Geophysical Research Abstracts, Vol. 7, 06959, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06959

Objective Functions in Artificial Neural Network Training for Rainfall-Runoff Modelling

N.J. de Vos (1) and T.H.M. Rientjes (1,2)

(1) Water Resources Section, Faculty of Civil Engineering and Applied Geosciences, Delft University of Technology, The Netherlands, (2) Department of Water Resources, International Institute for Geo-Information Science and Earth Observation, Enschede, The Netherlands (n.j.devos@citg.tudelft.nl / Fax: +31 15-2785915 / Phone: +31 15-2786857)

The forecasting of river discharges requires models that simulate the transformation of rainfall on a watershed into runoff from it. However, since this transformation involves a number of interacting processes, which are both complex and spatially/temporally variable, this is not an easy task. One approach to this modelling issue is to use so-called data-driven techniques, which are based on extracting and re-using information that is implicit in hydrological data, and which do not directly take into account the physical laws that underlie the rainfall-runoff process (as knowledge-driven models do). In this study, we have investigated the popular data-driven approach of Artificial Neural Network (ANN) modelling.

An ANN is a network of densely interconnected computational elements, which is trained (i.e., calibrated) using optimisation algorithms that adjust its internal parameters. The goal is to minimise an objective function that expresses the difference between the ANN response to sample input and target output data. An ANN is able to simulate rainfall-runoff processes by mapping the transformation from system input and/or system states (e.g., rainfall, evaporation, soil moisture content) to system output (river discharge or water levels).

The ability to exploit the total information content of ANN inputs depends strongly on the training of the network. Firstly, a training algorithm must be able to search the parameter space extensively and efficiently. Secondly, the objective function that is used for evaluating model performance should be appropriate for the application under investigation. Singular objective functions based on squared-error-based performance

measures, such as the Mean Squared Error (MSE) are commonly used in rainfall-runoff modelling. However, not all differences between modelled and observed hydrograph characteristics such as timing, volume, and absolute values can be adequately expressed by a single performance measure. This subject of model evaluation in the training of ANNs for rainfall-runoff modelling has hitherto largely been overlooked.

In this study, multi-layer feedforward ANN models were developed for forecasting the runoff from the Geer catchment in Belgium. Subsequently, a number of different objective functions are tested. Some of these are so-called multi-objective functions, which consist of multiple performance measures that are aggregated into a single objective function. Several combinations of training algorithms and objective functions are tested. The use of multi-objective functions generally improves the model forecasts and proves to be a valuable enhancement to ANN training.