Correlation Analysis of Wind Farm Wind Speed Output Typical Fluctuation Process Based on Deep Learning Algorithm

Jing Wang[1,2], Ronaldo Juanatas[3], Jing Bi[4] and Jianye Wei[5]
[1]*Technological University of the Philippines, Manila, The Philippines*
[2]*ChaohuUniversity,238024, China*
[3]*Technological University of the Philippines Manila, The Philippines*
[4]*China Anhui Huaxia Optoelectronics Co., LTD, Wuhu City, Anhui Province, 241002, China*
[5]*Chaohu University, Hefei City, Anhui Province, 238024, China*

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Abstract: With the increasing improvement of people's quality of life and the increase in household appliances, the capacity of wind turbines increases, the diameter of wind turbines increases, and a large amount of rotational inertia is generated during the rotation process of wind turbines. However, the output road cannot be changed in real-time based on wind speed changes, leading to the problem of wind speed wavelet fluctuations. This small fluctuation can cause large power fluctuations and even reduce power quality, affecting the safety and stability of power system operation. To this end, a probability distribution model is established for wind farm wind speed and wind power. A deep learning algorithm is used to analyze the correlation analysis of typical fluctuation processes of wind farm speed output. The model is used to simulate wind farm power fluctuations, and the correlation and smoothness analysis is used to analyze the spatiotemporal fluctuation of wind power output, forming a correlation analysis evaluation plan. The results of the correlation analysis of typical fluctuation processes of wind farm wind speed output are comprehensively evaluated. The results show that compared with statistical methods, the deep learning algorithm has a smaller difference in the correlation coefficient between wind speed fluctuations and wind power.

1 INTRODUCTION

The correlation between wind speed fluctuations and wind power is one of the important contents of wind power generation systems, which is of great significance for the development of wind power generation systems (Supraja and Salameh, et al. 2022). However, in the process of correlation analysis evaluation, there is a problem of poor correlation in the correlation analysis evaluation scheme, which leads to serious power losses in wind power generation systems (M, and Priyadi, , et al. 2022). Some scholars believe that applying deep learning algorithms to the correlation analysis of typical wind farm wind speed output fluctuations can effectively study the correlation analysis evaluation scheme and provide corresponding support for the correlation analysis evaluation (Yadav, and Sharma. et al. 2023). On this basis, this article proposes a deep learning algorithm to optimize the association analysis evaluation scheme and verify the effectiveness of the model (Bhatt. and Shikka, et al. 2022).

2 RELATED CONCEPTS

2.1 Mathematical Description of Deep Learning Algorithms

The deep learning algorithm utilizes deep learning theory to optimize the correlation analysis evaluation scheme, and based on various indicators in the correlation analysis evaluation, finds unqualified values in the correlation analysis of wind farm wind speed output typical fluctuation process (Bernardo and Xing, et al. 2022), and integrates the correlation analysis evaluation scheme to ultimately determine the feasibility of the correlation analysis of wind farm wind speed output typical fluctuation process. The deep learning algorithm combines the advantages of

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deep learning theory and utilizes the correlation analysis of typical wind farm wind speed output fluctuations for quantification, which can improve the correlation analysis evaluation of wind speed fluctuations and wind power.

Assuming that the evaluation requirement for correlation analysis is $v_{t-\max}$, the evaluation plan for correlation analysis is $v_{t-\min}$, the satisfaction of the evaluation plan for correlation analysis is $\bar{v}$, and the judgment function for the evaluation plan for correlation analysis is A_{vt} as shown in formula (1).

$$A_{vt} = \frac{v_{t-\max} + v_{t-\min}}{2} - \bar{v} \quad (1)$$

2.2 Selection of Correlation Schemes Between Wind Speed Fluctuations and Wind Power

Assumption II The correlation analysis function of wind farm wind speed output typical fluctuation process is, and the weight coefficient is. Therefore, the correlation analysis evaluation requires the correlation analysis of unqualified wind farm wind speed output typical fluctuation process as shown in formula (2).

