Geophysical Research Abstracts
Vol. 12, EGU2010-9099, 2010
EGU General Assembly 2010

Combining neural networks and genetic algorithms for hydrological flow forecasting

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We present a neural network approach to rainfall-runoff modeling for small size river basins based on several time series of hourly measured data. Different neural networks are considered for short time runoff predictions (from one to six hours lead time) based on runoff and rainfall data observed in previous time steps. Correlation analysis shows that runoff data, short time rainfall history, and aggregated API values are the most significant data for the prediction. Neural models of multilayer perceptron and radial basis function networks with different numbers of units are used and compared with more traditional linear time series predictors.

Out of possible 48 hours of relevant history of all the input variables, the most important ones are selected by means of input filters created by a genetic algorithm. The genetic algorithm works with population of binary encoded vectors defining input selection patterns. Standard genetic operators of two-point crossover, random bit-flipping mutation, and tournament selection were used. The evaluation of objective function of each individual consists of several rounds of building and testing a particular neural network model. The whole procedure is rather computational exacting (taking hours to days on a desktop PC), thus a high-performance mainframe computer has been used for our experiments.

Results based on two years worth data from the Ploucnice river in Northern Bohemia suggest that main problems connected with this approach to modeling are ovetraining that can lead to poor generalization, and relatively small number of extreme events which makes it difficult for a model to predict the amplitude of the event. Thus, experiments with both absolute and relative runoff predictions were carried out. In general it can be concluded that the neural models show about 5 per cent improvement in terms of efficiency coefficient over liner models. Multilayer perceptrons with one hidden layer trained by back propagation algorithm and predicting relative runoff show the best behavior so far. Utilizing the genetically evolved input filter improves the performance of yet another 5 per cent.

In the future we would like to continue with experiments in on-line prediction using real-time data from Smeda River with 6 hours lead time forecast. Following the operational reality we will focus on classification of the runoffs into flood alert levels, and reformulation of the time series prediction task as a classification problem. The main goal of all this work is to improve flood warning system operated by the Czech Hydrometeorological Institute.