



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee^{PhD}
information technology
electrical engineering



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Giuseppe Guarino

Deep Learning for Data Fusion and Air Quality Assessment in Remote Sensing

Tutor: Prof. Giovanni Poggi
co-Tutor: Prof. Giuseppe Scarpa (UniParthenope),
Gemine Vivone (CNR IMAA)

Cycle: XXXVIII

Year: First

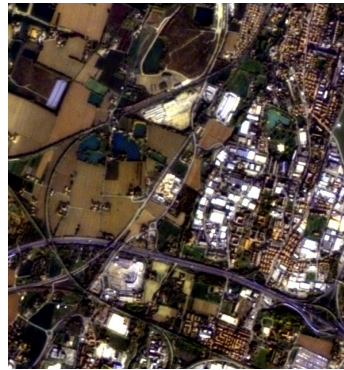
My background

- MSc degree in Automation Engineering and Robotics – Università degli Studi di Napoli Federico II
- Research group: GRIP (Image Processing Research Group)
- PhD start date: 1/11/2022
- Scholarship type: CNR Istituto di Metodologie per l'Analisi Ambientale (IMAA)

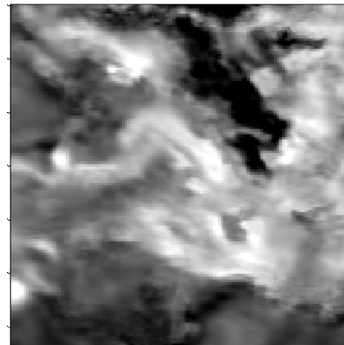
Research field of interest



Enhancement of satellite images resolution.



Estimation of air pollutants through satellite images



Summary of study activities

- **PhD Courses:**

- *Academic Entrepreneurship*: A course that delves into all the aspects you need to know to transform a research idea into a successful company.
- *How to boost your phd*: A course that explains which soft skills can help a researcher to transmit his ideas more effectively, and how to develop them.
- *Using Deep Learning Properly*: This course was focused on the exploration of classical error that can be made in using deep learning through python programming language

- **MSc Courses:**

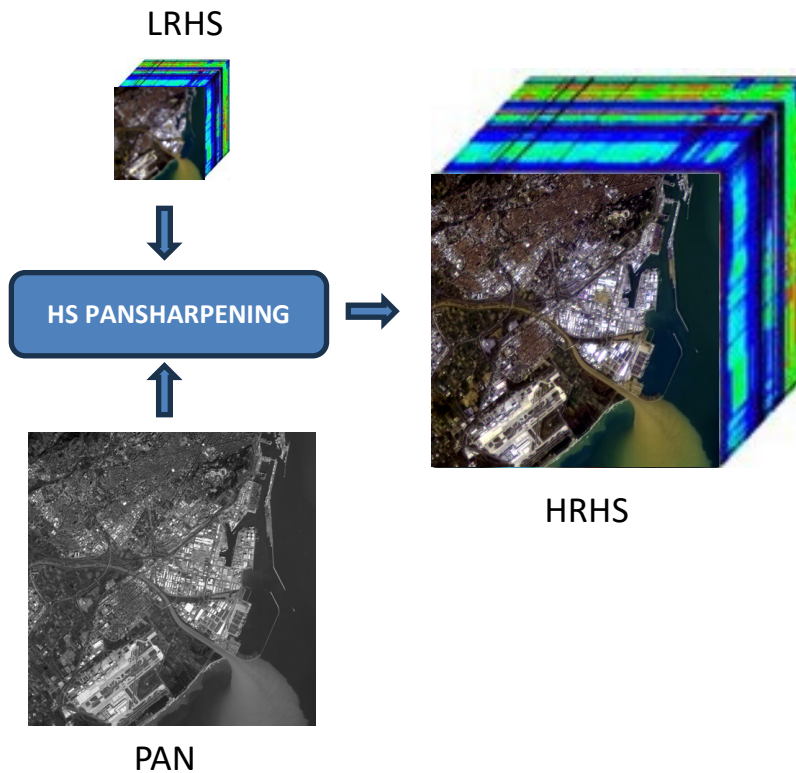
- *Visione per sistemi robotici*: a course aimed at solving robotic vision problems, with particular reference to biomedical applications.

