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Research on Smart Grid Forecasting Strategy Based on Artificial Intelligence

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Abstract: *This paper deeply discusses the smart grid forecasting strategy based on artificial intelligence technology. Firstly, the development status and integration trend of smart grid and artificial intelligence technology are summarized. Then the existing smart grid forecasting strategies are analyzed, and the application of artificial intelligence in forecasting strategies is emphatically discussed. On this basis, the framework of smart grid forecasting strategy based on artificial intelligence is constructed, and the key links of strategy construction are expounded in detail, including data collection and processing, model selection and training, and forecasting result evaluation. Through the application of practical cases, the effectiveness of this strategy in improving prediction accuracy and stability is verified. Finally, the research results are summarized, and the existing problems of the current strategy and the future research direction are pointed out. The research in this paper provides technical support for the optimal scheduling and decision-making of smart grid, and helps to promote the sustainable development of smart grid.*

Keywords: *Artificial intelligence; Smart grid; Forecasting strategy; Machine learning; Deep learning*

1. Introduction

With the increasing demand for energy and the increasing complexity of power system, smart grid, as an important development direction of modern power industry, has become an important means to achieve efficient use of energy and sustainable development. By integrating advanced information, communication and control technologies, smart grid realizes comprehensive monitoring and optimal dispatching of power system, thus improving the safety, reliability and economy of power system. [1]However, the forecasting strategy of smart grid is very important for its operation efficiency and performance, so it is of great practical significance and application value to study the forecasting strategy of smart grid based on artificial intelligence technology.[2]

The rapid development of artificial intelligence technology provides a new solution for smart grid forecasting strategy. By applying artificial intelligence technologies such as machine learning and deep learning, the historical data of power system can be deeply mined and analyzed, so as to realize accurate prediction of future power demand.[3] This data-based forecasting method can not only improve the forecasting accuracy, but also reduce the forecasting cost, which provides strong support for the optimal operation of smart grid.

2. Overview of Smart Grid and Artificial Intelligence

Smart grid is the product of deep integration of power system and information technology. It uses advanced information, communication, and control technology to realize comprehensive monitoring and optimal dispatching of power system. [4] Smart grid has the characteristics of self-healing, interaction, optimization, compatibility, integration and security, which can realize intelligent management of power system and improve the operation efficiency and performance of power system.

Artificial intelligence technology is a technology that simulates human intelligence, including machine learning, deep learning, natural language processing and many other fields.[5] Artificial intelligence technology can discover the laws and patterns in a large number of data through analysis and learning, thus realizing the prediction and decision-making for the future.[6] In the field of smart grid, artificial intelligence technology can be applied to power demand forecasting, fault detection and location, energy optimal scheduling and other aspects, providing strong support for intelligent

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management of smart grid.

3. Analysis of smart grid forecasting strategy

Smart grid forecasting strategy is an important part of smart grid operation management, which predicts the future power demand and operation state by analyzing and mining the historical data of power system, and provides decision-making basis for optimal dispatching of power system. [7]The existing smart grid forecasting strategies mainly include forecasting based on statistical methods, forecasting based on machine learning and forecasting based on deep learning.

The prediction based on statistical methods mainly uses statistical principles to analyze historical data and establish a prediction model. This method is simple and feasible, but the prediction accuracy is limited by the distribution of data and the complexity of the model. [8]The prediction based on machine learning learns the inherent laws and patterns of data through training models, and realizes the prediction of future data. This method has high prediction accuracy, but it needs a lot of training data and computing resources. Prediction based on deep learning is a new prediction method in recent years. [9]It uses deep neural network model to represent and learn data, and can deal with more complex data structures and patterns. This method is excellent in prediction accuracy and generalization ability, but it takes a long time to train the model and requires high computing resources.[10] The application of artificial intelligence technology in smart grid forecasting strategy is mainly reflected in model construction and algorithm optimization.[11] By applying algorithms such as machine learning and deep learning, a more accurate prediction model can be constructed and the prediction accuracy can be improved. At the same time, artificial intelligence technology can also optimize and adjust the prediction results to adapt to different scenarios and needs.

