Chapter 50
Prediction of Water Level Using Time Series, Wavelet and Neural Network Approaches

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ABSTRACT

To control water resources in many domains such as agriculture, flood forecasting, and hydro-electrical dams, forecasting water level needs to predict. In this article, a new computational approach using a data driven model and time series is proposed to calculate the forecast water level in short time. Concretely, wavelet-artificial neural network (WAANN) and time series (TS) are combined together called WAANN-TS that encourages the advantage of each model. For this real time project work, Yen Bai station, Northwest Vietnam was chosen as an experimental case study to apply the proposed model. Input variables into the Wavelet-ANN structure is water level data. Time series and ANN models are built, and their performances are compared. The results indicate the greater accuracy of the proposed models at Hanoi station. The final proposal WAANN−TS for water level forecasting shows good performance with root mean square error (RMSE) from 10−10 to 10−11.

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1. INTRODUCTION

Time series forecasting is the importance of prediction in various research projects such as individual, natural, social, technological, organizational, economical strategic decision under uncertainty environments. For example, forecasting financial data suggests investors to invest safely in the uncertainty financial market (Panigrahi & Behera, 2017); forecasting electricity load (Raza & Khosravi, 2015; Behera & Biswal, 2010), helps in better power system planning (Panigrahi & Behera, 2017); forecasting product price helps consumers having better choices; forecasting water level help decision maker better in control irrigation system; forecasting temperature helps planner predicting crop yields (Nury, Hasan, & Alam, 2017). Therefore, many researchers are interested in time series forecasting research because of various applications (Raza & Khosravi, 2015; Behera & Biswal, 2010; Panigrahi & Behera, 2017; Nury, Hasan, & Alam, 2017).

Time series forecasting techniques have been proposed in the literature in which past observations of the same variable are collected and analyzed to develop a model describing the underlying relationship (Zhang, 2003). The form a time series is represented by a vector $X_t = \left[x_{t-1}, x_{t-2}, \ldots, x_{t-n}\right]^T$ where the number of time $t - 1$, $t - 2$, …, $t - n$ series used in forecasting and x x may be multivariate or univariate. Time series forecasting techniques are classified into two types that are linear or nonlinear. Specifically, a type of linear models is often used moving average (MA), autoregressive moving average (ARMA), autoregressive integrated moving average (ARIMA) and a type of nonlinear model is often used the artificial neural network (ANN).

G.P. Zhang was the first author proposed hybrid ARIMA and ANN for time series forecasting (Zhang, 2003). His hybrid methodology took advantage of the unique strength of ARIMA and ANN models in linear and non-linear modeling. If $\{x_t\}_{t\,{}^3\,0}$ is a time series to be composed of linear and non-linear components that are represented by

$$x_t = Linear\ Component_t + NonLinearComponent_t \tag{1}$$

In the fact that ARIMA is used for the linear component and ANN is applied for nonlinear components. His experimental results showed that his hybrid methodology is more accuracy achieved than individual models. He suggested that by using dissimilar models or models that disagree like ARIMA and ANN make his hybrid methodology more strongly. However, his methodology has not shown the stationary property for non-linear component. Thus, this paper, the stationary of each component is then it is decided using ANN or WAANN.

S. Panigrahi and H. S. Behera proposed a hybrid model for time series forecasting by linear and nonlinear exponential smoothing (ETS) (Panigrahi & Behera, 2017). The time series is assumed that the sum of two components which are linear and nonlinear components.

Their hybrid algorithm is produced by 4 processes:

1. Computing ETS from original time series;
2. Subtracting ETS from original series to have the residual error sequence;
3. ANN is applied for the residual error sequence;
4. Combining ETS predictions with ANN predictions.