- **Conferences and Tutorials:**

- IEEE International Geoscience and Remote Sensing Symposium 2023
- Pansharpening by convolutional neural networks (IGARSS2023)

Research activity: Problem (1/2)

Hyperspectral Pansharpening



Problems

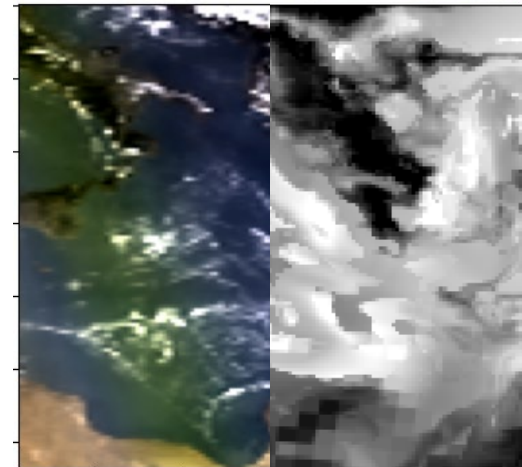
- Lack of satellite data
- No reference
- High volume of data
- Dimension variability

Research activity: Problem (2/2)

Detection of air pollutants

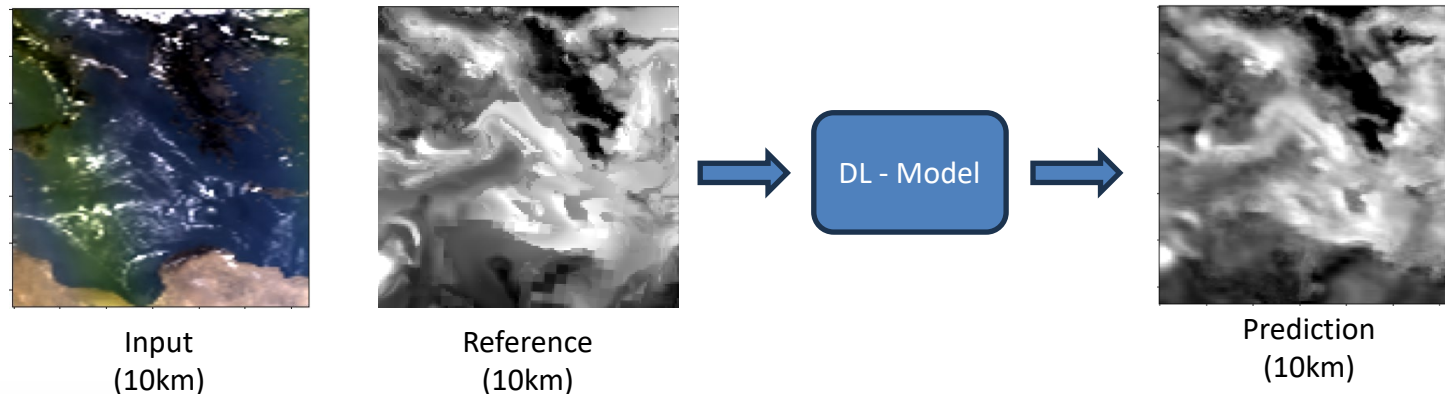
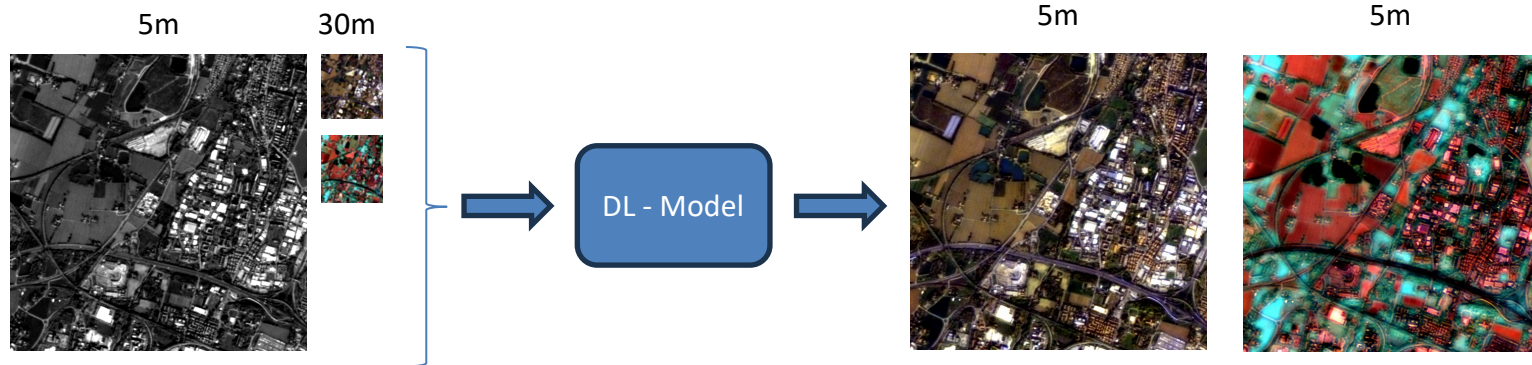
Satellite images VS Ground Station

