ITERATIVE IMAGE RECONSTRUCTION: A POINT OF VIEW

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Iterative methods are a basic tool for image reconstruction in several scientific domains ranging from Emission Tomography, to Microscopy and Astronomy. A pletora of methods is available and sometimes the same method is denoted with different names in different applications. In this talk we discuss an attempt of providing a unifying framework for most of these methods.

The starting point is a probabilistic modeling of the problem, justified by the remark that data are realizations of a multi-valued random variable. Different noise models lead, via a maximum likelihood (ML) approach, to the minimization of different functionals. The resulting problems are ill-posed even if with different degrees of ill-posedness. An example is the leat-squares problem that is naturally related to additive Gaussian noise. The continuous approximation to this model is the starting point of Tikhonov regularization theory.

The cure of ill-posedness is based on the use of *a priori* information on the solution and, in a probabilistic setting, this is quite naturally introduced by assuming that the solution is also a realization of a multi-valued random variable with a given probability distribution, the so-called *prior*. Then, via a Bayesian approach, the problem of maximum a posteriori (MAP) estimation, combining different kinds of noise (Gauss, Poisson, Gauss+Poisson) with different kinds of priors (Tikhonov, Maximum Entropy, Total Variation etc.), lead to the minimization of a wide class of functionals.

Most of the iterative methods proposed for the minimization of these functionals can be viewed as particular cases of an approach proposed by researchers of the University of Nice - Sophia Antipolis. Examples are provided. Relationship with optimization theory is briefly discussed.