Ph.D. in Information Technology
Thesis Defenses

May 31st, 2022
at 14:00
Room Seminari

Nicolo' BONETTINI – XXXIV Cycle

Machine Learning Techniques for Integrity Control

Supervisor: Prof. **Marco Marcon**

Abstract:

This thesis focuses on two particular aspects of integrity control: digital integrity and physical integrity. In particular, we propose Signal Processing, Machine Learning and Deep Learning techniques for solving relevant problems in these two areas.
Given the vastness of these fields, we select two applications we consider the most relevant to investigate: Multimedia Forensics for the digital integrity world, and Food Safety Hyperspectral X-ray analysis for the physical integrity world.
Digital integrity covers the crucial role of verifying and assessing trustworthiness in digital media content. We spend more and more time on social networks and chats, where we are constantly flooded with images and videos. Therefore, we strongly need tools to ensure that those contents are not tampered with. The more we continue in this vein, the more we are exposed to the risk of being fooled or manipulated by multimedia content over the internet. To solve this issue, we investigate three specific areas of interest: sensor integrity, coding integrity and semantic integrity.
Physical integrity concerns the integrity of objects: a gigantic field spanning from controlling buildings and infrastructures' integrity to checking integrity in microscopic manufacturing. Among all the possible applications in this broad field, we consider the application of Hyperspectral X-ray analysis in the context of Food Safety, that is, using this powerful method to find contaminants buried in food in different stages of its industrial preparation. In this sense, we cover the integrity of the acquired signal, which is likely to be compromised whether a foreign body alters its characteristics.

Francesco PICETTI – XXXIV Cycle

A Study on Deep Learning Methodologies Applied to Geophysical Inverse Problems

Supervisor: Prof. **Stefano Tubaro**

Abstract:

Exploration Geophysics aims at estimating accurate physical properties of the Earth subsurface from seismic data acquired close to the surface.
For physical reasons, data are band-limited and corrupted by a great variety of noises, disturbances, and other phenomena.
Therefore, the fundamental tasks of Geophysics are challenging inverse problems.

Moreover, the acquisition campaigns result in massive datasets, limiting the algorithms to be computationally feasible.
TTo tackle these challenges, traditional signal processing techniques have to be combined with more innovative strategies, such as convolutional neural networks, to ensure good performance even in the most complex scenarios.
In this thesis, different machine learning paradigms are applied to data preprocessing (interpolation with deep priors), imaging (GAN-based enhancement of images), and interpretation tasks (landmine detection with GPR data, and CNN segmentation of salt bodies on migrated volumes).
Through numerical experiments on both synthetic and field data, the devised machine learning methods are demonstrated to be effective compared to the state of the art.
The results suggest that improvements can be achieved by integrating pure data-driven algorithms within general inverse problems theory through a-priori information derived from domain knowledge.

PhD Committee

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