- Global coverage
 - Continuous measurements
 - No maintenance
 - Better resolution
-
- These maps are obtained with complex mathematical models.



Research activity: Objective

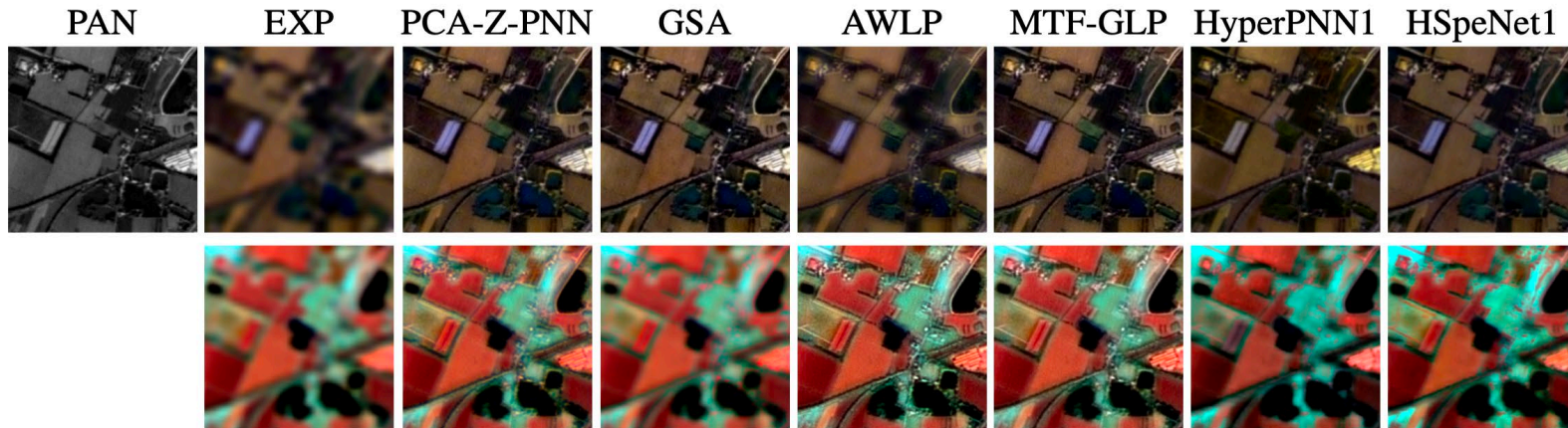
Our objective is to investigate Deep Learning approaches to address both of these tasks, aiming for solutions that are not only faster but also more computationally efficient compared to model-based techniques.



Research activity: Methodology

Over the last decade, numerous techniques aimed at addressing the hyperspectral pansharpening challenge and a wide array of quality indices for evaluating the outcomes have been introduced.

| | Bologna (PRISMA) | | | Florence (PRISMA) | | |
|----------------------|------------------------------|--------------------------|----------------------|------------------------------|--------------------------|----------------------|
| | D_λ (\downarrow) | D_S^* (\downarrow) | Q^* (\uparrow) | D_λ (\downarrow) | D_S^* (\downarrow) | Q^* (\uparrow) |
| GS [9] | 0.2648 | 0.0113 | 0.7269 | 0.2073 | 0.0344 | 0.7654 |
| GSA [10] | 0.0512 | 0.0121 | <u>0.9373</u> | 0.0555 | 0.0033 | 0.9414 |
| AWLP [11] | <u>0.0274</u> | <u>0.0490</u> | <u>0.9249</u> | <u>0.0257</u> | 0.0367 | 0.9385 |
| MTF-GLP [12] | 0.0396 | 0.0341 | 0.9277 | 0.0331 | 0.0254 | <u>0.9423</u> |
| MF [13] | 0.0939 | 0.0663 | 0.8460 | 0.1044 | 0.0447 | <u>0.8556</u> |
| PCA [31] | 0.2949 | 0.0125 | 0.6963 | 0.1826 | <u>0.0094</u> | 0.8097 |
| HyperPNN1 [20] | 0.1203 | 0.0117 | 0.8695 | 0.1198 | <u>0.0152</u> | 0.8668 |
| HSpNet1 [24] | 0.0748 | 0.0401 | 0.8881 | 0.0714 | 0.0149 | 0.9148 |
| Proposed w/out split | 0.0313 | 0.0637 | 0.9070 | 0.0502 | 0.0254 | 0.9256 |
| PCA-Z-PNN | 0.0264 | 0.0238 | 0.9504 | 0.0170 | 0.0096 | 0.9735 |

