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Multi-objective training of artificial neural networks for rainfall-runoff modelling

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The forecasting of river discharges requires models that simulate the transformation of rainfall on a watershed into runoff. One approach to this complex modelling issue is to use data-driven techniques, which are based on extracting and re-using information that is implicit in hydrological data, and which do not directly take into account the physical laws that underlie rainfall-runoff processes. In this study, we have investigated the popular data-driven approach of Artificial Neural Network (ANN) modelling. ANNs are flexible model structures that simulate rainfall-runoff processes by mapping the transformation from system input and/or system states (e.g., rainfall, evaporation, soil moisture content) to system output (e.g. river discharge).

Training (i.e. calibration) of ANNs involves the use of optimisation algorithms that adjust the network's internal parameters to minimise an objective function that expresses the difference between the ANN response to sample input and target output data. Recent studies have proven that global methods like Evolutionary Algorithms (EAs) are good alternatives for traditional techniques, which are commonly based on gradient methods (e.g. first-order steepest-descent or second-order Newtonian algorithms). EAs generally perform very well in terms of accuracy and robustness, but require more computational effort.

Singular objective functions based on squared-error-based performance measures, such as the Mean Squared Error (MSE) are commonly used in rainfall-runoff modelling. However, not all differences between modelled and observed hydrograph characteristics can be adequately expressed by a single performance measure. It has there-

fore been recognized that the calibration of rainfall-runoff models is inherently multi-objective.

In this study we have therefore tested Multi-Objective Evolutionary Algorithms (MOEAs) for training of ANNs. Multi-layer feedforward ANN models were developed for forecasting runoff from the Geer catchment in Belgium. Various combinations of objective functions are tested in order to find improved ways of evaluating ANN rainfall-runoff models.