

Davide Evangelista

Curriculum Vitae

Personal Informations

Name Davide
Surname Evangelista
Profession Research Assistant
Address
Telephone
Institutional Email
Website <https://www.unibo.it/sitoweb/davide.evangelista5/en>
Born at
Nationality Italian

Formation

- 01/2024 – 01/2025 **Research assistant (Bologna, Italy)**
Institution name: Alma Matter Studiorum, University of Bologna.
Research Project: Analisi e sviluppo di algoritmi basati su reti neurali per la ricostruzione di immagini di tomografia da viste sparse.
Supervisor: Elena Loli Piccolomini
- 09/2020 – 11/2023 **PhD in Mathematics (Bologna, Italy)**
Institution name: Alma Matter Studiorum, University of Bologna.
Research Interests: Neural Networks for image processing with application in LowDose CT Reconstruction; Neural Networks for image generation; GreenAI.
Supervisor: Elena Loli Piccolomini
Title of the Thesis: Regularization meets GreenAI: a new framework for image reconstruction in life sciences applications
- 09/2018 – 09/2020 **Master Degree in Mathematics (Bologna, Italy)**
Institution name: Alma Matter Studiorum, University of Bologna.
Supervisor: Elena Loli Piccolomini
Co-supervisor: Andrea Asperti
Title of the Thesis: A systematic comparison between Variational Autoencoder-based methods in image generation task
Evaluation: 110L/110
- 09/2015 – 09/2018 **Bachelor Degree in Mathematics (Bologna, Italy)**
Institution name: Alma Matter Studiorum, University of Bologna.
Supervisor: Fabrizio Caselli
Title of the Thesis: Teorema di Dirichlet sull'infinità dei numeri primi in particolari progressioni numeriche.
Evaluation: 109/110.

Research Interests

Stability analysis of Neural Network for ill-conditioned Inverse Problems:

It is well-known that the accuracy of neural networks in solving inverse problems surpasses that of virtually any other model-based method. Unfortunately, their performance is also known to be unreliable, as even

a slight perturbation in the input can be greatly amplified by the network. Following the path outlined by classical regularization theory, I am interested in understanding the reasons behind the instability of neural networks. Furthermore, I am developing hybrid algorithms that combine the reliability of formal mathematical models with the flexibility offered by modern neural network architectures to efficiently solve ill-conditioned inverse problems.

Neural Networks for Limited Angle Tomography:

In medical imaging, the reliability of a reconstruction algorithm often takes precedence over accuracy. Consequently, the high quality but low stability provided by classical end-to-end neural networks poses challenges when applied to real-world tasks. Therefore, it becomes imperative to develop efficient, task-specific algorithms that strike a balance between accuracy and stability, especially when addressing highly ill-conditioned problems encountered in Computed Tomography. As part of my research, I am designing efficient task-specific neural networks to address inverse problems arising in Limited Angle Tomography.

Generative Neural Networks:

Generative modeling involves the process of learning unknown probability distributions from sample data. Recently, generative models based on neural networks, such as Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), and Diffusion Models, have found application in underdetermined inverse problems like Sparse Tomography. In these scenarios, the goal is to generate information that is not initially present in the collected data. I am conducting mathematical investigations of these approaches with the aim of comprehending their properties and limitations.

GreenAI:

In my research, I am consistently guided by the GreenAI paradigm, which emphasizes prioritizing efficiency over accuracy when designing neural networks. This is achieved by optimizing the architecture to be task-specific, thereby reducing the computational burden during training.

