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Let evolution do the work: a new way for hydrological model construction

Florian Ulrich Jehn (1), Philipp Kraft (1), Lutz Breuer (1,2), and Tobias Houska (1)

(1) Institute for Landscape Ecology and Resources Management (ILR), Research Centre for BioSystems, Land Use and Nutrition (iFZ), Justus Liebig University , Giessen, Germany, (2) Centre for International Development and Environmental Research (ZEU), Justus Liebig University, Giessen, Germany

Model building in hydrology is hard work. One has to consider many different processes and thus, there is a plethora of likely model implementations. The more complex a model, the more difficult it gets to find suitable parametrizations, up to a point where it is almost impossible to overlook all the possibilities. This problem has become even clearer through the introduction of modelling frameworks such as FLEX, FUSE or CMF, because they allow an easier and quicker construction of models. Therefore, new ways of exploring the space of potential model structures are needed. For this, we propose a novel approach: The Automated Construction of Models guided by Evolution (the ACME method). Based on a large set of hydrological process descriptions a number of hydrological model structures are randomly generated. These models serve as the starting population. The starting population is tested for its fitness, based on their hydrological signatures and the Kling-Gupta Efficiency. Depending on the models' fitness, they get a higher chance to reproduce and inherit their properties to the next generation. This evolving generation is then tested again for its fitness. The whole cycle repeats until a model structure is found that satisfies the criteria (e.g. runoff, groundwater level, soil moisture) and objective functions defined by the hydrologist. To achieve this kind of automated model building and to test its abilities, the following steps will be presented: 1) Implementation of the evolutionary algorithms to work with the Catchment Modelling Framework (CMF). 2) A proof of concept application, where ACME is confronted with the real world data of the Schwingbach catchment in Germany, to test whether it can identify hydrological processes, such as groundwater outflow and drainage systems, which are known to be relevant in the study site. This step will also be used to find suitable settings for the parameters governing the underlying evolutionary algorithm. The main purpose of the free open-source development of ACME is to enable the scientific community to get more insights in model development for various catchment functioning and to have an innovative supportive tool for general hypothesis testing in hydrology.