4. Construction of smart grid forecasting strategy based on artificial intelligence.

The construction of smart grid forecasting strategy based on artificial intelligence is a complex process, which involves many links such as data collection and processing, model selection and training, and forecasting result evaluation. The specific contents and methods of these links will be introduced in detail below.

4.1 Data Collection and Processing

Data is the basis of constructing forecasting strategy, so data collection and processing is the first step of constructing forecasting strategy. In the field of smart grid, data mainly comes from all aspects of the power system, including power generation, transmission, distribution and electricity consumption. [12]These data include historical power demand data, weather data, equipment operation status data and so on. In the process of data collection, it is necessary to pay attention to the integrity and accuracy of data to avoid the influence of missing data and abnormal values on the prediction results. [13]At the same time, it is necessary to preprocess the data, including data cleaning, feature extraction and standardization, so as to improve the quality and usability of the data.

Data collection is a vital part of smart grid forecasting system. With the continuous development of smart grid technology, data sources become more diverse and huge. [14]In addition to the traditional power demand data and weather data, it may also involve energy market data, power equipment sensor data, user-side data and other data sources. The diversity of these data sources makes data collection more complicated, so it is necessary to establish an efficient data collection system and ensure the integrity and timeliness of data.

The integrity and accuracy of data are very important for the establishment and application of forecasting model. Missing data or abnormal values may lead to inaccurate or even wrong prediction results, so it is necessary to ensure the integrity and accuracy of data through technical means and quality control processes in the data collection stage. In addition, according to different data types and sources, different data cleaning and processing methods may be needed to ensure the reliability and availability of data.

In the data preprocessing stage, data cleaning, feature extraction and standardization are usually needed. Data cleaning aims to deal with noise, missing values and abnormal values in data to ensure the quality and consistency of data. Feature extraction is to extract useful features from the original data to predict the target, which usually needs to be combined with domain knowledge and data

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analysis technology to select and construct appropriate features. Data standardization is to convert data with different scales or different distributions into a unified standard scale, so as to facilitate the training and comparison of different models.

4.2 Model Selection and Training

Choosing an appropriate forecasting model is the key to building a forecasting strategy. When choosing a model, we need to consider the characteristics of data, prediction objectives and computing resources. For smart grid forecasting, commonly used models include linear regression model, support vector machine model, neural network model and so on. Among them, neural network model, especially deep learning model, has advantages in dealing with complex nonlinear problems and large-scale data sets.

In the stage of model selection, it is necessary to select the most suitable model in combination with specific forecasting tasks and data characteristics. Linear regression model is suitable for simple linear relationship prediction, while support vector machine model can deal with nonlinear relationships and high-dimensional data. For complex nonlinear problems and large-scale data sets, deep learning model can obtain better prediction performance by learning end-to-end feature representation.

Model training refers to the use of historical data to adjust model parameters, so that it can better fit the data and achieve the prediction goal. In the process of model training, it is necessary to divide the data into training set, verification set and test set, and evaluate the performance of the model and adjust the model parameters through cross-verification. For deep learning models, more data and computing resources are usually needed for training, and problems such as over-fitting and under-fitting need to be avoided.

In the process of model selection and training, it is necessary to comprehensively consider the prediction performance of the model, computing resource requirements, practical application scenarios and other factors in order to select and train the most suitable prediction model. At the same time, it is necessary to pay attention to the interpretability and interpretability of the model, so as to facilitate the subsequent analysis and interpretation of the prediction results. Data collection and processing, model selection and training are the key links to construct smart grid forecasting strategy. It is necessary to comprehensively consider the quality and characteristics of data and the applicability and performance of the model in order to realize accurate forecasting and effective management of power grid operation state and power demand.

When choosing a model, you can introduce some mathematical symbols to represent key concepts:

The linear regression model can be expressed as:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + \epsilon$$

Where y is the predicted power demand, $x_1, x_2, \ldots, x_n$ is the input characteristics (such as weather data, historical demand, etc.), $\beta_0, \beta_1, \ldots \beta_n$ is the model parameter, and ϵ is the error term.

