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Adaptive and formfree Identification of Material Laws and experimental Design in porous Medium Flow

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A numerical identification procedure is presented which is based on an Output Least Squares(OLS)-Method. We use an unbiased parametrization of the unknown nonlinear functions, which does not employ any a-priori shape informations. Piecewise 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 the severness 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. Being applicable to any situation with boundary and/or interior observation, we illustrate the performance of the algorithm with two specific examples from soil science: The first is the identification of an sorption isotherm from breakthrough experiments, where we also treat a novel experiment design with stop flow and feedback of the efficient, the second is the identification of the water retention and the hydraulic conductivity curve from outflow experiments. Either by systematic variation or by a further level of optimization the underlying experimental design can be optimized. Here we treat the optimal positioning of the tensiometer in outflow experiments and the optimal choice of the suction steps in a multistep experiment.