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Sensitivity analysis of input variables of a SWAT hydrological model using the machine learning technique of random forest

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Sensitivity analysis of complex models, with a large number of input variables and parameters, is time-consuming and inefficient, using traditional approaches. Considering the capability of computing importance indices, the machine learning technique of the Random Forest (RF) is introduced as an alternative to conventional methods of sensitivity analysis. One of the advantages of using the RF model is the reduction of computational costs for sensitivity analysis.

The objective of this research is to analyze the importance of the input variables of a semi-distributed and physically-based hydrological model, namely SWAT (soil and water assessment tool) using the RF model. To this end, an RF-based model is first trained using SWAT input variables (such as, precipitation and temperature) and SWAT output variables (like streamflow and sediment load). Then, using the importance index of the RF model, the ranking of input variables, in terms of their impact on the accuracy of the model results, is determined. Additionally, the results of the sensitivity analysis are examined graphically. To validate the ranking results of the RF-based approach, the parameter ranking results of the Sobol G function, using the RF-based approach and the sensitivity analysis method of Sobol' are compared. The ranking of the model input variables plays a significant role in the development of models and prioritizing efforts to reduce model errors.

Key words: Sensitivity analysis, model input variables, Machine learning technique, Random forest, SWAT model.