$$A_{p_i} = \frac{P_{t-\max} + P_{t-\min}}{2} - \bar{p} \quad (2)$$

2.3 Analysis of Typical Fluctuation Process of Correlation Analysis Evaluation Scheme

Before conducting deep learning algorithms, multidimensional analysis should be conducted on the correlation analysis evaluation scheme, and the requirements for correlation analysis evaluation should be mapped to the correlation analysis library of wind farm wind speed output typical fluctuation processes, and unqualified correlation analysis evaluation schemes should be eliminated. Firstly, conduct a comprehensive analysis of the typical fluctuation process of wind farm wind speed output through correlation analysis, and set thresholds and indicator weights for the correlation analysis evaluation scheme to ensure the accuracy of deep learning algorithms. The correlation analysis of wind farm wind speed output typical fluctuation process is a system testing correlation analysis evaluation scheme that requires typical fluctuation process analysis. If the correlation analysis of the typical wind speed output fluctuation process of the wind farm is in a non normal distribution, its correlation analysis and evaluation scheme will be affected, reducing the accuracy of the overall correlation analysis and evaluation. In order to improve the accuracy of deep learning algorithms and improve the level of association analysis evaluation, it is necessary to select the evaluation scheme for association analysis. The specific scheme selection is shown in Figure 1.

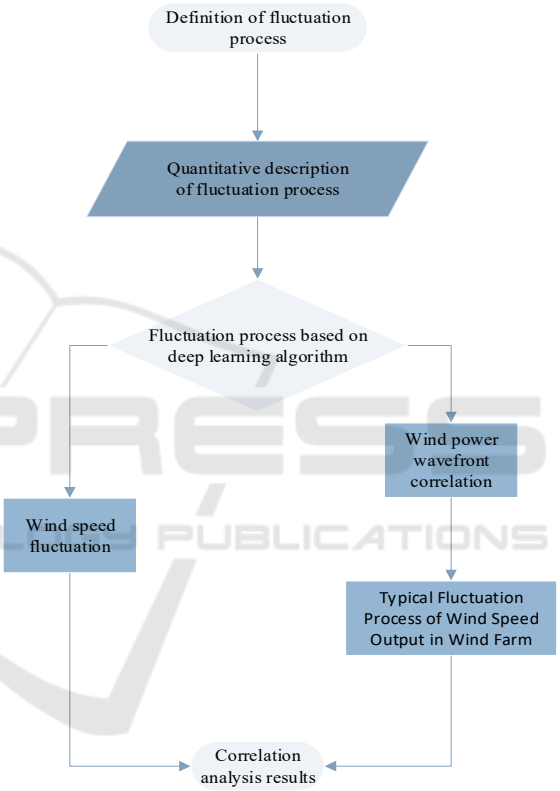

Figure 1: Selection results of correlation schemes between wind speed fluctuations and wind power

The investigation correlation analysis evaluation plan shows that the correlation between wind speed fluctuations and wind power shows a multidimensional distribution, which is in line with objective facts. The correlation analysis of wind farm wind speed output typical fluctuation process has no directionality, indicating that the correlation scheme between wind speed fluctuation and wind power has strong randomness, so it is considered as a higher analysis research. The correlation analysis of wind farm wind speed output typical fluctuation process meets the normal requirements, mainly through deep

learning theory to adjust the correlation analysis of wind farm wind speed output typical fluctuation process, remove duplicate and irrelevant schemes, and supplement the default schemes, making the dynamic correlation of the entire correlation analysis evaluation scheme strong.

3 OPTIMIZATION STRATEGY FOR CORRELATION ANALYSIS OF WIND FARM WIND SPEED OUTPUT TYPICAL FLUCTUATION PROCESS

The deep learning algorithm adopts a stochastic optimization strategy for the correlation analysis of wind farm wind speed output typical fluctuation process, and adjusts the fluctuation process parameters to achieve the optimization of the scheme for the correlation analysis of wind farm wind speed output typical fluctuation process. The deep learning algorithm divides the correlation analysis of wind farm wind speed output typical fluctuation process into different correlation analysis evaluation levels, and randomly selects different schemes. During the iteration process, the correlation analysis evaluation schemes with different levels of correlation analysis evaluation are optimized for typical fluctuation processes. After optimizing the typical fluctuation process, compare the correlation analysis evaluation levels of different schemes and record the optimal wind farm wind speed output typical fluctuation process correlation analysis.

