



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

PhD Student: Giacco Giovanni

Cycle: XXXVI

Training and Research Activities Report

Year: First

Giacco Giovanni

Tutor: prof. Carlo Sansone

Date: October 21, 2021

Training and Research Activities Report

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Author: Giovanni Giacco

1. Information:

- **PhD student:** Giovanni Giacco
- **DR number:** DR995137
- **Date of birth:** 27/04/1988
- **Master Science degree:** Computer Engineering
- **University:** University of Naples Federico II
- **Doctoral Cycle:** XXXVI
- **Scholarship type:** *no scholarship*
- **Tutor:** Carlo Sansone

2. Study and training activities:

Activity	Type ¹	Hours	Credits	Dates	Organizer	Certificate ²
GDPR basics for computer scientists, Dr. Ringo	Seminar	1.5	0.3	10/12/2020	Prof. P. Bonatti, DIETI	Y
Digital Project Management: practices, processes, techniques, tools and scientific approach	Seminar	2	0.4	18/11/2020	Dip. di Fisica "Ettore Pancini" & DIETI	Y
Statistical data analysis for science and engineering research	Course	12	4	17-19-24-25/02/03-04/03/2021	Prof. Roberto Pietrantuono - DIETI	Y
Analisi dei dati multispettrali e iperspettrali	Seminar	10	2	25/02/2021 - 26/02/2021	Fondazione E. Amaldi, ESA Ambassador	Y
The rise of Artificial Intelligence for Earth Observation	Seminar	1	0.2	02/03/2021	Eo4geo, Planetek Italia	Y
Visual Interaction and Communication in Data Science	Seminar	2	0.4	03/03/2021	Dipartimento di Fisica «Ettore Pancini» & DIETI –	Y

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					Unina	
Scientific Programming and Visualization with Python	Course	16	2	08-10/03/2021	DiSt department - Scuola Politecnica e delle Scienze di Base - UNINA	Y
Dai mainframe all'IoT: una retrospettiva sull'evoluzione delle architetture di calcolo	Seminar	2	0.4	08/03/2021	Prof. A. Cilardo, DIETI, ITEE	Y
Big Data and Computational Linguistics	Seminar	2	0.4	10/03/2021	Dipartimento di Fisica «Ettore Pancini» & DIETI - Unina	Y
Emotions in Reinforcement Learning Agents	Seminar	1	0.2	17/03/2021	Prof.ssa S. Rossi, PRISCA Lab. - DIETI	Y
Sensoria Health	Seminar	1	0.2	17/03/2021	Dipartimento di Fisica «Ettore Pancini» & DIETI - Unina	Y
The coming recolon of Data driven Discovery, Giuseppe Longo	Seminar	1.5	0.3	25/03/2021	Dipartimento di Fisica «Ettore Pancini» & DIETI - Unina	Y
Why Do We Cooperate? Understanding and Modelling Societies using Reinforcement Learning	Seminar	1	0.2	01/04/2021	Prof. Musolesi	Y
Distributional	Seminar	1.5	0.3	28/04/2021	Dipartimen	Y

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Semantic Methods: How linguistic features can improve the semantic representation					to di Fisica «Ettore Pancini» & DIETI – Unina	
Optimized Graph Representations for Right-Wing Reddit Community Detection Using Graph Neural Network	Seminar	1	0.2	30/04/2021	Mohamed Diaoulé Diallo - PRISCA	Y
Ethics of quantification	Seminar	2	0.4	26/05/2021	Prof. Andrea Saltelli	Y
Big Data Analytics and Business Intelligence	Course	48	6	12/03/2021 – 10/06/2021	Prof. Sperli Giancarlo, Unina	Y
Image Processing for Computer Vision	Course	72	9	09/03/2021 – 10/06/2021	Prof. Giuseppe Scarpa, Unina	Y
Sadas, Static Data Analysis System for decision making	Seminar	2	0.4	23/06/2021	Dipartimento di Fisica «Ettore Pancini» & DIETI – Unina	Y
Geospatial Machine Learning for Earth Observation and Climate Modeling	Seminar	1	0.2	02/02/2021	Konstantin Klemmer, AI4EO	N
L'esposizione ai campi elettromagnetici generati dal sistema 5G - Metodologie scalari e vettoriali di misura dell'esposizione e tecniche di estrapolazione	Seminar	4	0.8	16/07/2021	Prof. N. Pasquino, DIETI - Unina	Y
Which one is more important: more	Seminar	1	0.2	22/07/2021	Jason Weston,	N

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parameters or more computation?					IARAI	
How to Publish Open Access with IEEE to Increase the Exposure and Impact of Your Research	Seminar	1	0.2	29/09/2021	IEEE	Y
<i>Localized least-squares radial basis function methods for PDEs</i> , speaker	Seminar	1	0.2	05/10/2021	Elisabeth Larsson, Uppsala Universitet, Sweden.	Y
Qiskit: state of the art and tools for Quantum Computers from IBM	Seminar	2	0.4	15/10/2021	Prof. A. S. Cacciapuoti, DIETI - Unina	Y
SAR Polarimetry: Theory, Machine Learning & Applications	Seminar	2	0.4	19/10/2021	Prof. A. Iodice, DIETI - Unina	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	0.7	6	0	6.7
Bimonth 2	0	2	6	0	8
Bimonth 3	6	2.8	6	0	14.8
Bimonth 4	0	0.8	6	0	6.8
Bimonth 5	0	1.2	4	0	5.2
Bimonth 6	15	1.1	4	0	20.1
Total	21	8.6	32	0	61.6
Expected	30 - 70	10 - 30	80 - 140	0 - 4.8	

