Research on Data Analysis Model of Oilfield Development Based on Dynamic Neural Network

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Abstract. The uncertainty in the process of oil well development will have a negative impact on oil well production. The construction of dynamic neural network data analysis model for oil field development provides technical support and helps to promote the development of oil field development. In this paper, the dynamic neural network is studied firstly, and then the process of data analysis and pre-processing of oilfield development is analyzed. Finally, the application of optimization model of oilfield development data based on dynamic neural network is given.

Keywords: Oilfield Development, Dynamic Neural Network, Data Analysis Model

1. Introduction

The process of oil well development involves many factors, so we must balance these factors to minimize the uncertainty in the process of oil well development[1]. The uncertainty in the process of oil well development will have an adverse impact on the functional structure of oil well equipment and the timely treatment of abnormal oil wells[2]. Artificial neural networks can be divided into static and dynamic networks. However, the static neural network cannot accurately establish the complex dynamic mapping, and the description of the dynamic system is poor, so most of the systems are dynamic. With the dynamic neural network, it is more suitable to deal with nonlinear, time-related dynamic problems, and ensure the integrity of the system information[3]. According to the structure, dynamic neural network can be divided into full feedback neural network and partial feedback neural network[4]. Artificial neural network and intelligent algorithm provide technical support for the construction of oilfield development data analysis model, and further promote the development of oilfield development. Therefore, it is of great practical significance to study the oil field development data analysis model based on dynamic neural network.

2. Dynamic neural network

2.1. Full feedback neural network

The classic model of the full feedback neural network is that Hopfield network is a single layer symmetric structure with strong associative memory and learning ability, and each neuron is connected with each other, as shown in Figure 1 below[5-6]. When the number of nodes in the full feedback neural network increases, the network structure will be relatively complex. Due to the lack of
hidden layer, the system has poor ability to deal with nonlinear problems, so the application of Hopfield network is limited.

![Classical model of full feedback neural network](image1)

**Figure 1.** Classical model of full feedback neural network

2.2. Partial feedback neural network

The partial feedback neural network improves the structure based on the full feedback, and keeps part of the feedback link. Based on the structure of partial feedback neural network, the difference of full feedback neural network is that the feedback layer is added, and the output layer is sent to the input layer after experiencing delay. Some of them contain two feedback links, which are a hybrid network. Some of them keep more process information and are more dynamic for the complex process and involving more variables.

The whole energy function of continuous Hopfield network is defined as follows:

\[
E = \frac{1}{2} \sum_{i=1}^{n} \sum_{j \neq i}^{n} w_{ij} v_i v_j + \sum_{i=1}^{n} \theta_i v_i
\]  (1)

The output of dynamic neural network is no longer solely dependent on the current output. Due to the introduction of feedback link or time-dependent, the system takes more account of the state of the previous moment and shows good dynamic performance, so it has several advantages as shown in Figure 2.

![Advantages of dynamic neural network](image2)

**Figure 2.** Advantages of dynamic neural network
3. Analysis and pre-processing of oilfield development data

3.1. Qualitative analysis of oilfield development data
Qualitative analysis is based on the concept or characteristics of data. It includes data analysis, data display and data induction. As a high input and high-tech industry, oilfield development cycle is long, involving massive data, and the data type is complex, which brings more difficulties to data processing. First of all, oilfield development indicators reflect the dynamic data of oilfield or development unit. In the process of using information, we need to analyze it and count the data. Secondly, the data field involves many types of data in the development process, as shown in Table 1 below.

