RESEARCH OF COAL MINING SAFETY EVALUATION ON ROUGHSET-SVM

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Abstract Through the impact of fully mechanized coal mining face security personnel, equipment, operating environment and the analysis of geological environment, the establishment of a fully mechanized coal mining face safety evaluation index system is presented based on rough sets - Support Vector Machine fully mechanized coal mining face Safety assessment model. Model application method of rough set evaluation index system of attributes, eliminate redundant attributes, thus reducing the input of SVM learning sample dimension. On this basis, the use of SVM regression nonlinear characteristics was evaluated, and the final example shows the applicability of this model.

1. Introduction

SVM (Support Vector Machine, SVM) is a relatively new research artificial intelligence algorithm [1]. Its application field is more and more widely, and the advantage of SVM is overcome when dealing with small sample data of BP neural network fitting, which is easily put into the local minimum problem [2]. However cannot be determined in the data entry training SVM input data redundancy, increasing the complexity of computing run, rough set can effectively eliminate the noise in the input data [3]. From this perspective, it can support vector intelligent algorithm and rough set theory are complementary, and then to predict or evaluation of test sample, thereby reducing support in eliminating redundant information study and prediction of burden[4]. Therefore, in this paper, the application of rough set and support vector machine (RS-SVM) of evaluating comprehensive mining faces underground safety research.

2 Rough set, support vector machine (SVM) model to build

2.1 Model build description

In this paper, rough sets and support vector machine combined evaluation model is mainly on the application of comprehensive mining working face in coal mine safety assessment, thus build the model of the basic idea is: the first step in the application of the theory of rough sets to eliminate redundant input support vector machine on the influence factors of index data for effective denoising, the reduction of the core attribute index data into the training sample and forecast sample sent to support vector machine (SVM) to study and predict, and evaluate.
2.2 Rough set theory and the attribute reduction

Rough set theory is a polish mathematician Z. Pawlak proposed in 1982 a new type of dealing with vagueness and inaccuracy mathematical method, due to the rough set in dealing with uncertain information does not need apriority knowledge condition constraints, and is now in the attribute reduction, pattern recognition, fault monitoring, machine learning, decision analysis, and many other fields has been widely applied.

In the knowledge expression system $\langle U, C, D, V, f \rangle$, We often have to keep in the situation of the elementary categories in knowledge base area to redundant basic category, properties of simplified. Complete attributes to simplify the basic work is to use two basic concepts, simplify and nuclear. Let $R$ be an equivalence relation, and $r \in R$, when $\text{ind}(R) = \text{ind}(R - \{r\})$, said $r$ to $R$ can be omitted, otherwise $r$ to $R$ cannot be omitted, for any $r \in R^+$, if $R$ is independent, when $R$ is independent of the,and $P \subseteq R^+$, $P$ is also independent. all do not omit a collection of relations, in the $P$, nuclear called $P$, denoted by $\text{Core}(P) \cap \text{red}(P)$, among them, $\text{red}(P)$ all is $P$ simplified. It’s $P$ a reduction of attributes set.

2.3 The theory of SVM

SVM is Vapnik is equal to 1995 on the basis of statistical learning theory first proposed a new machine learning algorithm [5]. Support vector machine (SVM) is under the condition of limited samples for VC dimension of statistical learning theory and structural risk minimum principle to achieve its basic method is to use a few support vectors represent the entire sample set, and by using the original space of kernel function is replaced the high-dimensional feature space and the dot product operation, avoiding the complex dot product calculation.

We assume that the training data: $(x_1, y_1), \ldots, (x_t, y_t)$, $x_i \in \mathbb{R}^n$, $y_i \in \{1, -1\}, i = 1, 2, \ldots, t$ can be an optimal separating hyperplane: $(\omega \cdot x) + b = 0$ $x \in \mathbb{R}^n$, $\omega \in \mathbb{R}^n, b \in \mathbb{R}$ linear separate. to find the hyperplane, needs to solve the following quadratic programming problem

$$
\min \psi(\omega) = \frac{1}{2} (\omega \cdot \omega)
$$

subject to $y_i [(\omega \cdot x_i) + b] \geq 1, i = 1, 2, \ldots, t$ (2)

