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Adapting neural networks for river flow forecasting

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Monthly river flow forecast is a fundamental step for water resource system planning and management problems, since storage-yield sequences are frequently related to monthly periods.

Recently, artificial neural networks have been widely accepted as a potential useful way of modelling hydrologic processes, and have been applied to a range of different areas including rainfall-runoff, water quality, sedimentation and rainfall forecasting.

Highly non-stationary data and seasonal irregularity, typical of a Mediterranean weather regime, seriously limit the prediction accuracy.

In this paper, a neural network technique will be presented for one month ahead forecasting of the runoff at the S. Chiara section in the Tirso basin located in Sardinia (Italy).

The basin area is 2082 km^2 and is characterized by the availability of detailed data from several rainfall gauges. A new "Cantoniera Tirso " dam was recently built a few kilometres down the river, creating a reservoir with a storage volume of 780 Mm^3, one of the largest in Europe. The Tirso basin is of particular interest because of its geographic con?guration and water resource management since a dam was built in the S.Chiara section in 1924, providing water resources for central Sardinia.

Basic data for modelling are rainfall and runoff time series with a monthly time step for 69 years and are characterized by a non-stationary behaviour and seasonal irregularity. In particular, the general trend clearly shows a trend towards drought. The annual mean rainfall was 1660 Mm^3 for the first 49 years, and decreased to 1550 Mm^3 during the last 20 years of the historical record.

Static neural networks have been employed in the past years in order to forecast the runoff data of the Tirso basin. The data collection regarding the last 69 years was been split in two periods of 49 and 20 years, the former being used as training set and the latter as test set. Due to the deeply different behaviour in such two periods, the neural network trained with the first one had poor performance when tested in the second one.

In this work, a different neural approach has been adopted, where the static Multi Layer Perceptron is substituted with a dynamic neural network. This takes in the input a delay line, whose output represents the real input of the following neural network. The sequence of data is no longer divided in two sets, but the forecasting in each instant t is based on the whole time series preceding t. The neural network has two kinds of memory: a shortterm one, which takes into account the data stored in the delayline, and a longterm one, due to the connections weights. The longterm memory, which embeds the dynamic of the system, is adapted dynamically at each time instant on the basis of the signal evolution, so that if the system modifies its behaviour, the structure of the network is able to take this event into account.

The dynamic model showed better performance with respect to static model proposed by the same authors.

In the final paper model features and numerical results will be discussed and compared whit those presented in literature.