# Finding the optimal regularization parameter: old and new methods

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## Abstract

Discrete ill-posed inverse problems arise in various areas of science and engineering. The presence of noise in the data often makes it difficult to compute an accurate approximate solution. To reduce the sensitivity of the computed solution to the noise, one replaces the original problem by a nearby well-posed minimization problem, whose solution is less sensitive to the noise in the data than the solution of the original problem. This replacement is known as regularization. In this talk we consider the situation when the minimization problem consists of a fidelity term, that is defined in terms of a p-norm, and a regularization term, that is defined in terms of a q$-$norm,$0 < \mathrm{p}, \mathrm{q} \leq 2$. The relative importance of the fidelity and regularization terms is determined by a regularization parameter. We will present and compare esperimentally the well known L$-$curve, Generalized Cross Validation, Discrepancy approaches with a new one which is based on the so-called residual whiteness principle. We also discuss methods for the solution of the minimization problem and automatic selection of the regularization parameter. The first method is based on the majorization-minimization in generalized Krylov subspaces of increasing dimension while the second one is an iterative framework based on the alternating direction method of multipliers.