WIND SPEED FORECAST USING PARAMETRIC NEURAL NETWORKS

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Abstract summary

In this research, by using parametric neural networks, we have tried to improve the wind speed forecast in a new wind farm which is called Binalood. For improving the forecast, we have tried to get the sensory information from several adjacent meteorological stations. Information of some of the stations has less effects on the target wind farm. The station which has most relevant information is chosen. Switching between stations can be done by the parametric neural networks. Simulation results show the effectiveness of the proposed method.

Objectives

Neural networks are usually used as a black box. In this way they are a general tool for solving problem ranging from economy to various engineering fields. The aim of this research is to improve the flexibility of the neural networks beyond the common general tool. In any neural networks there are three main parts: first one is the structure, second one is the learning method and third one is its activation function. Here we aim to improve the activation function to power it for wind speed forecasting.

Methods

One of the most used activation function is sigmoid function. In this paper we aim to improve this common activation function from ordinary hyperbolic tangent to new parametric activation function. This is done by introduction of a new parameter \( p \) which sensitizes the network with respect to complexity of the system under investigation:

\[
\begin{align*}
    f(x) &= \tanh(x) \\
    f_p(x) &= \frac{1}{\ln(p)} \cdot \tanh(\ln p \cdot x)
\end{align*}
\]

This will push the tool toward a gray-box mean. The parameter \( p \) will enables us to analyze the complexity of the input information. We aim to predict wind speed with respect to multiple measuring stations. As the wind direction varies we should be able to find out best strategy for our prediction system. One way is to find out the correlation between stations around target wind farm. In the following figure the Binalood farm is located in point A. We have used station B and C for extra correlated information needed to improve the forecast. The parameter \( p \) can be used for transition from point B to point C. Then, this is done automatically.

Results

The following figures show simulation results with different methods. The first figure from left indicates the error for ordinary verses parametric neural network. The second one shows real and forecasted wind speed which are very near. Third figure shows the correlation which is more than 0.9. The improvement by using parametric neural networks plus multi-station measuring system provides significant forecasting improvement.

Conclusions

Simulations show how parameter neural networks outperform ordinary neural networks with the similar learning algorithm. This is mostly due to the flexibility of the parametric neural network’s activation function which allows the changing of both absolute and slope of the activation function. Proper multi-station measuring system is another improvement for the forecasting criteria.

References & Acknowledgement


The authors also wish to thank Mr. Arastoo Sadeghiyan the manager of wind & wave office of Iran renewable energies organization and Mr. Ali GhaliShooyan, the manger of Binalood wind farm; for providing valuable aids and related wind speed information.