Postdoctoral Position

Unfolded Proximal Neural Operators for Inverse Problems in Imaging

Supervisors: Loïc Denis and Jordan Patracone
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Location: Laboratoire Hubert Curien, Saint-Étienne, France
Teams: The postdoc will join both the ODIR Team and the MALICE Inria Project-Team.
Duration: 18 months
Starting date: September-October 2025

Keywords: Inverse Problems; Deblurring; Neural Operators; Deep Unfolding

Context: This project will develop a novel framework for solving inverse problems in imaging, focusing on the joint reconstruction of a sequence of high-quality images from multiple degraded or incomplete observations. These inverse problems are typically addressed using neural network models that explicitly respect the underlying variational structure, enhancing both interpretability and adaptability. However, most existing approaches rely on discretized formulations that are sensitive to resolution changes, resulting in poor generalization across scales.

To overcome this, we propose to operate directly in function spaces, ensuring discretization invariance and enabling models trained at one resolution to generalize seamlessly to others. In this context, we will define and explore an extension of unfolded proximal networks—where the network architecture is derived from the variational formulation of the inverse problem—into function spaces, leading to unfolded proximal neural operators.

Mission: Depending on their expertise, the postdoctoral researcher will:

1. Define and implement deep unfolded proximal neural operators.
2. Develop self-supervised training strategies suitable for scenarios without ground-truth data.
3. Provide theoretical guarantees by deriving generalization estimates.
4. Analyze real-data coming from experiments using holographic microscopy.

Candidate profile:

- PhD in applied mathematics, machine learning, signal/image processing, or related fields
- Strong background in optimization and inverse problems
- Experience with proximal methods, statistical learning, or operator theory is a plus
- Good programming skills in Python; experience with PyTorch preferred
- High proficiency in written and spoken English

Application: Please send the following to loic.denis@univ-st-etienne.fr; jordan.patracone@univ-st-etienne.fr:

- Cover letter explaining your motivation and fit
- Full CV with list of publications
- Contact information for 1–2 references
- Top publications and link to PhD thesis

Funding: This postdoc is funded under the EUR Manutech-SLEIGHT. The gross monthly salary is approximatively 2800€ gross per month, depending on experience.

Host laboratory: The Hubert Curien Lab hosts experts in both machine learning and optical imaging. This project lies at the intersection of these domains, with direct application to surface engineering and biomedical imaging.
More information: https://laboratoirehubertcurien.univ-st-etienne.fr

References

[1] D. Chen et al. "Imaging with equivariant deep learning: From unrolled network design to fully unsupervised learning." IEEE Signal Processing Magazine, 2023.

[2] N. Kovachki et al. "Neural Operator: Learning Maps Between Function Spaces With Applications to PDEs". JMLR, 2023.

[3] V. Kouni et al. "DECONET: An unfolding network for analysis-based compressed sensing with generalization error bounds". IEEE TSP, 2023.

[4] P. L. Combettes, J.-C. Pesquet. "Deep neural network structures solving variational inequalities". Set-Valued Var. Anal., 2020.