Energies, vol.14, no.23, pp.7943-1-7493-26, .

Short-term forecasting of wind energy: a comparison of deep learning frameworks

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Abstract-

**Wind energy has been recognized as the most promising and economical renewable energy source, attracting increasing attention in recent years. However, considering the variability and uncertainty of wind energy, accurate forecasting is crucial to propel high levels of wind energy penetration within electricity markets. In this paper, a comparative framework is proposed where a suite of long short-term memory (LSTM) recurrent neural networks (RNN) models, inclusive of standard, bidirectional, stacked, convolutional, and autoencoder architectures, are implemented to address the existing gaps and limitations of reported wind power forecasting methodologies. These integrated networks are implemented through an iterative process of varying hyperparameters to better assess their effect, and the overall performance of each architecture, when tackling one-hour to three-hours ahead wind power forecasting. The corresponding validation is carried out through hourly wind power data from the Spanish electricity market, collected between 2014 and 2020. The proposed comparative error analysis shows that, overall, the models tend to showcase low error variability and better performance when the networks are able to learn in weekly sequences. The model with the best performance in forecasting one-hour ahead wind power is the stacked LSTM, implemented with weekly learning input sequences, with an average MAPE improvement of roughly 6, 7, and 49%, when compared to standard, bidirectional, and convolutional LSTM models, respectively. In the case of two to three-hours ahead forecasting, the model with the best overall performance is the bidirectional LSTM implemented with weekly learning input sequences, showcasing an average improved MAPE performance from 2 to 23% when compared to the other LSTM architectures implemented. **

Index Terms- long short-term memory; deep learning; wind power forecasting; time series forecasting

Citation:
Mora, E.; Cifuentes, J.; Marulanda, G. "Short-term forecasting of wind energy: a comparison of deep learning frameworks", Energies, vol.14, no.23, pp.7943-1-7493-26, .