
**PhD in Information Technology and Electrical Engineering**

**Università degli Studi di Napoli Federico II**

# PhD Student: Antonio Mazza

**XXXIII Cycle**

**Training and Research Activities Report – Second Year**

**Tutor: Giuseppe Scarpa**

# 1. Information

Antonio Mazza, Master Degree in Telecommunication Engineering – University of Naples "Federico II"

XXXIII Cycle - ITEE - University of Naples "Federico II"

Tutor: Prof. Giuseppe Scarpa

# 2. Study and Training activities

During my second year of the Ph.D I have attended the following courses:

- ❏ Machine Learning (4.7 CFU)

and the following seminars:

- ➢ Computationale and Machine Learning Methods for Complex Ecosystems
- ➢ Medical Thermal Therapy and Monitoring Using Microwave Inverse Scattering
- ➢ Microwave Sensing Through the Subsurface for Addressing the Water Puzzle
- ➢ Presentazione ADI: Vittorie, Sfide, Obiettivi
- ➢ Designer matter: Meta-Material Interaction with Light, Radio-Waves and Sound.
- ➢ Forest mapping from Sentinel-1 InSAR data (DLR)
- ➢ Digital Beamforming for Radio Frequency Interference Suppression in Synthetic Aperture Radar (DLR)
- ➢ Modeling of Subsurface Scattering from Ice Sheets for Pol-InSAR Applications (DLR)
- ➢ An Update on the NASA-ISRO SAR Mission and an Architecture for its Successor (DLR)
- ➢ Forest Structure Characterization from SAR Tomography (DLR)
- ➢ Onboard Quantization for Interferometric and Multichannel SAR Systems (DLR)

In the following table is depicted a summary of the activities presented above:

| Student: Antonio Mazza<br>antonio.mazza@unina.it | | | | | Tutor: Giuseppe Scarpa<br>giuseppe.scarpa@unina.it | | | | Cycle XXXIII | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Credits year 1 | | | | | | | | Credits year 2 | | | | | | | | Credits year 3 | | | | | | | | | |
| | Estimated | 1 bimonth | 2 bimonth | 3 bimonth | 4 bimonth | 5 bimonth | 6 bimonth | Summary | Estimated | 1 bimonth | 2 bimonth | 3 bimonth | 4 bimonth | 5 bimonth | 6 bimonth | Summary | Estimated | 1 bimonth | 2 bimonth | 3 bimonth | 4 bimonth | 5 bimonth | 6 bimonth | Summary | Total | Check |
| Modules | 18 | 0 | 0 | 0 | 0 | 9 | 0.4 | 9.4 | 12 | 0 | 0 | 7 | 0 | 0 | 0 | 7 | | | | | | | | 0 | 16.4 | 30-70 |
| Seminars | 13 | 0 | 0.8 | 1.3 | 0 | 2.4 | 0.5 | 5 | 5 | 0.2 | 0 | 0.8 | 0 | 3.6 | 1.2 | 5.8 | | | | | | | | 0 | 10.8 | 10-30 |
| Research | 34 | 10 | 8.2 | 8.7 | 10 | 0 | 0 | 36.9 | 43 | 9.8 | 10 | 2.2 | 10 | 6.4 | 8.8 | 47.2 | | | | | | | | 0 | 84.1 | 80-140 |
| | 65 | 10 | 9 | 10 | 10 | 11.4 | 0.9 | 51.3 | 60 | 10 | 10 | 10 | 10 | 10 | 10 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 111. | 180 |

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3. Research activity

In the secondyear of my Ph.D I focused the research activity on:

a. Vegetation monitoring via Deep Learning approaches in Remote Sensing Applications:
    i. Forest/Non-forest mapping using TanDEM-X products
    ii. Forest Change detection
b. Super-Resolution of Sentinel-2 bands.

