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Hierarchical and Adaptive Concept for the Identification of Material Laws by Boundary Observations

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ABSTRACT

Identification of material laws (either as formfree nonlinearities or as parameters in a fixed (global) parametrization) from boundary state observations by means of an output least squares approach (OLS) requires specific means to detect the possible level of accuracy of reconstruction depending on the experimental design and the error level of the observation. We propose two means and their possible combination.

Firstly, we use an unbiased parametrization of the unknown nonlinear functions, which does not employ any a-priori shape information. Picewise polynomial functions provide an ansatz space where the unknown parameters only locally influence the representation of the nonlinearity. The minimization of the OLS-functional is highly sensitive to the initial value and slow convergence for a high number of degrees of freedom is to be expected. Therefore the identification is embedded into a multi-level algorithm which adapts the degree of parametrization to severeness of ill-posedness, as a low degree of parametrization acts as regularization. A stopping rule is based on the maximal error amplification according to the sensitivity matrix.

Secondly, the problem of strongly varying sensitivities (even for given global parametrizations) has to be addressed. We propose an adaptive weighting in the OLS-functional based on the pseudoinverse of the sensitivity matrix at the achieved parameter set. The further nonlinearity, introduced into the OLS-functional is resolved in an retarding manner leading to a sequence of ”usual” OLS-problems. The concepts are illustrated by outflow and breakthrough experiments with soil columns to identify either retention curve and unsaturated conductivity on reaction (Monod-) parameters for reactive transport.