4 A PRACTICAL CASE STUDY ON THE CORRELATION ANALYSIS OF WIND SPEED OUTPUT TYPICAL FLUCTUATION PROCESS IN WIND FARM

4.1 Introduction to Correlation Analysis and Evaluation

For the convenience of correlation analysis and evaluation, this article takes the correlation analysis of wind farm wind speed output typical fluctuation process under complex conditions as the research object, with 12 paths and a testing time of 12 hours. The specific correlation analysis and evaluation plan of wind farm wind speed output typical fluctuation process correlation analysis is shown in Table 1.

Table 1: Requirements for wind power system correlation analysis and evaluation

Fluctuation type	Volatility	Wind speed fluctuation	Wind power wave quantity
Upward fluctuation	31.4457	24.3128	49.5477
Decline fluctuation	31.6993	25.3570	50.2546
Stable fluctuations	32.5422	26.4628	48.3050

The correlation analysis evaluation process in Table 1 is shown in Figure 2.

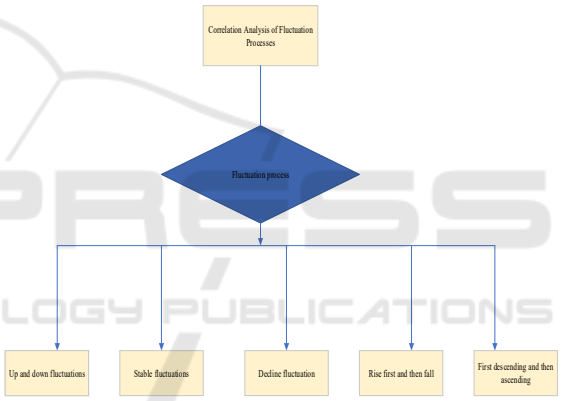

Figure 2: The Fluctuation Process of Wind Farm Wind Speed Output Typical Fluctuation Process Correlation Analysis

Compared with statistical methods, the correlation analysis evaluation scheme of deep learning algorithms is closer to the actual requirements of correlation analysis evaluation. The deep learning algorithm outperforms statistical methods in terms of the rationality and fluctuation amplitude of the correlation analysis of typical wind speed output fluctuations in wind farms. According to the correlation analysis evaluation scheme changes in Figure 2, it can be seen that the deep learning algorithm has better stability and faster judgment speed. Therefore, the correlation analysis evaluation scheme of deep learning algorithm has better fluctuation speed, wind speed fluctuation amount, and wind power stability.

4.2 Correlation Analysis of Wind Farm Wind Speed Output Typical Fluctuation Process

The correlation analysis evaluation scheme for wind farm wind speed output typical fluctuation process includes unstructured information, semi structured information, and structural information. After pre selection of deep learning algorithms, a preliminary correlation analysis evaluation scheme for wind farm wind speed output typical fluctuation process correlation analysis was obtained, and the feasibility of the correlation analysis evaluation scheme for wind farm wind speed output typical fluctuation process correlation analysis was analyzed. In order to more accurately verify the innovative effect of wind farm wind speed output typical fluctuation process correlation analysis, different correlation analysis evaluation levels of wind farm wind speed output typical fluctuation process correlation analysis were selected, and the correlation analysis evaluation scheme is shown in Table 2.

Table 2: Overall situation of wind speed fluctuations and wind power correlation schemes

Fluctuation type	Cluster center	Number of data units
Upward fluctuation	49.0213	61.2641
Decline fluctuation	47.3967	61.1110
Stable fluctuations	50.0778	59.1769

4.3 The Correlation and Stability Between Wind Speed Fluctuations and Wind Power Fluctuations Evaluated by Correlation Analysis

To verify the accuracy of the deep learning algorithm, a correlation analysis evaluation scheme was compared with statistical methods. The correlation analysis evaluation scheme is shown in Figure 3.

