



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 – First 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 first year of the Ph.D I have attended the following courses:

- ❑ Tomografia e imaging: principi, algoritmi e metodi numerici (9 CFU)
- ❑ Elaborazione Numerica dei Segnali (6 CFU)
- ❑ 2018 IEEE-EURASIP Summer School on Signal Processing (with poster presentation)

and the following seminars:

- Convolutional Neural Networks - Application to Remote Sensing
- IBM Q: Building the first universal quantum computers for business and science
- Tailoring Waves at the Extreme with Metamaterials
- Uso del cellulare e tumori cerebrali: Le evidenze epidemiologiche
- Malattie Professionali da campi elettromagnetici tra scienza e giustizia
- Lo sviluppo e la gestione della proprietà intellettuale: Da un caso reale agli aspetti generali
- Phase contrast tomography
- How to publish a scientific paper
- Il 5G e l'evoluzione delle reti radiomobili
- Filtraggio dell'azimuth ambiguity in Immagini SAR

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

		Credits year 1						
	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary
Modules	20	0	0	6	0	3	9	18
Seminars	5	0.8	0	1.3	0	2.4	1.1	5.6
Research	35	9.2	10	2.7	10	4.6	3	39.5
	60	10	10	10	10	10	13.1	63.1

:

3. Research activity

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

- a. Data fusion via Deep Learning approaches in Remote Sensing Applications:
 - i. Regression on SAR/Optical images for feature extraction
 - ii. Forest Classification

Here I briefly explain each of which:

- a. Data fusion methods, i.e., processing dealing with data and information from multiple sources to achieve improved information for decision making can be grouped into three main categories:
 - pixel-level;
 - feature-level;
 - decision-level.

In the context of remote sensing, with reference to the sources to be fused, fusion methods can be roughly gathered into the following categories:

 - multi-resolution;

- multi-temporal;
- multi-sensor;
- mixed.

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 a regression problem involving SAR/Optical images with the goal of feature extraction (like vegetation indices) by means of convolutional neural networks. An example of multi-sensor/multi-temporal fusion.
- ii. Ongoing research is now 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.

- [1] Pohl, C.; Genderen, J.L.V. Review article Multisensor image fusion in remote sensing: Concepts, methods and applications. *Int. J. Remote Sens.* 1998, 19, 823–854.
- [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).
- [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. González, 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. González, 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.
- [9] Goodfellow, I.; Pouget-Abadie, J.; Mirza, M.; Xu, B.; Warde-Farley, D.; Ozair, S.; Courville, A.; Bengio, Y. Generative Adversarial Nets. In *Proceedings of the Advances in Neural Information Processing Systems 27 (NIPS 2014)*; Montréal, Canada, 8–13 December 2014; pp. 2672–2680.
- [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] Scarpa, G.; Gargiulo, M.; Mazza, A.; Gaetano, R. “A CNN-Based Fusion Method for Feature Extraction from Sentinel Data”. *Remote Sens.* **2018**, *10*, 236.
- [2] A. Mazza, M. Gargiulo, G. Scarpa and R. Gaetano, "Estimating the NDVI from SAR by Convolutional Neural Networks," *IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium*, Valencia, 2018, pp. 1954-1957.

- [3] M. Gargiulo, A. Mazza, R. Gaetano, G. Ruello and G. Scarpa, "A CNN-Based Fusion Method for Super-Resolution of Sentinel-2 Data," *IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium*, Valencia, 2018, pp. 4713-4716.

In review:

- [4] A.Mazza, F.Sica, "Deep Learning Solutions For TANDEM-X-based Forest Classification" to IGARSS 2019

5. Conferences and Seminars

I have attended the following conference/seminar:

- a. GTTI – 2nd Italian Workshop on Radar and Remote Sensing 2018 (oral presentation)
- b. International Geoscience and Remote Sensing Symposium '18 (oral presentation)
- c.

6. Activity abroad

I have spent three months abroad at the CIRAD, Montpellier, France and a week at DLR, Munich, Germany.

7. Tutorship

Co-tutor of a Master Degree thesis student.