
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

**DOTTORATO DI RICERCA / PhD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING**

Activities and Publications Report

PhD Student: **Giuseppe Guarino**

Student DR number: DR996619

PhD Cycle: XXXVIII

PhD Chairman: Prof. Stefano Russo

PhD program student's start date: 01/11/2022

PhD program student's end date: 31/10/2025

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PhD scholarship funding entity:

CNR Istituto di Metodologie per l'Analisi Ambientale (IMAA)

General information

Giuseppe Guarino received in year 2022 the Master Science degree in Automation Engineering and Robotics from the University of Napoli Federico II. Within the PhD program in Information Technology and Electrical Engineering, he attended a curriculum in Telecommunications Engineering. He received a grant from CNR Istituto di Metodologie per l'Analisi Ambientale.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1 st	Academic Entrepreneurship	Ad hoc course	4	Prof. Pierluigi Rippa	ITEE
1 st	How to boost your PhD	Ad hoc course	4	Prof. Antigone Marino	ITEE
1 st	Using Deep Learning Properly	Ad hoc course	4	Dr. Andrea Apicella	ITEE
1 st	Visione per sistemi robotici	MSc course	9	Prof. Davide Cozzolino	University of Naples Federico II
2 nd	Strategic Orientation for STEM Research & Writing	Ad hoc course	5	Chie Shin Fraser	ITEE
3 rd	Elaborazione di segnali multimediali	MSc course	9	Prof. Luisa Verdoliva	University of Naples Federico II

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
2 nd	IEEE-EURASIP Summer School on Signal Processing (S3P-2024)	Capri, Italy	4	23/09/2024 – 27/09/2024	Italian Telecommunications and Information Technologies Group – GTTI
2 nd	DeepLearn 2024: 11th International School on Deep Learning	Porto, Portugal	5	15/07/2024 – 19/07/2024	University of Maia (Porto, Portugal) and IRDTA (Brussels/London)

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1 st	IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2023	3.1	Dino Ienco, Charlotte Pelletier, Paolo Gamba, Francescopaolo Sica, Paul Aimé,	University of Montpellier, Bretagne, Trento ...	IEEE GRSS

Activities and Publications – Final Report

UNINA PhD in Information Technology and Electrical Engineering – XXXVIII Cycle

PhD candidate: Giuseppe Guarino

			Sveinn E. Armannsson, Alejandro C. Frery		
1 st	Pansharpener by convolutional neural networks (IGARSS2023)	0.6	Prof. Giuseppe Scarpa and Eng. Matteo Ciotola	University of Naples Federico II, Naples, Italy	IEEE GRSS
1 st	Holographic visualization: signal processing and technological challenges	0.2	Prof. Peter Schelkens	University of Brussels, Brussels, Belgium	EURASIP Journal on Image and Video Processing
1 st	Unleashing the Power of LLMs: A Historical Perspective on Generative AI	0.2	Prof. Tarry Singh	Real.AI	ITEE
1 st	What's Up with Image and Video Forensics?	0.2	Prof. Fernando Pérez-González	University of Vigo, Vigo, Spain	EURASIP Journal on Image and Video Processing
1 st	Human Centric Visual Analysis - Hand, Gesture, Pose, Action, and Beyond	0.2	Dr. Joe (Zhou) Ren	Amazon AWS	IEEE SPS
1 st	The Super Neuron Model – A new generation of ANN-based Machine Learning and Applications	0.2	Prof. Moncef Gabbouj	Tampere University, Tampere, Finland	EURASIP Journal on Image and Video Processing
1 st	Threat Hunting & Incident Response	0.4	Vladimir Kurdin	Group-IB	ITEE
1 st	Game Theory for Information Engineering	0.6	Prof. Leonardo Badia	University of Padova, Padova, Italy	ITEE
1 st	Digital Forensics	0.4	Artem Artemov	Group-IB	ITEE
1 st	From Handcrafted to End-to-End Learning, and Back: a Journey for Multi-Object Tracking	0.4	Prof. Dr. Laura Leal-Taixé	NVIDIA	Artificial Intelligence Doctoral Academy (AIDA)
1 st	Privacy and Data Protection	0.2	Dr. Stefano Mele	Gianni & Origoni	ITEE
1 st	Complex Network Systems: Introduction and open challenges	0.2	Prof. Pietro de Lellis	University of Naples Federico II, Naples, Italy	SSM
2 nd	Learning in nonstationary environments	0.4	Prof. Cesare Alippi	Polytechnic of Milan	University of Napoli Federico II
2 nd	From ACE Technologies to Sustainable, Accessible and Equitable Urban Mobility: An Optimization Journey	0.4	Prof. Mauro Salazar	Eindhoven University of Technology, Eindhoven, Netherlands	ITEE

