Post-doctoral position: **Learning-based methods for large-scale imaging inverse problems**

Keywords: Imaging inverse problems, deep learning, implicit neural representations.

Location: ENS Lyon, Lyon, France.

Supervisor: Julián Tachella (tachella.github.io), CNRS research scientist, email: julian.tachella@cnrs.fr.

Start date and duration: The exact starting date is flexible and will be arranged with the candidate. It should take place between the end of 2024 and the beginning of 2025. The position will be part of the ANR UNLIP project, and will have a duration of between 13 and 18 months according to the applicant's previous postdoc experience.

Research environment:
The postdoctoral research associate will be part of the SySiPh at ENS Lyon in Lyon, France. ENS Lyon is a small-sized research-driven university that is consistently ranked among the best universities in France. The applicant will benefit from a stimulating environment of research scientists in machine learning, signal processing, and physics, with weekly seminars (shared with Inria OCKHAM team) given by international experts and weekly machine learning reading groups.

Subject:
Imaging inverse problems are ubiquitous across science and engineering, having a wide range of applications, from astronomical imaging to computational photography. In recent years, (deep) learning-based solutions have obtained state-of-the-art performance in many applications. However, existing methods are hard to scale to large-scale imaging problems (e.g., high-resolution images, 3D volumes, 3D + time signals) due to the large amounts of GPU memory required for training and inference [1]. Most state-of-the-art methods require that the data lies in a regular grid (pixels, voxels, etc.), which results in an exponential dependency on memory if higher-resolution reconstructions are desired.

Implicit neural representations (INR) provide an alternative signal representation that can provide high-resolution reconstruction while requiring less memory to store the signal's content [2]. However, INRs have been mostly used for reconstructing a signal at a time, i.e., not leveraging any learning across a dataset of examples. Some solutions that incorporate learning have shown promising results [3,4,5]; however, it is yet unclear whether these methods can obtain a performance on par with grid-based methods and whether they can be extended to general inverse problems. The goal of this project is to study new memory (and compute) efficient learning-based reconstruction algorithms that leverage these new signal representations. Moreover, this project will adapt self-supervised learning methods [6], which do not require ground-truth data for training, to handle these new representations.

Necessary qualifications:

- A PhD thesis on imaging inverse problems, computer vision or signal processing.
- Basic knowledge of deep learning libraries such as PyTorch or JAX.
- Publications in top imaging journals (e.g., IEEE TCI, TIP, TSP, TPAMI, SIAM Imag. Sciences) or in top CV/ML conferences (e.g., CVPR, ICCV, NeurIPS, ICML, ICLR, AISTATS).

Preferred qualifications (but not mandatory):

- Contributions to open-source Python libraries.
- Experience with implicit neural representations.
- A strong theoretical background on inverse problems.

Apply:
Interested candidates are invited to send an email to Julián with any questions regarding the position. Applicants should send a CV, including a list of publications and contact information for two references, to Julián Tachella.

Salary and benefits:
The salary is set following the CNRS postdoc pay grades, which ranges from 3020 euros/month gross to 4200 euros/month gross according to the applicant's previous postdoc experience. The position comes with additional benefits such as additional pay to cover public transport (or cycling) and a significant amount of annual leave.

References:

1. Rudzusika, Jevgenija, et al. "3D Helical CT Reconstruction with a Memory Efficient Learned Primal-Dual Architecture." IEEE Transactions on Computational Imaging (2024).
2. Yüce, Gizem, et al. "A structured dictionary perspective on implicit neural representations." Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. (2022).
3. Tancik, Matthew, et al. "Learned initializations for optimizing coordinate-based neural representations." Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. (2021).
4. Chen, Yinbo, Sifei Liu, and Xiaolong Wang. "Learning continuous image representation with local implicit image function." Proceedings of the IEEE/CVF conference on computer vision and pattern recognition. 2021.
5. Dupont, Emilien, et al. "From data to functa: Your data point is a function and you can treat it like one." arXiv preprint arXiv:2201.12204 (2022).
6. Tachella, Julián, Dongdong Chen, and Mike Davies. "Sensing theorems for unsupervised learning in linear inverse problems." Journal of Machine Learning Research 24.39 (2023): 1-45.