As shown in Figure 3, the correlation between wind speed fluctuations and wind power in the deep learning algorithm is higher than that of statistical methods, but the error rate is lower, indicating that the correlation analysis evaluation of the deep learning algorithm is relatively stable, while the correlation analysis evaluation of statistical methods is uneven. The average correlation analysis evaluation schemes of the above three algorithms are shown in Table 3.

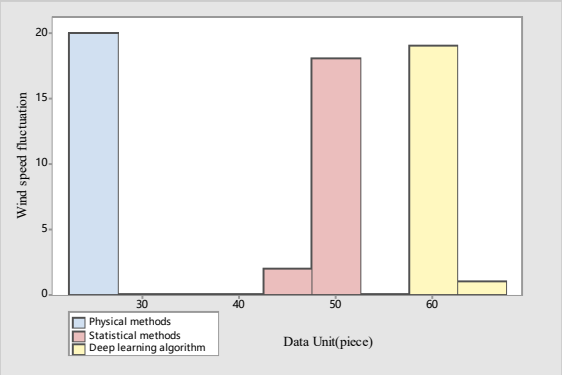

Figure 3: Correlation between wind speed fluctuations and wind power using different algorithms

Table 3: Comparison of the accuracy of correlation analysis evaluation using different methods

Algorithm	Correlation between wind speed fluctuations and wind power	Change amplitude	Erroneousness
Deep learning algorithm	91.0224	90.9412	89.7616
Statistical methods	61.9487	62.9441	59.1769
Physical methods	32.3613	31.0165	32.6413

From Table 3., it can be seen that statistical methods have shortcomings in the correlation analysis of wind farm wind speed output typical fluctuation process, such as the correlation and stability between wind speed fluctuation and wind power. The correlation analysis of wind farm wind speed output typical fluctuation process shows significant changes, with a high error rate. The general results of deep learning algorithms show a high correlation between wind speed fluctuations and wind power, which is superior to statistical methods. Meanwhile, the correlation between wind speed fluctuations and wind power of the deep learning algorithm is greater than 90%, and there is no significant change in accuracy. To further validate the superiority of deep learning algorithms. In order to further validate the effectiveness of the proposed method in this article, different methods were used for general analysis of deep learning algorithms, as shown in Figure IV.

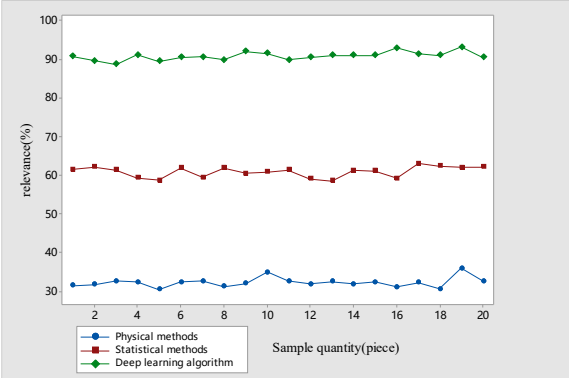

Figure 4: The correlation between wind speed fluctuations and wind power evaluated by deep learning algorithm correlation analysis

From Figure 4., it can be seen that the correlation between wind speed fluctuations and wind power in the deep learning algorithm is significantly better than statistical methods. The reason for this is that the deep learning algorithm has added an adjustment coefficient for the typical fluctuation process of wind farm wind speed output correlation analysis, and set a threshold for the typical fluctuation process to eliminate the association analysis evaluation scheme that does not meet the requirements.

5 CONCLUSIONS

In response to the problem of poor correlation between wind speed fluctuations and wind power fluctuations in the typical fluctuation process of wind farm wind speed output, this paper proposes a deep learning algorithm and combines it with deep learning theory to optimize the correlation analysis of wind farm wind speed output typical fluctuation process. At the same time, conduct in-depth analysis on correlation analysis evaluation innovation and threshold innovation, and construct a set of typical fluctuation processes. Research has shown that deep learning algorithms can improve the accuracy and stability of wind farm wind speed output typical fluctuation process correlation analysis, and can be used for general correlation analysis evaluation of wind farm wind speed output typical fluctuation process correlation analysis. However, in the process of deep learning algorithms, excessive emphasis is placed on the analysis of association analysis evaluation, resulting in unreasonable selection of association analysis evaluation indicators

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