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# The Application of Project Practice Teaching in the Higher Vocational Computer Professional Courses Taking the Simulation Model of Enterprise Safety Management Evaluation for Example

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**Abstract:** In the higher vocational computer major course, the project practical teaching methods, is helpful to arouse the enthusiasm of students' learning and enhance the students' practical skills. In this project, the practical teaching process will be taken enterprise safety management evaluation simulation model for instance. This project takes the evaluation of enterprise safety management as the research object, combines the Kernel Principal Component Analysis (KPCA) with support vector machine (SVM) and proposes an improved KPCA-SVM model to predict the security level of enterprise. The simulation data shows: the prediction effect of KPCA -SVM model is better than that of SVM method or PCA-SVM method, which provides a new idea for the future research on the safety management evaluation. The instance is order to make student realize the combination theory with practice.

**Key words:** Project practice, computer professional courses, safety management evaluation

## INTRODUCTION

The higher vocational computer professional course is aimed at improving the students' practical teaching analysis, thinking and ability to solve practical problems, helping students understanding and the understanding various commands and operations of computer programming software through typical practical cases and improving the students' practical ability and skills, realizing the combination of theory with practice, then, improving the quality of teaching further. In this project, the actual project content resorts to informatization of enterprise's safety management, uses computer programming technology and simulation platform to build the evaluation and simulation model of enterprise safety management. Enterprises often fail to use existing factors effectively to know the security state of enterprises in the safe production management process. Therefore, building a scientific and effective evaluation model of enterprise safety management has very important practical significance.

Safety management evaluation methods mainly include fuzzy mathematics (Du *et al*., 2008), analytic hierarchy (Chen *et al*., 2007), neural network (Zhu, 2000) and other methods, but these methods have disadvantages, such as subjective capriciousness, promotion failure. The support vector machine (SVM), put forward by Cortes and Vapnik (1995) and is a new artificial intelligence model that has generalization performance. Effectively solving the nonlinear problem of small sample is its main advantages. This project uses support vector machine to evaluate the state of enterprise's safety management. SCHÖLKOPF proposed kernel principal component analysis (KPCA)is applicable to the field of nonlinear based on PCA, this method could effectively extract the nonlinear information of input data and had been widely used in pattern recognition, image processing, signal processing and so on (Li and Wang, 2008; Qi and Li, 2012; Wang, 2013) but it still applies less in the field of safety management. Based on the above analysis and cognition, the project combined KPCA with SVM, The student uses computer programming technology and simulation platform to build the evaluation and simulation model of enterprise safety management.

## BUILDING MODEL IN THE PRACTICAL TEACHING MODEL (KERNEL PRINCIPAL COMPONENT ANALYSIS ALGORITHM)

Teachers explain in detail the principle of kernel principal component analysis algorithm, which lay the foundation for the students' subsequent programming. Assuming that the training sample set of the safety management evaluation is expressed as $x_i \epsilon R^n$ (i = 1, 2, ..., l), the training sample of the safety management evaluation through $\Phi$ mapped to high-dimensional feature space, it changes into $\Phi(x_i)$ (i = 1, 2, ..., l), then a linear principal component analysis in high dimensional feature space. If average data is zero, then the feature space covariance matrix can be defined as:

$$C = \frac{1}{1}\sum_{i=1}^{1} \Phi(x_i)\Phi(x_i)^T \tag{1}$$

Set C characteristic values for $\lambda$, characteristic vector for V, there are:

$$\lambda V = CV \tag{1}$$

As the sample data with (2) for inner product, there are:

$$\lambda\langle \Phi(x_k), V\rangle = \langle \Phi(x_k), CV\rangle,\ k = 1, 2, \cdots, 1 \tag{3}$$

The eigenvalues $\lambda$ of the matrix C corresponding eigenvector V ,it can use the above $\Phi(x)$ linear represented as:

$$V = \sum_{i=1}^{1} \alpha_i \Phi(xx_i) \tag{4}$$

$$\lambda \sum_{i=1}^{1} \alpha_i \langle \Phi(x_i), \Phi(x_k)\rangle = \frac{1}{1}\sum_{i=1}^{1}\alpha_i \left\langle \Phi(x_k), \sum_{j=1}^{1}(\Phi(x_j)\right\rangle \cdot \langle \Phi(x_j), \Phi(x_i)\rangle \tag{5}$$

