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# A novel approach to parameter uncertainty analysis of hydrological models: Application of machine learning techniques

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Monte Carlo (MC) simulation-based techniques are widely used for analyzing parameter uncertainty in hydrological models. Although MC simulations are flexible and robust, and capable of solving a great variety of problems, they are not always practicable for computationally intensive models. This study presents a novel approach for assessment of parameter uncertainty in hydrological models using machine learning techniques. The presented approach replicates MC simulation by using various machine learning techniques, 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 machine learning models. One of the issues was selection of the input variables for the machine learning models; 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. Machine learning models are 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 machine learning models encapsulate the underlying characteristics of the parameter uncertainty and can be used to predict uncertainty descriptors for the new data.

In this study three machine learning models - artificial neural networks, model trees and locally weighted regressions are used. The approach was demonstrated by estimating parameter uncertainty of a lumped conceptual hydrological model, HBV with application to a case study of meso scale mountainous catchment of Nepal. Uncertainty measures such as prediction intervals estimated by three machine learning methods are compared to those obtained by MC simulation in verification period. The results are promising as the uncertainty measures estimated by machine learning models are reasonably accurate. The proposed technique could be useful in real time applications for computationally intensive models (e.g. physically based hydrological models) which require run times that make traditional MC analysis impractical and when the forecast lead time is very short.