Application of A New Hybrid Intelligent Algorithm in the Evaluation of Sustainable Development of Fossil Energy

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Abstract
In recent years, with the continuous burning of fossil fuels and the gradual reduction of storage, sustainable development and utilization of fossil fuels has caused more and more attention around the world. Therefore, a study on the sustainable development of the evaluation of the fossil energy is conducted in the paper, and taking the issue of sustainable development of fossil energy as the research object, on the basis of the full analysis of existing problems of support vector regression method in the evaluation of sustainable development of energy and based on global optimization characteristics of genetic algorithm, a hybrid model of a fusion of two algorithms (GA-LSVR) is proposed and constructed, finally the analysis of a simulation example verified that the improved method has very high accuracy and better stability.

Key words: Fossil energy; Model building; GA-LSVR

1. INTRODUCTION
Considering the global energy supply, although in recent years new distributed power supply has been rapidly developed and accessed to the grid, but even for quite a long period of time the supply pattern is still dominated by fossil energy. Therefore, as one of the main energy, fossil energy is facing the important problem of sustainable development. To this end, domestic experts are trying to study how to improve the relationship between energy development and utilization and conservation. With the development of sustainable development, sustainable development has been transformed into sustainable evaluation. The main purpose of sustainable development evaluation is to provide the basic information on related systems in the short and long term operation for decision makers from local to global scales, providing enough support to decision makers, in order to avoid the inaccuracy problem in formulation and implementation of the sustainable planning strategy. The sustainable development of fossil energy is the key point of sustainable development in the whole ecological circle. Only in recent years, a lot of research has been done, so the relevant theories and empirical studies are not very mature, and need to be further improved. The relevant literature and data shows that the most frequently used method in the study of the sustainable development of fossil energy evaluation is support vector machine evaluation method, and the support vector machine is a nascent algorithm and model establishment and parameter choice are uncertain, which leads to the shortcomings of low evaluation accuracy and poor stability to a certain extent. Therefore, based on the support vector machine algorithm's shortcomings, on the basis of research on genetic algorithm with the advantages of parallel operation and the capability of global optimization, a hybrid model is proposed based on genetic algorithm and local support vector regression (GA-LSVR), which could accurately evaluate the sustainable development of the fossil energy.

2. CONSTRUCTION OF INDEX SYSTEM
In the process of evaluation, the establishment of evaluation index is the key to determine the accuracy of sustainability evaluation. The number of the index system must be able to fully reflect the operating status of the sustainable development of fossil energy, rather than follow the principle that the larger the number, the more accurate, and the smaller the number, the less accurate. Because although more evaluation indexes could more comprehensively reflect fossil energy characteristics, but more evaluation index must also bring some difficulties to the data collection, and increase the time and cost of evaluation to a certain extent; and less evaluation index can reduce the cost of evaluation, and simplify the evaluation process, but it's difficult to reflect comprehensively the development of the whole system. Therefore, it should be possible to select the highly useful evaluation index system to form a system which can not only accurately reflect the sustainable development of energy, but also save the cost of evaluation. Therefore, the selection of the evaluation index system requires the use of certain scientific methods for screening the overall indicators, in order to establish a high performance evaluation index system.

The construction process of index system is a gradual process, and the specific flow chart is shown in figure 1. It can be seen clearly that the construction of the index system includes: the analysis of the theme of the index system, the construction of the framework and the selection of the high index. Among all the steps, it is very important to select and construct the index.
3. SCREENING OF INDEX CORRELATION

3.1. Principle of correlation analysis

The basic concept of relevance analysis points out that relevance analysis is a very useful tool to analyze the relationship between the world's things, the degree of correlation and the convergence relationship of things. Through the correlation analysis we can use number to analyze intuitively the Correlation degree between things. One of the most classical correlation coefficient analysis is the Pierson moment correlation coefficient proposed by the famous scientist Karl Pierson.

Correlation analysis is a very useful tool, mainly used to determine whether two or more things in nature and Society (or phenomenon) is related to each other and measure the intensity of the statistical relations (or linear correlation degree between variables) between things (or phenomenon), and reflect the convergence relations of the things (or data). Correlation analysis can accurately describe the correlation degree between variables in the form of number. In practice, the most commonly used correlation coefficient is the Pierson moment correlation coefficient proposed by Karl Pierson, a British statistician.
It can be described concretely as follows: for correlation coefficient $|R| \leq 1$, when $R > 0$ there is a positive correlation between the two, namely the two change in the same direction, reduce or increase at the same time; when $R < 0$, there is a negative correlation between the two; when $R = 0$, the two are not related. In addition, when $0 \leq |R| \leq 0.5$, there is a low correlation between the two, when $0.5 \leq |R| \leq 0.8$, it indicated that there is a significant correlation between them. When $0.8 \leq |R| \leq 1$ it indicated that the two are highly correlated.

Before selecting the index, the correlation coefficient between the two evaluation indexes should be calculated first, and then the relevant evaluation index should be removed according to the preset threshold value to simplify the index system as much as possible. The specific operation steps are: when the calculated correlation value of the two index is larger than the preset threshold value, one of the two needs to be deleted, so as to achieve the goal of keeping the index independent and simplifying the index.

### 3.2. Standardization analysis of correlation index data

Because different indicators have different dimensions, it is difficult or even impossible to evaluate the relationship between indicators directly. For this reason, this paper firstly carries on the standardized processing to the evaluation index, and makes all the index data between $[0,1]$ and the most classical method, Proportional transformation method is used.