Define l×l matrix K:

$$K_{ij} = K(x_i, x_j) = \langle \Phi(x_i), \Phi(x_j)\rangle$$

can be simplified as D:

$$1\lambda Ka = K^2 a \tag{6}$$

Calculating formula (6) , work out the formula below:

$$1\lambda a = Ka\ \ a = (\alpha_1, \alpha_2, \cdots, \alpha_1)^T \tag{7}$$

The cumulative variance contribution ratio of the principal component:

$$\lambda_i \Big/ \sum_{i=1}^{1} \lambda_i$$

determine the number of it and determined by formula (7):

$$\sum_{i=1}^{p} \lambda_i \Big/ \sum_{i=1}^{1} \lambda_i \geq 85\% \tag{8}$$

putting Eq. 7 into 8,then:

$$\langle V_k, V_k\rangle = \left\langle \sum_{i=1}^{1} \alpha_i^k \Phi(x_i), \sum_{i=1}^{1} \alpha_i^k \Phi(x_i)\right\rangle = \sum_{i=1}^{1}\sum_{j=1}^{1} \alpha_i^k \alpha_j^k \langle \Phi(x_i), \Phi(x_j)\rangle \tag{9}$$

$$= \sum_{i=1}^{1}\sum_{j=1}^{1} \alpha_i^k \alpha_j^k K_{ij} = \langle a_k, Ka_k\rangle = \lambda_k \langle a_k, a_k\rangle = 1 \tag{10}$$

The nuclear matrix k standardization into

$$\tilde{K} = K - LK - KL + LKL \tag{11}$$

$$L = \frac{1}{1}\begin{bmatrix} 1 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ 1 & \cdots & 1 \end{bmatrix} \tag{12}$$

At this point, the formula of calculating kernel principal change into:

$$t_k = \langle \tilde{V}_k, \Phi(x)\rangle = \sum_{i=1}^{1} \tilde{\alpha}_i^k \langle \tilde{\Phi}(x_i), \tilde{\Phi}(x)\rangle = \sum_{i=1}^{1} \tilde{\alpha}_i^k \tilde{K}(x_i, x),\ (k = 1, 2, \cdots, p) \tag{13}$$

(13) Said test sample vector of the safety management evaluation map location in the feature space, it can be used as the basis for the safety management evaluation.

## (MECHANISM OF SUPPORT VECTOR MACHINE ANALYSIS ALGORITHM)

Given the training sample of the safety management evaluation set the solving of optimal classification plane problem can be converted into optimization problem, namely:

$$\{(x_i, y_i) \mid x_i \in R^n, y_i \in \{-1, 1\}, i = 1, 2, \cdots, 1\} \tag{14}$$

$$\min L(?, b) = \frac{1}{2}\|?\|^2 \tag{15}$$

$$\text{s.t.}\quad y_i \cdot (?x + b) \geq 1\ \ (i = 1, 2, \cdots, 1) \tag{16}$$

$\omega$ is the weight vector, b is classification threshold.
Using the Lagrange multiplier $\alpha_i$, (16) equation change into:

$$\min L(?, b, a) = \frac{1}{2}\|?\|^2 - \sum_{i=1}^{1} \alpha_i (y_i(\omega \cdot x_i + b) - 1) \tag{17}$$

$$\text{s.t.}\quad y_i \cdot (?_i x + b) \geq 1\ \ (i = 1, 2, \cdots, 1) \tag{18}$$

Partial derivatives of ω and b, partial derivatives are zero, constraint condition is obtained as follows:

$$L(?, b, a) = Q(a) = \sum_{i=1}^{l}\alpha_i - \frac{1}{2}\sum_{i=1}^{l}\sum_{j=1}^{l}\alpha_i\alpha_j y_i y_j \langle x_i, x_j \rangle \quad (19)$$

In view of duality theory knowledge of the optimization theory, the problem of the optimal separating hyper plane is maximize functional:

$$\max Q(a) = \sum_{i=1}^{l}\alpha_i - \frac{1}{2}\sum_{i=1}^{l}\sum_{j=1}^{l}\alpha_i\alpha_j y_i y_j \langle x_i, x_j \rangle \quad (20)$$

$$\text{s.t.}\begin{cases} \sum_{i=1}^{l}\alpha_i y_i = 0 \\ \alpha_i \geq 0 \quad (i = 1, 2, \cdots, l) \end{cases} \quad (21)$$