Here I briefly explain each of which:

a. Forests play an important role for the Earth's ecosystem, reducing the concentration of carbon dioxide in the atmosphere and regulating global warming. To asses the impact of forest on the ecosystems, the study of deforestation and development of global forest coverage and biomass is necessary. Remote sensing represents a very useful tool for a regular monitoring at a global scale of vegetated areas.
   The research aims to develop Deep Learning approaches in order to fuse different kind of data as to find complex relationships that are not easy to model.

    i. In a first phase the research was focused on fusion of TANDEM-X SAR images and related features, like the interferometric correlation,

for the purpose of land cover classification using convolutional neural networks.

ii. Ongoing research is now focused on the use of the quantity above in order to detect deforestation activities in the Amazon rainforest.

b. The twin Sentinel-2 satellites from the Copernicus mission of the ESA provide a global World coverage with short revisit time. They also provide a multi-resolution stack composed of 13 spectral bands, between the visible and short-wave infrared (SWIR), distributed over three resolution levels. Some information of interest can be extracted from the bands at lower resolution. It would be useful to obtain these information at full resolution (10m for Sentinel-2).
The research aims to develop Deep Learning approaches in order to fuse the details extracted from full resolution bands to inject in the low-resolution bands trying to limi the spectral distortion.

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[2] Goodfellow, I.; Bengio, Y.; Courville, A. Deep Learning; MIT Press: Cambridge, MA, USA, 2016. Available online: http://www.deeplearningbook.org (accessed on 13 December 2017).
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[3] Fotiadou, K.; Tsagkatakis, G.; Tsakalides, P. Deep Convolutional Neural Networks for the Classification of Snapshot Mosaic Hyperspectral Imagery. Electron. Imaging 2017, 2017, 185–190.

[4] Jiao, L.; Liang, M.; Chen, H.; Yang, S.; Liu, H.; Cao, X. Deep Fully Convolutional Network-Based Spatial Distribution Prediction for Hyperspectral Image Classification. IEEE Trans. Geosci. Remote Sens. 2017, 55, 5585–5599.

[5] Long, J.; Shelhamer, E.; Darrell, T. Fully convolutional networks for semantic segmentation. In Proceedings of the 2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Boston, MA, USA, 7–12 June 2015; pp. 3431–3440.

[6] Addabbo, P.; Focareta, M.; Marcuccio, S.; Votto, C.; Ullo, S.L. Land cover classification and monitoring through multisensor image and data combination. In Proceedings of the 2016 IEEE International

Geoscience and Remote Sensing Symposium (IGARSS), Beijing, China, 10–15 July 2016; pp. 902–905.

[7] M. Martone, P. Rizzoli, C.Wecklich, C. Gonz´alez, J.-L. Bueso-Bello, P. Valdo, D. Schulze, M. Zink, G. Krieger, and A. Moreira, "The global forest/non-forest map from tandem-x interferometric SAR data," Remote Sensing of Environment, vol. 205, pp. 352 – 373, 2018.

[8] M. Martone, F. Sica, C. Gonz´alez, J.-L. Bueso-Bello, P. Valdo, and P. Rizzoli, "High-resolution forest mapping from tandem-x interferometric data exploiting nonlocal filtering," Remote Sensing, vol. 10, pp. 1477, 2018.

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[10] K. He, X. Zhang, S. Ren, and J. Sun, "Deep residual learning for image recognition," in CVPR, June 2016.

[11] G. Huang, Z. Liu, L. Van Der Maaten, and K. Q. Weinberger, "Densely connected convolutional networks.," in CVPR, 2017.

[12] A. Krizhevsky, I. Sutskever, and G. E Hinton, "Imagenet classification with deep convolutional neural networks," in Advances in neural information processing systems, 2012, pp. 1097–1105.

4. Products

   a. Publications:

[1] M. Gargiulo; A. Mazza; R. Gaetano, G. Ruello and G. Scarpa "Fast Super-Resolution of 20 m Sentinel-2 Bands Using Convolutional Neural Networks". *Remote Sens.* **2019**, *11*, 2635.

[2] A. Mazza, F. Sica, "Deep Learning Solutions for Tandem-X-Based Forest Classification", *IGARSS 2019 - 2019 IEEE International Geoscience and Remote Sensing Symposium*, Yokohama, 2019, pp. 2631-2634.

[3] A. Mazza; F. Sica, P. Rizzoli and G. Scarpa "TanDEM-X Forest Mapping Using Convolutional Neural Networks". *Remote Sens.* **2019**, *11*, 2980.

5. Conferences and Seminars

I have attended the following conference/seminar:

a. International Geoscience and Remote Sensing Symposium '19 (poster presentation)
b. Science Meeting: TerraSAR-X/TanDEM-X Science Meeting 2019 (poster presentation)

6. Activity abroad

I have spent four months abroad at DLR, Munich, Germany from August to December 2019.

7. Tutorship

Co-tutor of two Master Degree thesis student.

Supporting students in laboratory activities during Image Processing for Computer Vision course