), Italy, 01/09/2025 – 05/09/2025.

Part of Local Arrangement Committee at “IX Forum Nazionale delle Misure”, Napoli (NA), Italy, 10/09/2025 – 12/09/2025.

2025 IEEE INTERNATIONAL WORKSHOP ON *Metrology for Green technologies, Renewable ENergy and ecological SusTainability (METROGREENST)*, Giardini Naxos (ME), Italy, 24/09/2025 – 26/09/2025.

Two poster presented:

- “Evaluation of RF-EMF Exposure in 5G FR1 Band Using IEC 62232 Assessment Methodologies”;
- “Mobile Network Penetration in Italy: A Preliminary Space and Time Analysis”.

2025 Spring School on Trasferable Skills, Online, 30-31/10/2025.

6. Activity abroad:

-

7. Activity in partner companies:

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8. Tutorship

Tutorship activity for the bachelor’s degree students of the course *Analisi Matematica I*, taught by Professor Gloria Paoli.