Activities and Publications – Final Report

UNINA PhD in Information Technology and Electrical Engineering – XXXVIII Cycle

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2 nd	Introduction to Large Language Models: Evolution and the current state	0.4	Prof. Tanmoy Chakraborty	IIIT-Delhi, Delhi, India	ITEE
2 nd	Generative AI for Software Engineering: Strategies, Impacts and Practical Applications	1.0	Annalisa Di Leva, Cynthia Cuvi, Giulia Favale, Alessio Zoccoli	5G Academy	ITEE
2 nd	Sustainable IT: Strategies and Best Practices for a Green Engineering Future	1.0	Annalisa Di Leva, Dimitri Cuomo, Benedetta Ramazzotti, Tiziano Marcozzi	5G Academy	ITEE
2 nd	Exploring the Frontiers of Modern Cryptography	0.3	Prof. Antonis Michalas	Tampere University, Tampere, Finland	ITEE
2 nd	Analytic center selection of optimization-based controllers for robot ecology	0.2	Prof. Gennaro Notomista	University of Waterloo, Waterloo, Canada	ITEE
2 nd	The Power of Retrieval for Video Analysis on Human Behavior Understanding	0.2	Jianquan Liu	NEC Corporation	EURASIP Journal on Image and Video Processing
2 nd	HOMINIS	1.0	Prof. Tarry Singh, Dr. Giuseppe Fiameni, Dr. Michela Tuozzo, Prof. Guglielmo Tamburrini	Real.AI, NVIDIA, University of Naples Federico II, Naples, Italy	ITEE
2 nd	Time-based sampling: Theory and an application to video reconstruction from events	0.2	Prof. Pier Luigi Dragotti	Imperial College London, London, England	EURASIP Journal on Image and Video Processing
2 nd	Energy-Efficient Data Science	0.2	Dr. Carlos Ordóñez	University of Houston, USA	ITEE

Research activities

During his Ph.D., Dr. Guarino’s research focused on remote sensing image fusion and classification, with emphasis on hyperspectral data processing.

Hyperspectral Pansharpening.

His main research addressed hyperspectral pansharpening, which fuses a high-spatial-resolution panchromatic image with a low-spatial-resolution hyperspectral image to produce data with enhanced spatial detail and preserved spectral fidelity. Since hyperspectral images contain hundreds of bands, Dr. Guarino tackled challenges related to computational complexity and limited training data by creating and releasing a large-scale dataset of real hyperspectral-panchromatic pairs. He also developed an open-source benchmarking toolbox integrating state-of-the-art model-based and deep learning methods for fair comparison. Building on this, he proposed novel deep learning frameworks using unsupervised training and band-handling strategies to manage spectral dimensionality efficiently.

Satellite-based Air Pollution Estimation.

He investigated estimating air pollutants (NO₂, PM_{2.5}) directly from hyperspectral satellite imagery, bypassing the need for auxiliary meteorological data. This approach enables faster, large-scale monitoring using spectral information alone.

Cross-Sensor Scene Classification.

Finally, he explored semi-supervised domain adaptation for cross-sensor scene classification, developing an adversarial learning framework to extract domain-invariant features. This work was conducted during a research stay at Inria, Université Côte d’Azur (Montpellier, France).

Tutoring and supplementary teaching activities

None

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1 st	21	7.1	32	0
2 nd	14	5.3	33	0
3 rd	9	0	58.6	0

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
3 rd	Centre Inria d’Université Côte d’Azur in Montpellier (FR)	Dino Ienco, Head of EVERGREEN research team	1/11/24 - 18/04/25	Research on Semi-supervised Heterogeneous Domain Adaptation for scene classification

PhD Thesis

In this Ph.D. thesis, Giuseppe Guarino investigates advanced data fusion strategies to enhance the spatial and spectral quality of remote sensing imagery, with a focus on hyperspectral pansharpening. While hyperspectral imagery provides rich spectral information, its inherently low spatial resolution limits its utility for fine-scale analysis. Pansharpening techniques aim to overcome this limitation by fusing low-resolution hyperspectral data with high-resolution panchromatic images to produce data with both high spatial and spectral fidelity. However, existing deep learning approaches often fail to address key challenges specific to hyperspectral data, including extreme spectral dimensionality, the scarcity of real hyperspectral–panchromatic pairs, and limited spectral overlap with the panchromatic band, restricting their scalability and real-world applicability.