Using the dual problem though laser optimization method to solve the above problems, by nonlinear transformation $\Phi(x)$ the input space transform into a high dimensional space, in this space for the optimal classification plane (generalized). At this point, the corresponding decision function:

$$
f(x) = \text{sgn} \{\omega \cdot x + b\} = \text{sgn} \sum_{i=1}^{t} \alpha_i y_i (\Phi(x_i) \cdot x) + b\ldots(3)
$$

Type: $\alpha_i$ Lagrange multiplier; $b$ is classification threshold; the optimal separating hyperplane in the normal vector:

$$\omega = \sum_{i=1}^{t} \alpha_i y_i x_i$$

Type: $K(x, y) = (\Phi(x) \cdot \Phi(y))$ is the kernel function satisfy the Mercer condition. Here we choose RBF kernel function

2.4 Rough set support vector machine (SVM) of coal mine safety evaluation model of fully mechanized working face

The advantage of rough set is its can effectively realize knowledge reduction. Using rough set theory of support vector machine (SVM) input data preprocessing, simplify the data input of support vector machine (SVM) to reduce support vector machine learning tasks, accelerate the support vector machine (SVM) learning process [6]. Rough sets and support vector machine (SVM) there is a complementary relationship between. In order to give full play to the advantages of two methods
respectively, the integration of both is meaningful [7]. RSSVM model is applied in this article to evaluate safety of fully mechanized working face of coal mine, the first use of rough set to select the input vector, and then selected attributes to a support vector machine (SVM) learning and prediction, so as to get the final forecast [8], as shown in figure 1. So this paper on the influencing factors of coal mine safety of fully mechanized working face analysis and study on the data collected from various sources; Then in the collected data, using rough sets data variables were selected. At this stage to obtain sample set to remove all the unnecessary variables, retain only affect the accuracy of prediction variables; Then, these variables are fed into the support vector machine prediction system, through the study of support vector machine (SVM), the output prediction results. At this point, a rough set support vector machine (SVM) model was built. After the completion of a model is established in this paper, to test whether it is able to improve the prediction effect, this article USES the model to make empirical analysis.

3. The example analysis

Going according to the energy security status of a mine fengfeng group (see table 1, which is suitable for: C11 to C45 respectively represent the properties of the equipment intact rate, the equipment for repair rate, failure rate of equipment, the equipment depreciation rate, temperature, humidity, illumination and noise intensity, gas, wind speed, air fresh, geological structure, the stability of roof, coal seam floor, dip Angle of coal seam, coal thickness variation coefficient and stability coefficient of thick coal seam, the gas geologic condition, hydrogeological condition, the spontaneous combustion of coal seam, coal seam thickness, average age, average length of service, the average education, fixed number of year average training time, mean time to rest) to test the proposed model and method. In this paper, the qualitative indicators discretization processing first, the method of using rough sets the index factors in attribute reduction, reduction off redundant factors of C14, C27, C40, C45, as shown in table 2. Then using MATLABR2008a programming software to realize the SVM coal mine fully mechanized working face [9], the evaluation model of input and output will have selected 22 indicators influencing factors as input variables, safety evaluation value as output index. 1-18 working face in the data as learning samples set into the SVM learning training year by year.

| C11 | C12 | C13 | C21 | C22 | C23 | C24 | C25 | C26 | C31 | C32 | C33 | C34 | C35 | C36 | C37 | C38 | C39 | C41 | C42 | C43 | C44 | C45 | Y |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.9 | 2.4 | 7.4 | 21 | 90.2 | 5 | 85 | 0.65 | 78 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |
| 0.95 | 2.1 | 9.3 | 10.3 | 86 | 5 | 85 | 0.75 | 71 | 72 | 69 | 21 | 23 | 19 | 30 | 35 | 41 | 35 | 32 | 38 | 36 | 39 | 44 | 3.6 | 9 | 98 | 85 |

Table 1  Jizhong Energy Group peak of the actual situation of a mine

Fig.1 Coal Mining Safety Evaluation model
4. Conclusion
Coal mine safety evaluation model of fully mechanized working face is proposed in this paper, combined with hebei central energy fengfeng group. The paper used coarse intensive Jane algorithm for attribute reduction, which is the result of the main indicators factors affecting the safety of fully mechanized working face. At the same time, it determines the support vector machine (SVM) input variable, then the SVM training and prediction of the final output of fully mechanized working face of coal mine safety forecasting for ratio. This model is put forward to improve the level of safety management of coal enterprise has certain positive meaning.

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