| Data classification                                      | Development data                                      |
|----------------------------------------------------------|------------------------------------------------------|
| Control and utilization of geological reserves           | Control degree of water drive reserves                |
|                                                          | Production degree of water drive reserves             |
|                                                          | Production differential pressure                      |
| Stable production degree of oil field                    | Dynamic liquid level                                   |
|                                                          | Formation pressure                                    |
| Development situation of oil field                       | Composite decline rate                                |
|                                                          | Natural decline rate                                  |
|                                                          | Total decline rate                                    |
| Development level of oil field                           | Recovery ratio                                        |
| Injection water utilization rate and injection production balance | Water storage capacity                              |
|                                                          | Injection production ratio                            |
|                                                          | Water injection rate                                  |
|                                                          | Water injection efficiency                            |
| Development situation of oil field                       | Daily oil production                                  |
|                                                          | Daily liquid production                               |
|                                                          | Moisture content                                      |

In addition, in the process of oilfield development, there are many factors that affect the development indicators. Through the analysis and display of data, qualitative analysis and screening of data influencing factors are carried out. The factors affecting oil production can be roughly divided into two categories: environmental factors and human factors. Therefore, it is also necessary to summarize and analyze the oilfield development data, so as to grasp the dynamic change and change law of oilfield development. It can be said that accurate data analysis is an important basis for scientific oilfield development.

3.2. Quantitative analysis of oilfield development data
The quantitative analysis of oilfield development data is generally carried out by means of grey correlation analysis and cluster analysis, among which the grey correlation analysis quantifies the state by judging the correlation degree between system factors, so as to effectively demonstrate the results of qualitative analysis, accurately and quickly reflect the changing characteristics. Fuzzy clustering is based on fuzzy equivalent matrix and has rigorous mathematical theory. It can classify similar data or location data, and satisfy the reflexivity, transitivity and symmetry. According to different requirements, the classification results are also different, which not only increases the flexibility of classification, but also simplifies the calculation process and improves the operation speed.

3.3. Pre-treatment of oilfield development data
In the process of oilfield development, a large number of data will be generated every day. These data are distributed irregularly, so it is impossible to input data directly. It is necessary to take processing measures for the collected data, that is, to pre-process the oilfield development data. The pre-treatment of oilfield development data mainly includes several steps as shown in Figure 3. In addition, the
standardization of data, data filtering technology and Walsh based data processing should be carried out, so as to provide data analysis theory for oilfield index prediction and establish the basis of oilfield development data analysis model.

![Data cleaning](image1)
![Data reduction](image2)
![Data integration](image3)
![Data transformation](image4)

**Figure 3.** Pre-treatment process of oilfield development data

### 4. Model application of oilfield development data based on dynamic neural network

The data needed for the data analysis model of oilfield development include the basic production index of measure wells, the economic evaluation index of measure, the analysis index of measure output benefit and the evaluation index of measure effect. For oil well development, the commonly used measures mainly include fracturing and water plugging. These development measures will be subdivided into sub categories and different measures. To predict the effect of measures, different indicators should be selected for data analysis. In the actual operation, select the learning sample composed of injection pressure data, select the input node, dynamic neuron hidden layer node and output node for network structure parameters. The optimal learning algorithm is selected by the basis function, and the learning samples are substituted into the feedback dynamic neural network for training.

**Table 2.** Performance comparison of oilfield development data analysis models

| Model               | Accuracy of sample analysis |
|---------------------|----------------------------|
| Dynamic neural network | 94%                        |
| BF neural network    | 83%                        |

In order to verify whether the model of neural network has better data analysis effect, the same group of data are analyzed with BP neural network and dynamic neural network models which are widely used, and the data analysis results are compared, as shown in table 2 above. It can be seen that the dynamic neural network model is superior to the BP neural network model in the accuracy and speed of data analysis, and realizes the global optimization.

### 5. Conclusions

There are many uncertain effects in the process of oil well development, so it needs scientific artificial neural network to analyze and study the data of oil field development. Dynamic neural network is more suitable for dealing with nonlinear and time-dependent dynamic problems, which helps to ensure the integrity of system information. Moreover, dynamic neural network model has more prominent advantages in the accuracy and speed of data analysis, so it is more and more widely used. In a word, the construction of oil field development data analysis model based on dynamic neural network promotes the development of oil field development and has high research and application value.

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