The objective function of support vector machine model (SVM) can be simplified as:

$$min_{\omega,b} \frac{1}{2}\omega^T \omega + c \sum_{i=1}^{N} max(0,1 - y_i(\omega^T \phi(x_i) + b))$$

Where ω is the weight vector, b is the bias term,C is the penalty parameter, y_i is the target value, and $\phi(x_i)$ is the feature mapping.

The output of the neural network model can be expressed as:

$$y = f\left(\sum_{i=1}^{n} w_i x_i + b\right)$$

Where f is the activation function, w_i is the weight, b is the offset and x_i is the input.

In the process of model training, it is necessary to select the appropriate loss function and optimization algorithm, and constantly adjust the parameters of the model through iterative training, so that the model can better fit the data and predict the future trend.

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4.3 Evaluation of Forecast Results

The evaluation of forecasting results is an important link to test the performance of forecasting strategies. Commonly used evaluation indicators include accuracy, recall and F1 value.

In the part of forecasting result evaluation, we can use the following formula to express the evaluation index:

Accuracy:

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}$$

Where TP is a real case, TN is a true negative case, FP is a false positive case and FN is a false negative case.

Recall rate or true case rate:

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

F1:

$$\text{F1} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

Precision equal to $\frac{\text{TP}}{\text{TP+FP}}$

These indicators can reflect the pros and cons of the prediction results from different angles. In the evaluation process, it is necessary to compare the prediction results with the actual values, calculate the values of evaluation indicators, and adjust and optimize the prediction strategy according to the evaluation results.

5. Evaluation and optimization of strategy application effect

In order to verify the practical application effect of smart grid forecasting strategy based on artificial intelligence, the actual power grid data in a certain area are selected for testing. Compared with the actual operation data, it is found that the strategy is excellent in forecasting accuracy and stability, and can effectively support the optimal scheduling and decision-making of smart grid.

However, we also realize that there are still some problems and challenges in practical application. For example, data quality problems, model generalization ability, computational resource constraints, etc. may all affect the performance of the forecasting strategy. Therefore, it is necessary to further optimize and improve the strategy. In order to solve the problem of data quality, more advanced data cleaning and preprocessing technology can be adopted to improve the quality and reliability of data. For the generalization ability of the model, we can try to introduce more features and domain knowledge to enhance the expressive ability and adaptability of the model. In terms of computational resource limitation, we can explore more efficient algorithms and model compression techniques to reduce the computational cost of forecasting strategies. In addition, we can also consider integrating and fusing various forecasting strategies to make full use of their advantages and improve forecasting accuracy and stability. For example, prediction based on statistical methods, prediction based on machine learning and prediction based on deep learning can be integrated to form a comprehensive prediction framework. This can not only improve the accuracy of prediction, but also increase the reliability and stability of prediction results.

6. Conclusion and prospect

In this paper, the forecasting strategy of smart grid based on artificial intelligence is deeply studied, and the accurate forecasting of power demand is realized by constructing the forecasting model based on artificial intelligence. In practical application, the strategy shows high prediction accuracy and stability, which provides strong support for optimal dispatching and decision-making of smart grid. However, it is also recognized that there are still some problems and challenges to be solved. Future research can be carried out from many aspects: first, further optimize the prediction model to improve the prediction accuracy and efficiency; The second is to strengthen data quality management and

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improve the validity and reliability of data; Third, explore multi-source data fusion technology, make full use of information from various data sources, and improve the accuracy and comprehensiveness of prediction results; Fourth, strengthen the verification and evaluation of forecasting strategy in practical application, and provide more reliable technical support for the development of smart grid. Smart grid forecasting strategy based on artificial intelligence is one of the important directions of smart grid development, which has broad application prospects and great social value. With the continuous development and improvement of artificial intelligence technology, it is believed that the future smart grid forecasting strategy will be more accurate, efficient and intelligent, and make greater contributions to the efficient utilization and sustainable development of energy.

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