Optimization based formulation and solution of inverse problems

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The probably most well-known and most widely used approach to solving inverse problems is by combined minimization of data misfit and some regularization term, usually referred to as Tikhonov-Philips regularization. Still, this relies on the use of some forward operator, which is the concatenation of the observation operator with the parameter-to-state-map for the underlying model. Recently, all-at-once formulations have been considered as an alternative to this reduced formulation, avoiding the use of a parameter-to-state map, which would sometimes lead to too restrictive conditions. Here the model and the observation are considered simultaneously as one large system with the state and the parameter as unknowns. A still more general formulation of inverse problems, containing both the reduced and the all-at-once formulation, but also the well-known and highly versatile so-called variational approach (not to be mistaken with variational regularization) as special cases, is to formulate the inverse problem as a minimization problem (instead of an equation) for the state and parameter. Regularization can be incorporated via imposing constraints and/or adding regularization terms to the objective. In this talk, after providing the general setting with convergence results, we will discuss some examples and in particular dwell on some applications in (nonlinear) acoustics.

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