The Least Squares SVM for the Prediction of Production in the Field of Oil and Gas

Jun Peng, Chongqing University of Science and Technology, Chongqing, China
Yudeng Qiao, Chongqing University of Science and Technology, Chongqing, China
Dedong Tang, Chongqing University of Science and Technology, Chongqing, China
Lan Ge, Sinopec Chongqing Fuling Shale Gas Exploration and Development Co., Ltd., Chongqing, China
Qinfeng Xia, Sinopec Chongqing Fuling Shale Gas Exploration and Development Co., Ltd., Chongqing, China
Tingting Chen, Sinopec Chongqing Fuling Shale Gas Exploration and Development Co., Ltd., Chongqing, China

ABSTRACT

With the development of cognitive information technology and continuous application, human society has also accelerated the development. Cognitive information is widely used in the field of oil and gas, where production forecasts are of great importance to firms and companies. In this article, the support vector machine and the least squares support vector machine (LS-SVM) and particle swarm optimization algorithm research, combined to accurately predict and make error estimates. In this article, the model is applied to verify the actual output data of certain enterprises in previous years. The results show that the model has good convergence, high prediction accuracy and training speed, and can predict its output more accurately. The method used in this article is of the development of cognitive information technology, the authors have reason to believe that with the continuous development of cognitive information technology, our society will have a breakthrough.

KEYWORDS

Cognitive Information, Forecast, LS-SVM, Oil and Gas, Population, PSO, SVM

1. INTRODUCTION

In the development and operation of oil and gas fields, the accurate prediction of oil and gas production is one of the important indexes which are necessary to realize oilfield production scheduling, project planning, economic regulation and personnel management. In order to manage, plan and operate more rationally, making the economic budget and staffing arrangements optimization. Scientific and reasonable forecasting methods must be used to forecast the actual oil and gas production (Zhang, 2016). There are some usual prediction methods that are neural network, yield reduction method, gray prediction, Weng’s model method, differential simulation method. There are also scholars using curve fitting methods or complex and time-consuming reservoir simulation method for large data analysis and so on (Pang, 2013). The neural network prediction method is to use the historical data of the production for training, and constantly adjust the weight between the connected neurons to achieve yield prediction (Wang, 2005). The yield reduction method uses the historical output data and output

DOI: 10.4018/IJCINI.2018010105
decreasing law equation to realize the production forecast (Chen, 2016; Bai, 2016). Gray prediction theory is to use a small amount of data to do the differential equation and establish the forecast model (Wu, 2013). Weng’s model method utilize the non-linear regression analysis of historical oil and gas production data to obtain the model parameters. Then the oil and gas production can be predicted after the parameters are obtained reasonably (Zhang, 2014). Based on the study of the dynamic time series of oilfield development, the differential simulation method utilizes the differential dynamic simulation principle to predict.

As demonstrated, the functional module of neural network prediction method exist definite limitations and the precision is bad (Fang, 2010). The yield reduction method is applicable only to the yield prediction which accords with the law of decreasing production (Liu, 2009). The gray prediction theory is just suitable for the forecast of the trend of exponential growth (Dan, 2014). As for the non-exponential growth data, the gray scale is larger and as the dispersion degree of data is bigger, the prediction accuracy is getting worse accordingly. The Weng’s model method has some limitations of prediction because of many factors affecting the yield cannot be taken into account. In the prediction of different states, the differential simulation method cannot achieve effective yield prediction if the future information is unclear (Fu, 2010).

In this paper, the historical data of oil and gas production are processed both vertically and horizontally and then remove the wrong data to ensure that the data is a true reflection of the potential trend of oilfield production. After that this article establish the least squares to support vector machine oil and gas production forecasting model, using the relationship between the highest accuracy and the weight of the independent component to predict (Li, 2016) and using the improved particle swarm optimization algorithm (Zhang, 2012) based on the characteristics of population parallel search strategy (Hu, 2013) to find the optimal objective function value and the parameter optimization is optimized automatically. Because the particle swarm optimization algorithm is easy to fall into the local optimal defect (Liu, 2015), this paper uses a premature convergence criterion based on population diversity information to guide the selection of the initial population. But also, the use of particle group classification theory (Nouaouria, 2014a, 2014b), to improve the overall population quality, to enhance the global optimization ability, and finally establish PSO LS-SVM oil and gas production forecasting model and analyze the relevant influencing factors. This article draws on the idea of remove the irrelevant and redundant features by feature selection (Wang, 2017). The appropriate samples are selected to predict the oil and gas production and the model forecast results are verified by experiments. This method provides a new idea for oil and gas production prediction. This article is also part of the application of cognitive informatics in oil and gas (Wang, 2015).

The remaining part of the paper is organized as follows. In the second section, we introduce the details of PS-based LS-SVM modeling, including the basic principles and the selection of the initial population of particle swarm, to determine the convergence of precocious and the determination of model parameters. In the third section, we will carry out the experimental test, including the selection of parameters and simulation experiments to verify.

2. LEAST SQUARES SUPPORT VECTOR MACHINE AND IMPROVED PARTICLE SWARM OPTIMIZATION THEORY

2.1. Least Squares Support Vector Machine

Because the parameters of LS-SVM are relatively few, and the equation constraints are used instead of the original inequality constraints, some uncertain factors are reduced. Its loss function is defined directly as the sum of squares of errors and the inequality constraints in the optimization are transformed into equality constraints. And then the quadratic programming problem is transformed into a linear system of equations, which reduces the computational complexity and accelerates the solution speed. Hence, this method is used to predict the model (Gu, 2010). The basic principles are as follows.
The Integration and Control of Behaviour: Insights from Neuroscience and AI
www.igi-global.com/chapter/integration-control-behaviour/31024?camid=4v1a

A Cognitive Approach to the Mechanism of Intelligence
www.igi-global.com/article/cognitive-approach-mechanism-intelligence/1550?camid=4v1a