This thesis makes three primary contributions. First, it delivers a comprehensive review and unified open-source implementation of state-of-the-art hyperspectral pansharpening methods, encompassing both model-based and deep learning approaches, to promote fair and reproducible evaluation. Second, it introduces a large-scale dataset of real hyperspectral–panchromatic pairs to enable realistic benchmarking. Third, it proposes three novel deep learning frameworks that tackle the intrinsic challenges of hyperspectral data fusion through efficient band-handling strategies and specialized loss functions. Finally, it explores the practical benefits of hyperspectral pansharpening for cross-sensor scene classification, demonstrating improved domain adaptation and classification performance across heterogeneous sensors.

Research products

Research results appear in **7 papers** published in international journals, **0 papers** published in national journals, **9 contributions** to international conferences, **0 contributions** to national conferences, **0 patents**.

List of scientific publications

International journal papers

M.Ciotola, **G. Guarino**, A. Mazza, G. Poggi, G. Scarpa,

"A Comprehensive Benchmarking Framework for Sentinel-2 Sharpening: Methods, Dataset, and Evaluation Metrics."

Remote Sensing, 2025

G. Guarino, M. Ciotola, G. Poggi, G. Vivone, G. Scarpa,

"Zero-Shot Hyperspectral Pansharpening Using Hysteresis-Based Tuning for Spectral Quality Control",

IEEE Transactions on Geoscience and Remote Sensing, 2025

A. Mazza, **G. Guarino**, G. Scarpa, Q. Yuan, G. Vivone,

"PM2.5 Retrieval with Sentinel-5P Data over Europe Exploiting Deep Learning",

IEEE Transactions on Geoscience and Remote Sensing, 2025

M. Ciotola, **G. Guarino**, G. Vivone, G. Poggi, J. Chanussot, A. Plaza, G. Scarpa,
"Hyperspectral Pansharpening: Critical Review, Tools and Future Perspectives",
IEEE Geoscience and Remote Sensing Magazine, 2024

M. Ciotola, **G. Guarino**, G. Scarpa,
"An Unsupervised CNN-Based Pansharpening Framework with Spectral-Spatial Fidelity Balance",
Remote Sensing, 2024

G. Guarino, M. Ciotola, G. Vivone, G. Scarpa,
"Band-wise Hyperspectral Image Pansharpening using CNN Model Propagation",
IEEE Transactions on Geoscience and Remote Sensing, 2023

G. Guarino, M. Ciotola, G. Vivone, G. Poggi, G. Scarpa,
"PCA-CNN Hybrid Approach for Hyperspectral Pansharpening",
IEEE Geoscience and Remote Sensing Letters, 2023.

International conference papers

G. Guarino, C. F. Dantas, D. Ienco, R. Gaetano, G. Vivone, M. Ciotola, G. Scarpa,
"Adversarial Feature Disentanglement for Semi-Supervised Heterogeneous Domain Adaptation",
IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2025

M. Ciotola, **G. Guarino**, F. Pacifici, G. Scarpa,
"Pixel-wise Coregistration-at-loss for Enhanced CNN-based Pansharpening",
IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2025

G. Guarino, M. Ciotola, G. Scarpa,
"A Spectral-Preserving Zero-Shot Technique for Hyperspectral Pansharpening",
Scandinavian Conference on Image Analysis (SCIA), 77-91, 2025

G. Guarino, M. Ciotola, G. Poggi, G. Vivone, G. Scarpa,
"Hybrid GSA-CNN Method for Hyperspectral Pansharpening",
IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2024, pp. 901-904, 2024

G. Guarino, A. Mazza, G. Di Giuseppe, G. Poggi, G. Vivone, G. Scarpa,
"CNN-Based NO₂ Estimation from Sentinel-5P Data: A Proof-of-Concept",
IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2024, pp. 5744-5747, 2024

M. Ciotola, **G. Guarino**, G. Vivone, J. Chanussot, A. Plaza, G. Scarpa,
"Hyperspectral Pansharpening: Review and Future Perspectives",
IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2024, pp. 1231-1234, 2024

M. Ciotola, **G. Guarino**, G. Poggi, G. Scarpa,
"Balancing Spectral and Spatial Quality in CNN-Based Unsupervised Pansharpening",
IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2024, pp. 1091-1094, 2024

G. Guarino, M. Ciotola, G. Vivone, G.Poggi, G. Scarpa,
“An unsupervised CNN-based hyperspectral pansharpening method”,
IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2023, pp. 5982-5985, 2023

M. Ciotola, **G. Guarino**, A. Mazza, G.Poggi, G. Scarpa,
“Pansharpening by efficient and fast unsupervised target-adaptive CNN”,
IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2023, pp. 5579-5582, 2023

Patents and/or spin offs

None

Awards and Prizes

None

Date 27/10/2025

PhD student signature



Supervisor signature