1. Standardization of positive index
   The greater the positive index value, the greater the positive effect on the sustainable development of energy. Assume that $Z_{kj}$ represents the normalized value of the $j$th index in the $k$th evaluation object, $k = 1, 2, \ldots, n$. $x_{ij}$ is the specific value of the $j$th index in the $k$th evaluation object, representing the number of evaluation object, and further the basic formula of positive Standardization is:

   $$Z_{kj} = \frac{x_{kj}}{\max_{1 \leq k \leq n}(x_{kj})}$$

2. Standardization of negative index
   The smaller the negative index value, the greater the positive effect on the sustainable development of energy. And the corresponding standard formula could be expressed as:

   $$Z_{kj} = \frac{x_{kj}}{\max_{1 \leq k \leq n}(x_{kj})}$$

### 4. EVALUATION MODEL OF SUSTAINABLE DEVELOPMENT OF FOSSIL ENERGY BASED ON LOCAL SUPPORT VECTOR REGRESSION

As it is known to all the world that the sustainable development of fossil energy is related to energy itself, economy, environment and so many other factors. And there exists a strong coupling relationship among the relevant input index. Although the screening of related characteristics is conducted before input, the impact could not be eliminated. In addition, the sample data of fossil energy is very small, it is easy to make the evaluation model of neural network have many shortcomings, such as low precision, slow convergence speed and easy to fall into local optimal solution. However, local support regression can be used to make the nonlinear and non-separable problem in the low dimensional space to the linear and separable with high dimension by nonlinear mapping, so that it can be used to solve the nonlinear problems of index factors in the evaluation model. And this method is studied under the principle of structural risk minimization, has a very good generalization. Even if the training sample set is very small, can also get a smaller error discriminant function. Figure 2 shows the flow chart of LSVR training.
The correlation analysis of local support vector machine model shows that this method can deal with many practical problems, such as small sample, nonlinear and local minimum point. In addition, this method can also be used to evaluate the sustainable development of fossil energy, and has the advantages of short time, high precision and so on. Because according to the advantages of the nonlinear mapping this method can transform inseparable data in low dimensional space into linear and separable data in high dimensional space, so that we can clearly see that, this method can solve the problems in fossil energy evaluation including small sample, nonlinear data, multiple index data and frequent change. But through practical experience knowledge, in the process of regression training of local support vector, multiple parameters including penalty parameters, error band width, Kernel parameter and number of local optimization individual are set by the staff according to their actual experience, but in the practical application reasonable selection of all the parameters is not easy thing to do. The genetic algorithm has very good hidden parallelism and strong global search ability. In this paper, the genetic algorithm is used to optimize the relevant parameters of support vector machine (SVM), and a model based on genetic algorithm and local support vector regression is established.

5. ENERGY SUSTAINABLE DEVELOPMENT EVALUATION MODEL BASED ON GA-LSVR

In the traditional regression model of local support vector, relevant parameters can be set up according to the relevant experience of laboratory personnel artificially, and the accuracy of any parameter setting will have great influence on the accuracy of the model. Therefore, only when all the parameters are set reasonably, we can get better results. Therefore, the accuracy of the evaluation model has a great relationship with the parameters selected by the experimenter. But the actual experience shows that in the artificial selection to make all
parameters optimal is a very difficult thing, so we need to study an optimization method to automatically select related parameters, in order to get the parameter set with highest optimization level.

Therefore, based on summarizing the shortcomings of previous methods, this paper puts forward a new evaluation model of sustainable development of fossil energy, as shown in figure 3. The local support vector regression is used to establish the relevant evaluation model, and the genetic algorithm is used to optimize the parameters of the model. Thus, the GA-LSVR can realize the automatic optimization of multi type parameters on the basis of the traditional local support vector regression model, and improve the accuracy of the traditional model evaluation to a certain extent. Therefore, the GA-LSVR method can be used to obtain a relatively high accuracy evaluation model, and to a large extent, improve the accuracy of sustainable development evaluation system.

![Flow chart of GA-LSVR hybrid algorithm](image)

**Figure 3.** Flow chart of GA-LSVR hybrid algorithm

6. SIMULATION ANALYSIS OF ENERGY SUSTAINABLE DEVELOPMENT EVALUATION MODEL BASED ON GA-LSVR

In order to verify the effectiveness of the method proposed in this paper, an example is given to illustrate the proposed method by using the data of the relevant years given by a research institute. The related parameters in genetic algorithm is: the penalty parameter is set to $C$; the width of the band is $\varepsilon$; kernel parameter is set as $\sigma$; the number of localization individuals is set as $k$, and then set up the model in the MATLAB simulation platform to verify the effectiveness. The final regression results and model test errors are shown in Figure 4 and table 1.
The results obtained from the above analysis show that compared with the previous two models the accuracy of the evaluation model established in this paper has been improved to varying degrees, and the average error was reduced to 0.7777\%. The basic data in regression output is almost the same compared with the original data, and the model has reached a very high and stable accuracy.

### 7. SUMMARY

Based on the analysis of the poor accuracy of the sustainable development of fossil energy, this paper makes a research on the application of hybrid intelligent algorithm (GA-LSVR) in the evaluation of fossil energy. In this paper, firstly index system of the sustainable development of fossil energy evaluation is established, and the screening method of the correlation between the index systems is designed. Then based on the analysis of the traditional LSVR and GA algorithm, this paper puts forward a model of hybrid evaluation model based on GA-LSVR. Finally, the effectiveness is verified through analysis of examples, and it proves that the method is feasible highly, and lay a solid foundation for evaluation index system of the sustainable development of China's fossil energy. This research has very important significance.

### References:


