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EDITORIAL

Theoretical analysis of advanced intelligent computing in environmental research

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1. Introduction

Since the industrial revolution, human society has entered a stage of rapid development, and human activities have also become the dominant negative factor affecting environmental stability (Fjeldsa *et al* 1997). Irrational over-exploitation of natural resources and immature environmental governance have aggravated the decline of biodiversity, water and soil pollution and greenhouse effect, which have promoted the transformation of the human economy towards sustainable development. In the 2030 Agenda for Sustainable Development proposed by the United Nations, the sustainable development of the environment is listed as one of the three important aspects, alongside the economy and society. The environment and human social and economic activities are closely linked, and a more advanced, safe and intelligent modern environmental system can promote the economic and social development of human beings from the aspects of ecological environment management and energy supply. In the past, limited by theoretical level and computer performance, people's research on environmental systems and related fields lagged behind. With the continuous maturing of computer technology, intelligent computing methods such as machine learning and big data have been widely used in various fields represented by computer vision (Lyu *et al* 2021) and natural language processing (Huang *et al* 2015).

In the field of environmental resources, intelligent computing has also shown state-of-the-art performance. It can make accurate and reliable predictions for modern power systems and renewable energy. It can also plan and manage environmental and ecological resources through reasonable decisions. This Focus Issue contains eight articles, which introduce and study in detail the application of intelligent computing in environmental monitoring, power system and renewable energy forecasting, reservoir and hydropower dispatching, and ecological environment management in figure 1. The articles in this Focus Issue have proved through experiments that the proposed methods have the leading effectiveness and advancement in the industry. In the subsequent sections, we will further explore the impact of intelligent computing on human society and the ecological environment from two specific application scenarios: environmental governance and hydropower system operation scheduling optimization.

2. Environmental governance

When people conduct scientific management of the environment, data analysis and prediction are needed as the basis for decision-making. For example, river runoff forecasting plays an important role in flood fighting and rescue, water resources development, and river basin ecological environment management. Also in the field of hydrology, water quality analysis and prediction can improve the ecological environment of lakes, and at the same time can promote the prevention and control of water pollution to ensure the safety of drinking water. As a type of prediction widely used around people, temperature prediction is of great significance to people's daily life and even the development of industry and agriculture.

As an outstanding representative of deep learning, artificial neural network (ANN) is widely used in the prediction of environment-related data. Its strong nonlinear fitting ability can comprehensively consider multiple factors affecting the environment to obtain accurate prediction results. ANN also has many variants with different network structure characteristics. Convolutional neural networks (CNNs) and recurrent neural networks (RNNs) are two types

Figure 1. Word cloud of this Focus Issue.

of network that are widely used in different fields. CNN with sparse connections and weight-sharing characteristics can obtain excellent feature extraction ability by stacking multiple layers because of the small number of parameters. Chong *et al* (2020) proposes a model that integrates wavelet transform and CNN for rainfall forecasting, which has high accuracy in both monthly rainfalls forecasting and daily rainfall forecasting. RNN can capture hidden information in the time dimension to perform time series forecasting. Wang *et al* (2020) uses a gated recurrent unit based on RNN for runoff forecasting and achieves excellent performance. Chen *et al* (2021) in this Focus Issue proposes a two-stage temperature prediction method called PGnet based on mask matrix and CNN, and used an evolutionary method with a jump mode strategy for time series forecasting. Multiple sets of ablation experiments have proved the effectiveness of the modified neural network and demonstrated the excellent effect of the neural network on environment-related data.

