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A new weighted MSE loss for wind speed forecasting based on deep learning models

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Wind speed forecasting is very important for a lot of real-life applications, especially for controlling and monitoring of wind power plants. Owing to the non-linearity of wind speed time series, it is hard to improve the accuracy of runoff forecasting, especially several days ahead. In order to improve the forecasting performance, many forecasting models have been proposed. Recently, deep learning models have been paid great attention, since they excel the conventional machine learning models. The majority of existing deep learning models take the mean squared error (MSE) loss as the loss function for forecasting. MSE loss is linear. Consequently, it hinders further improvement of forecasting performance over nonlinear wind speed time series data.

In this work, we propose a new weighted MSE loss function for wind speed forecasting based on deep learning. As is well known, the training procedure is dominated by easy-training samples in applications. The domination will cause the ineffectiveness and inefficiency of computation. In the new weighted MSE loss function, loss weights of samples can be automatically reduced, according to the contribution of easy-training samples. Thus, the total loss mainly focuses on hard-training samples. To verify the new loss function, Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) have been used as base models.

A number of experiments have been carried out by using open wind speed time series data collected from China and Unites states to demonstrate the effectiveness of the new loss function with three popular models. The performances of the models have been evaluated through the statistical error measures, such as Mean Absolute Error (MAE). MAE of the proposed weighted MSE loss are at most 55% lower than traditional MSE loss. The experimental results indicate that the new weighted loss function can outperform the popular MSE loss function in wind speed forecasting.