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Data-driven classification of hydrogeological conditions and its application in optimization problems in groundwater management

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Decision support in many research fields including surface water and groundwater management often relies on various optimization algorithms. However, application of an automated model optimization may require significant computational resources and be very time consuming. On the other side, during each scenario simulation large amount of data is produced which potentially can be used to train a data-driven model that can help to solve similar optimization problems more efficiently, e.g. by providing preliminary likelihood distribution of optimized variables. The main problem for application of any machine learning technique for characterization of hydrogeological situations is high variability of conditions including aquifer hydraulic properties and geometries, its interaction with surface water objects as well as artificial disturbance.
The aim of this study is to find parameters that can be used as a training set for model learning, apply them on various learning algorithms and to test how strong performance of following optimization algorithm can be improved by supplementing it with a trained model. For the purposes of the experiment synthetically generated groundwater models with varying parameters are used. Generated models simulate a common situation when optimum position and parameters of designed well site have to be found. Parameters that compose set of model predictors include types, relative positions and properties of boundary conditions, aquifer properties and configuration. Target variables are relative positions of wells and ranges of their pumping/injection rates. Tested learning algorithms include neural networks, support vector machines and classification trees supplemented by posterior likelihood estimation. A variation of an evolutionary algorithm is used for optimization purposes.