3. Research activity:

Developments in the capability to monitor our home planet with Earth Observation (EO) satellites have led to new opportunities for science and business. There is an increasing need to exploit the large amounts of data generated by the new generation of satellites coming online. Artificial Intelligence (AI) is an essential part of the solution, enabling scalable big data

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exploration and bringing unique insight and predictive capabilities. In this context, my research topic, "**Artificial Intelligence in Earth Observation applications**", fits.

During this first year of my PhD, I analyzed the problems concerning my research topic and studied state-of-the-art works about them. My main research activities concern the application of Machine Learning, and Deep Learning methodologies, to satellite imagery to translate satellite imagery into maps that expose different information. I used both free satellite imagery (e.g., Sentinel-2, Landsat-8) and commercial ones (e.g., Pleiades, Worldview-3, PlanetScope). In addition, Unmanned Aerial Vehicle (UAV) based imagery have been used too.

Further details on the topics explored follow.

3.1. Research on Soil consumption and Land Cover Land Use Classification in the urban context

Continual mapping and monitoring of impervious surfaces and land cover land use (LCLU) are crucial for developing sustainable urban management strategies and environmental change monitoring actions. Due to the complexity of urban land use and the diversity of impervious surface materials, generating these maps is a challenging task. Actual solutions based on Sentinel-2 satellite images are often inefficient in an urban context because they can't express the variety of land cover in built-up areas. To face this problem, I generated a novel training dataset both for imperviousness and LCLU use cases. Based on a U-Net backbone, residual blocks and the FuseNet principle, a deep learning model has been tested to exploit Sentinel-2 multispectral content, not only classical RGB bands. Evaluation results for the proposed solution show state-of-the-art results but with better performances of the model to classify the variety of the classes in the urban context. The first work concerning some preliminary results is in preparation.

As future work, I will continue this line of research by extending the current model to a new one able to exploit time-series data and/or SAR data.

3.2. Research on Downscaling Landsat-8 Land Surface Temperature with Sentinel-2 satellite imagery

Urban heat island (UHI) is a phenomenon of high spatial and temporal variabilities. UHI monitoring is possible through thermal satellite remote sensing of land surface temperature (LST). The coarser spatial resolution of Landsat-8 thermal bands, i.e. 100 m, does not address the necessity to monitor LST in the urban context, so I worked on a solution to downscale it to a 10 m spatial resolution using Sentinel-2 data and a machine learning approach.

The proposed method is based on a Catboost regressor trained on a set of features which includes (i) Sentinel-2 multispectral bands, (ii) multispectral indexes. Preliminary results show

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excellent performance in Mean Absolute Error (1.3 °C) and R2 (0.81). Results have been validated on upscaled Landsat-8 LST data and temperature data for some ground points available across Italy.

In future work, I will evaluate results with more control ground points to better assess the model's performance. In addition, I'd like to study the feasibility of the downscaling approach with very high-resolution satellite imagery.

3.3. Research on Automated crack detection for post-earthquake building damage assessment from drone imagery

During my first year, I collaborated with the Department of Structures for Engineering and Architecture (DiSt) at Unina, to develop an automated solution to detect cracks on buildings surfaces. Cracks localization was a preliminary step to reach the final goal of automatically assessing the post-earthquake damages, compiling some section of the AeDES form used by the Civil Protection in Italy.

In this work, I developed a patch-based solution, based on Convolutional Neural Networks (CNNs), to identify cracks on building surfaces. A novel dataset has been created, based on drone imagery but also camera images and Google Street view images, to address the scarcity of drone images at our disposal. In addition, I'm working on a model to detect windows in the buildings to understand where the crack is located and estimate its gravity related to where it occurs.

Preliminary results show an accuracy of around 89% for the detection of patches which includes cracks.

As future work, some enhancement needs to be done both on the dataset, to enhance its size and quality, and the model to improve the overall performance. A first work concerning preliminary results and the whole application is in preparation.

4. Research products:

In preparation:

- Giacco Giovanni, Stefano Marrone, Giuliano Langella, Carlo Sansone; “*Land Cover Classification in the urban context by using Multispectral Sentinel-2 Satellite Imagery*”
- Giacco Giovanni, Giulio Mariniello, Domenico Asprone, Edoardo Cosenza, Carlo Sansone; “*Automatic compilation of the AeDES form for the assessment of building post-earthquake damages by using drone imagery*”

5. Conferences and seminars attended

During my first PhD year I did not participate to any conference.

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6. Activity abroad:

During my first PhD year I did not spend any time abroad.

7. Tutorship

During my first PhD year I did not make any tutorship activity.