Decision tree is also a commonly used prediction method in machine learning, which represents the mapping relationship between object attributes and object values, and provides feasibility research and analysis for decision-making through the use of

probability analysis. Random forest algorithm applies the idea of ensemble learning, and uses the bagging ensemble method for multiple decision trees to obtain a predictive model with better performance. The random forest algorithm has high accuracy, can show the importance of input features, and has excellent generalization capability. It can analyze and evaluate a variety of factors affecting the environment, so as to provide certain analysis methods and decision-making basis for environmental governance. In this Focus Issue, Fang *et al* (2021) proposes a random forest-based model to analyze the response of human nutrient input to the water quality of tropical lagoons. The proposed model combines the characteristics of the random forest algorithm, can determine the key nutrient input sources that affect water quality, and can predict the impact of man-made nutrient reduction on water quality. Through this model, people can identify the human activities that have the most obvious impact on the quality of the water body during the restoration of the lagoon environment, so as to restore the ecological environment at a lower socio-economic cost. Human activities have a certain impact on the environment, and the environment also affects human social activities. Zhang *et al* (2021) adopts a conjoint analysis method to analyze

the impact of four environmental attributes: water pollution, air pollution, littering, and green area on the employment choices of graduates. Through the analysis of the results obtained by this method, cities can manage the environment in a targeted manner to attract more graduates.

3. Hydropower system operation scheduling optimization

Reservoirs and hydropower stations are one of the important means of interaction between human beings and nature. Hydroelectric systems, mechanical systems and electrical energy generating devices convert water energy into electrical energy. Compared with traditional thermal power generation, hydropower has the characteristics of clean, efficient, sufficient and stable supply, and hydropower projects have the functions of flood control, drought resistance and irrigation, which have great economic value to human society. However, hydropower stations also have a certain impact on the ecological environment of the basin. Reasonable dispatch and operation of hydropower stations are of great significance for promoting economic and social development and ecological environment protection of the river basin.

Several articles in this Focus Issue study the optimization of hydropower station operation scheduling. Dispatching strategies in hydropower stations can be divided into economic benefit-oriented and ecological environment-oriented. Lu *et al* (2021) proposes a long-term optimal scheduling method for cascade hydropower stations based on the seasonal autoregressive integrated moving average model. This method combines the research of the correlation degree and correlation mode of multiple variables that affect the operation of the cascade hydropower market, and can redistribute water resources in time and space according to the situation of incoming water and market cleaning. By realizing the optimal allocation of resources in a multi-market environment, people can increase the utilization rate of water resources and obtain more economic benefits. Yu *et al* (2021) focuses on the short-term dispatch of cascade hydropower, based on the information gap decision theory to perform robust dispatch of cascade hydropower, and coordinate the performance of bilateral contracts and market bidding, thereby increasing profits for power generation companies. In addition to reasonable dispatching algorithms, accurate power system load forecasting can not only ensure the stable and safe operation of modern power systems, but also reduce the loss between power generation and power consumption, thereby reducing the operating costs of power companies. Niu *et al* (2021) proposes an electricity load forecasting model based on feature decomposition and parameter optimization. The model decomposes the original load through ensemble empirical mode decomposition,

and uses support vector machine to predict each subsequence. This method uses real-valued cooperation search algorithm (CSA) for hyperparameter optimization, and uses binary CSA for feature selection, which effectively improves the accuracy of load forecasting. Niu *et al* (2021) and Yu *et al* (2021) pay more attention to the impacts of reservoir and hydropower station on ecological environment. The former uses the enhanced harmony search algorithm to solve the optimization problem of reservoir ecological operation, and the latter uses the multi-objective game theory model to construct the multi-objective operation model of the Three Gorges Project to solve the complex balance between economy, society and ecology. It can be seen that intelligent computing plays a key role in the dispatching decision of reservoirs and hydropower stations, which can improve the economic and ecological benefits of hydropower and promote sustainable development.

In this Focus Issue, the application of intelligent computing in the prediction of environmental variables and the dispatching of hydropower stations is discussed in depth under the background of the continuous transformation of the global economy. In future research, the in-depth integration of machine learning and environmental governance is still the mainstream research direction. Machine learning is developing rapidly. Through continuously updated and improved machine learning, people can make more accurate predictions of the environment, and formulate reasonable policies to develop and manage the environment, thereby promoting the common progress of human economy, society and ecological environment governance.

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