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Improving flood wave predictors by meta-learning

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The main goal of this work is to improve real time flood warning system operated by the Czech Hydrometeorological Institute (CHMI) in a very sensitive part of Northern Bohemia, the Smeda River basin. This area has been subject to several flash floods during last decade, and thus it is important to model and predict the dynamics of the flood wave. Following the operational reality we reformulated the traditional time series prediction problem as either a runoff regression problem, or a classification of water level values into predefined decisive water level thresholds. Moreover, in contrast to our previous work [1,2], the modelled system utilizes data from three subsequent runoff gauges, namely Bily Potok, Frydlant and Visnova. The distance between them is 15 km and 12 km, respectively. The watershed area is 180 km2. Together with flood wave time series we utilized relevant precipitation totals from Hejnice rain gauge.

While it is difficult to forecast the time of occurrence and the extent of floods, it is possible to predict fairly accurately the movement of the flood wave along a river [3]. Several methods are available for the flood wave propagation forecasting in general. Two simple hydrometric methods based on the extrapolation of the discharge difference and discharge-travel time are in use in CHMI. On a similar base, the neural model is created whose inputs are historical runoff values in the first two gauges, and an output is a classification of predicted water level (or runoff prediction) in the third gauge. Number of previous runoff values depends on the shape of a flood wave.

It has been shown that during the training phase of neural models that setting of proper configuration of the model is important for successful prediction, while the common practice is to set these parameters (type of network, number of hidden units or layers, learning rate, kernel function type, ...) empirically. Moreover, the problem is data-dependent, thus it makes sense to use some meta-learning search heuristics to set the parameters with respect to particular data set at hand. In our research we utilized the evolutionary algorithms and local hill climbing techniques to efficiently search the parameter space in order to improve the quality of the model. While the procedure itself is computationally exacting, it provides improvement in terms of prediction quality of flood wave predictors.

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