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Combination of Automated Learning and Evolutionary Computation for fast stochastic Optimization of Groundwater Management Problems

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The combined use of models, together with optimization algorithms, has evolved as a crucial element in the decision making process for groundwater management. Typically, the optimization algorithm iteratively runs the model, evaluates the output with respect to an objective function and, finally, identifies an optimal solution. This procedure may afford hundreds to thousands of model runs, particularly for high dimensional, non-linear and non-convex optimisation problems. Our research focuses on tactics to minimize the required number of simulations and thus the computational time, without compromising the performance of the optimization algorithm. Otherwise CPU demanding models will hardly be applicable within a reasonable timeframe. By utilizing a modern variant of evolutionary algorithms, the so-called evolution strategies with covariance matrix adaptation (CMA-ES), we demonstrated that there is a huge potential to save iterations compared to alternative, more common solvers. In this presentation, we discuss prominent characteristics of groundwater management problems involving more than one realization of reality, focusing on the stacking approach, a common method to account for descriptive uncertainty. Here, during optimization, multiple realizations are considered simultaneously. A reliable managerial solution has to succeed in all or at least most of the realizations. A practical consequence is that the number of realizations multiplies the computational time. Nevertheless, the results of our study are evidence for only a small fraction of the stack (the critical realizations) controlling the identification of the optimal solution. This observation encouraged us to develop a procedure which is based on a automated learning method, dynamic stack ordering, and to ignore uncritical solutions.