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A novel approach to Monte Carlo-based uncertainty analysis of hydrological models using artificial neural networks

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The presented approach replicates Monte Carlo (MC) simulation by using an Artificial Neural Network (ANN), which is subsequently used for assessment of model parametric uncertainty. It is assumed a hydrological model M(p) is given and the propagation of the uncertainty in parameters p to the output is to be investigated. MC simulation of model M(p) is run and the stored realizations are used to form the dataset for training an ANN. One of the issues was selection of the input variables for the ANN model; it was done by searching for the variables (or their transformed variants) with the highest relatedness (average mutual information) to the sought distribution of the model M output. ANN is trained to approximate the functional relationships between the variables characterizing the process modelled by M(p) and the uncertainty descriptors of its output. The trained ANN model encapsulates the underlying characteristics of the parameter uncertainty and can be used to predict uncertainty descriptors for the new data. The approach was validated by comparing the uncertainty descriptors in the verification data set with those obtained by MC simulation. The method is applied to estimate parameter uncertainty of a lumped conceptual hydrological model, HBV. The results are promising as the prediction intervals estimated by ANN are reasonably accurate. The proposed techniques could be useful in real time applications when it is not possible to run a large number of simulations for complex hydrological models and when the forecast lead time is very short.