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Model structure identification based on ensemble model evaluation

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Identifying the most appropriate hydrological model for a given problem is more than fitting the parameters of a fixed model structure to reproduce the measured hydrograph. Defining the most appropriate model structure is dependent of the modeling objective, the characteristics of the system under investigation and the available data. To be able to adapt to the different conditions and to propose different hypotheses of the underlying system, a flexible model structure is preferred in combination with a rejectionist analysis based on different diagnostics supporting the model objective. By confronting the model structures with the model diagnostics, an identification of the dominant processes is attempted.

In the presented work, a set of 24 model structures was constructed, by combining interchangeable components representing different hypotheses of the system under study, the Nete catchment in Belgium. To address the effect of different model diagnostics on the performance of the selected model structures, an optimization of the model structures was performed to identify the parameter sets minimizing specific objective functions, focusing on low or high flow conditions.

Furthermore, the different model structures are compared simultaneously within the Generalized Likelihood Uncertainty Estimation (GLUE) approach. The rejection of inadequate model structures by specifying limits of acceptance and weighting of the accepted ones is the basis of the GLUE approach. Multiple measures are combined to give guidance about the suitability of the different structures and information about the identifiability and uncertainty of the parameters is extracted from the ensemble of selected structures.

The results of the optimization demonstrate the relationship between the selected objective function and the behaviour of the model structures, but also the compensation for structural differences by different parameter values resulting in similar performance. The optimization gives also useful information when determining the limits of acceptance in the GLUE approach. The assessment of the identifiability helps in the identification of overparameterized model structures and consequently in the selection of the model structures.