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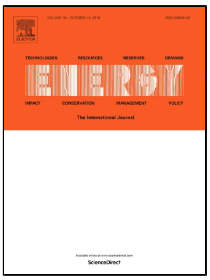

Deep belief network based *k*-means cluster approach for short-term wind power forecasting

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Deep belief network based *k*-means cluster approach for short-term wind power forecasting ♣

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A R T I C L E I N F O

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A B S T R A C T

Wind energy is the intermittent energy and its output has great volatility. How to accurately predict wind power output is a problem that many researchers have been paying attention to and urgently need to solve. In this paper, a deep belief network (DBN) model is developed for wind power forecasting. The numerical weather prediction (NWP) data was selected as the input of the proposed model and the data directly affects the prediction precision. The NWP data and wind data in the wind farm have the similar characteristics. Therefore, in this paper the *k*- means clustering algorithm was joined to deal with the NWP data. Through clustering analysis, a large number of NWP samples, which has the great influence in forecasting accuracy, are chosen as the input of the DBN model to improve the efficiency of the model. The DBN model was validated by the Sotavento wind farm in Spain. The results of DBN forecasting were compared with those of Back-propagation neural network (BP) and Morlet wavelet neural network (MWNN). The results show that the forecasting error of DBN model was mostly at a small level, and the forecasting accuracy of the proposed method outperforms BP and MWNN by more than 44%.

1. Introduction

As an important energy development strategy, renewable energy (RE) will occupy an increasingly important position in the future. Therefore, in recent years, the scale of RE power generation has been developing rapidly, and the proportion of power generation in the total power generation has become larger and larger. Wind power generation is one of the main representatives of RE power generation in currently [1-2]. Wind energy is stochastic, intermittent and uncertain, which will adversely affect the safe and stable operation of power grid and the quality of power supply [3]. If the power of the wind farm can be accurately forecasted, it will greatly decrease the impact of wind power on power grid operation, reduce the cost of operation of the power system, and provide a reliable basis for grid operation [4].

From the time scale of prediction, wind power forecasting can be divided into ultra-short term prediction, short-term prediction, medium-term prediction and long-term prediction [5]. Among them, the ultra-short term prediction is mainly using historical data of the wind farm, and prediction scale about a few hours; Short-term prediction is to predict wind power output for dozens of hours to a few days, and the NWP data was mainly used as the input data for the modeling. In terms of forecasting methods, there are mainly physical methods [6], statistical methods [7], and hybrid methods [8], etc... The physical method is mainly according to the geographic environment, weather information (such as temperature, humidity and pressure etc.) to establish accurate wind power forecasting model. But due to the high cost and the difficulty in modeling, it cannot forecast the wind power in real-time [9-10]. The statistical method is based on the statistical analysis of the historical data of the wind farm to find out the relation function or hidden rules between the wind power and some factors, and use these factors to improve the forecasting accuracy. Statistical methods are mainly divided into time series analysis and artificial intelligence analysis [11]. In [12], a wind power forecasting model based on time series was proposed, and the superiority of this method was proved by comparing with other methods. Based on the seasonal factors and atmospheric circulation information, the seasonal prediction model of wind speed and wind power was established by using

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