Publications

- *A. Asperti, D. Evangelista, E. Loli Piccolomini, A survey on Variational Autoencoders from a GreenAI perspective*, SN Computer Science, 1st March 2021;
- *A. Asperti, D. Evangelista, M. Marzolla, Dissecting FLOPs along input dimensions for GreenAI cost estimations*, International Conference on Machine Learning, Optimization, and Data Science, 2021;
- *E. Morotti, D. Evangelista, E. Loli Piccolomini, A green prospective for learned post-processing in sparse-view tomographic reconstruction*, Journal of Imaging, 2021;
- *E. Morotti, D. Evangelista, E. Loli Piccolomini, RISING a new framework for few-view tomographic image reconstruction with deep learning*, Computerized Medical Imaging and Graphics, 2022;
- *D. Evangelista, E. Morotti, J. Nagy, E. Loli Piccolomini, To be or not to be stable, that is the question - stability and accuracy trade-off in neural networks for inverse problems*, arXiv.2211.13692, 2022;
- *D. Bianchi, M. Donatelli, D. Evangelista, W. Li, E. Loli Piccolomini, Graph Laplacian and Neural Networks for Inverse Problems in Imaging: GraphLaNet*, International Conference on Scale Space and Variational Methods in Computer Vision, 2023;
- *D. Evangelista, E. Morotti, J. Nagy, E. Loli Piccolomini, Ambiguity in solving imaging inverse problems with deep learning based operators*, Journal of Imaging, 2023;
- *A. Asperti, D. Evangelista, S. Marro, F. Merizzi, Image embedding for denoising generative models*, Artificial Intelligence Review, 2023;

Conferences

- *AIP2023 Applied Inverse Problem Conference* - MS48 Robustness and reliability of Deep Learning for noisy medical imaging;
- *SMILE2023: Sustainable Medical Imaging with Learning and Regularization* - Talk: On the Stability of Hybrid Algorithms in CT Image Reconstruction;
- *SIAM2022 Conference on Imaging Sciences* - MS30 Deeply Learned Regularization for Inverse Imaging

Problems;

- o *SIAM2022 Mathematics of Data Science* - MS17 Graphs and Neural Networks for Inverse Problems in Imaging;
- o *Mathematics for Artificial Intelligence and Machine Learning* - UniTo - Talk: Stability-Accuracy Trade-off in Neural Networks for Ill-conditioned Inverse Problems;

Collaborations and Research Groups

- o Scientific Computing @ Emory Research Group. URL: <http://www.math.emory.edu/site/codes/>.
- o OASIS Research Group. URL: <http://www.oasis.unimore.it/site/home.html>.
- o Collaboration with BRACCO Group with Harbin Institute of Technology (HIT) for a project about Contrast Agent Enhancement. The collaboration has resulted in a patent that is expected to be approved soon.

Experiences abroad

03/2023 – 04/2023 **Visitor Student (Emory, Georgia)**

Institution name: Emory University, Georgia.
Supervisor: James Nagy

01/2022 – 04/2022 **Exchange Visitor Student (Emory, Georgia)**

Institution name: Emory University, Georgia.
Research Project: Solving the Instability Problem that arises when Neural Networks are used to solve Inverse Problems;
Supervisor: James Nagy

Teaching

2021/2022 **Deep Learning [cod. 91250]**

2022/2023 Role: Tutor.
Professor: Andrea Asperti.

2021/2022 **Statistical and Mathematical Methods for Machine Learning [cod. 91255]**

2022/2023 Role: Tutor.
Professor: Elena Loli Piccolomini.

2020/2021 **Numerical Methods [cod. 35433]**

Role: Tutor.
Professor: Carolina Beccari.

2020/2021 **Calcolo Numerico [cod. 02023]**

Role: Tutor.
Professor: Elena Loli Piccolomini.

2019/2020 **Analisi Numerica e Modellizzazione Geometrica T [cod. 75602]**

2020/2021 Role: Tutor.
Professor: Carolina Beccari.

2019/2020 **Numerical Methods M [cod. 73513]**

2020/2021 Role: Tutor.
Professor: Fabiana Zama.

2019/2020 **Statistica Numerica [cod. 72534]**

2020/2021 Role: Tutor.
Professor: Elena Loli Piccolomini.

Computational Skills

- Python Advanced level. I'm particularly able in its use for Data Analysis, Computer Vision and Deep Learning, with libraries like numpy, matplotlib, tensorflow, pytorch, keras, pandas and sklearn.
- Matlab Advanced level, obtained in the university. I'm particularly able in its use for Numerical Methods and Image Processing. Language Taught in courses: 73513 - Numerical Methods M., 75602 - Analisi Numerica e Modellazione Geometrica T.
- R Intermediate level. I'm particularly able in its use for Machine Learning and Statistics.