Stage topic:

Multilevel proximal methods for image restoration

Student level: L3 or M1

Duration: 6 to 8 weeks for L3, 12 weeks for M1

Place: LIP, ENS Lyon, 46 Allée d'Italie, 69364 Lyon

Working language : french or english

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Scientific context of the stage

Image processing is a discipline of mathematics concerned with the development of methods for the transformation, analysis and interpretation of images in order to improve their quality and/or to obtain information. Image restoration problems are usually formulated as inverse problems, which consist in recovering an image as closely as possible to the original (or reference) one, from a set of observations degraded by some source of noise [1].

Fig 1. Example of degraded image, noise, and recovered images by different recovering techniques.

Such problems usually have very high-dimensional data, and are therefore difficult to solve. Popular approaches employed in this field are proximal methods (a type of gradient descent method for functions that are not smooth), which are really efficient in the case of low-dimensional data, but the efficient solution of very high-dimensional problem is still an open question.

Main objective of the stage

The stage is concerned with the development of multilevel versions of proximal methods, able to tackle really large problems by exploiting the fact that a problem in imaging can be represented at different levels of resolution (reducing the number of pixels) [2]. The main idea of the multilevel method is to consider a

hierarchy of problems of reduced dimensions, rather than directly solving a large problem with many variables.

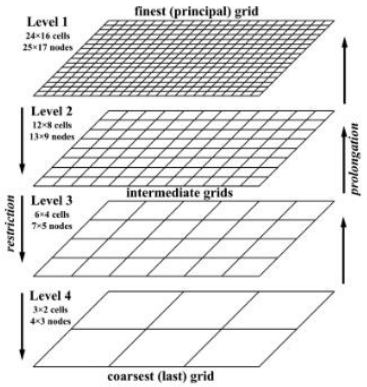

Fig. 2. General scheme of a multilevel method considering multiple levels of resolution.

Required skills

The stage will focus on both numerical implementations and theoretical aspects. For this reason programming skills in python or Matlab are highly recommended. Previous knowledge of gradient methods is a plus, but it is not required.

Collaborations

The stage will be held in collaboration with Nelly Pustelnik (Laboratoire de Physique ENS Lyon) and Marion Foare (LIP, ENS Lyon).

References

[1] A. Chambolle and T. Pock, An introduction to continuous optimization for imaging, Acta Numerica, 2016

[2] P. Parpas, A multilevel proximal gradient algorithm for a class of composite optimization problems, SIAM J. Sci. Comput., 2017.