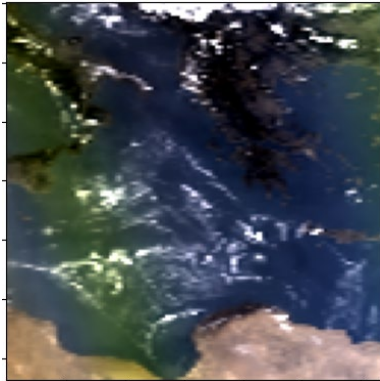


G. Guarino, M. Ciotola, G. Vivone, G. Poggi, G. Scarpa, 'PCA-CNN Hybrid Approach for Hyperspectral Pansharpening', *IEEE Geoscience and Remote Sensing Letters*.

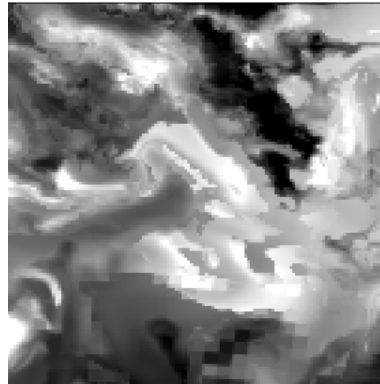
Products

| | |
|------|---|
| [C1] | <i>G. Guarino, M. Ciotola, G. Vivone, G. Poggi, G. Scarpa, 'An unsupervised CNN-based hyperspectral pansharpening method', IEEE IGARSS 2023, pp. 5982-5985, 2023</i> |
| [C2] | <i>M. Ciotola, G. Guarino, A. Mazza, G. Poggi, G. Scarpa, 'Pansharpening by efficient and fast unsupervised target-adaptive CNN', IEEE IGARSS 2023, pp. 5579-5582, 2023</i> |
| [J1] | <i>G. Guarino, M. Ciotola, G. Vivone, G. Scarpa, 'Band-wise Hyperspectral Image Pansharpening using CNN Model Propagation', IEEE Trans. on Geoscience and Remote Sensing (In review – "Major Review" received)</i> |
| [L1] | <i>G. Guarino, M. Ciotola, G. Vivone, G. Poggi, G. Scarpa, 'PCA-CNN Hybrid Approach for Hyperspectral Pansharpening', IEEE Geoscience and Remote Sensing Letters.</i> |

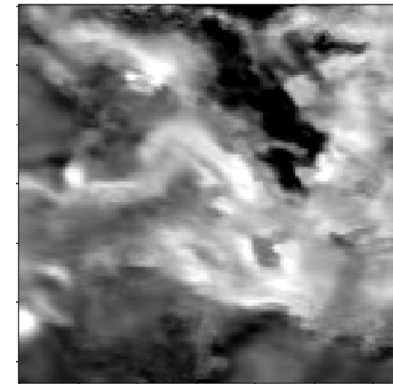
Next Year



Input
(10km)



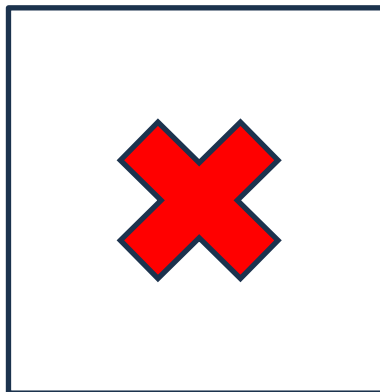
Reference
(10km)



Prediction
(10km)



Input
(5m)



NO Reference
(5m)



Prediction
(5m)

Thank you for the attention!