The above formula belongs to two convex quadratic programming problems,its global optimal solution is set as α*, then B, namely the component of α* is $\alpha_j^*>0$, by Eq. 20 and 21 formulas solve the only optimal for the two programming problems ω* and b*:

$$?^* = \sum_{i=1}^{l}\alpha_i^* y_i x_i \quad b^* = y_j - \sum_{i=1}^{l}\alpha_i^* y_i \langle x_i, x_j \rangle \quad (22)$$

By ω* and b* may be the optimal separating hyper plane:

$$(?^* \cdot x) + b^* = 0 \quad (23)$$

Obtain the function of decision

$$f(x) = \mathrm{sgn}(g(x)) \quad (24)$$

Among them

$$g(x) = \sum_{i=1}^{l}\alpha_i^* y_i \langle x_i, x \rangle + b^* \quad (25)$$

## THE PROJECT IMPLEMENTATIONS PROCESS

With the construction and guide of teachers, students complete the flow of the safety management evaluation model. Specific process is: Assuming the evaluation of safety management has k levels, the training set has l samples $\{x_i, y_i\}$ (i = 1, 2, …, l), the test set has m samples $\{x_j, y_j\}$ (j = l+1, l+2, …., l+m), $x_i, x_j \in R^9$ is the sample of safety management, $y_i \in \{1, 2, ..., k\}$ and stands for safety level, the specific process in Fig. 1:

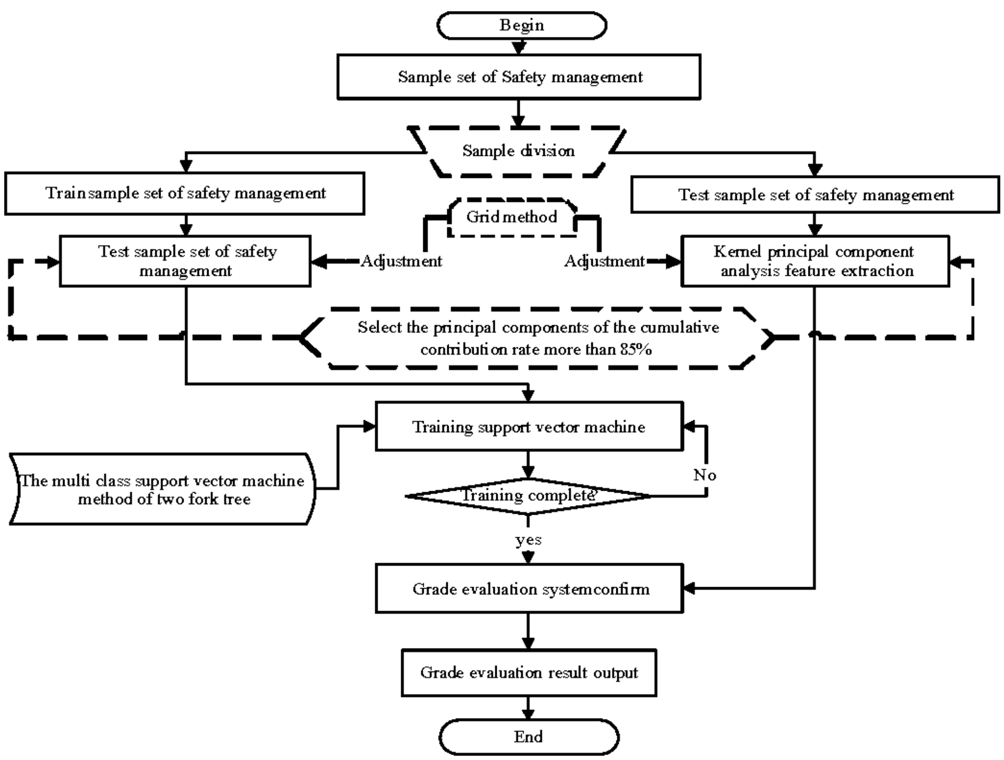


Fig. 1: The flow chart of the safety management evaluation

## DATA SOURCE IN THE PRACTICAL PROJECT

In the form of task driven, teachers require students to access to relevant data, select the appropriate sample. After discussing, teachers and students together select the data.According to the data provided by the literature (Jin and Ma, 2011), this project uses the field surveys data of 33 coal mining enterprises from China as the sample, the sample includes 12 indicators, Followed by business licenses complete rate (X1), ……, the qualified rate of mine map (X12), Quantitative data comes from the actual collection, qualitative data comes from the expert scoring. All sample evaluation results are divided into five grades, respectively level 5 (very security), level 4 (security), level 3 (common security), level 2 (more dangerous), level 1 (dangerous), five samples randomly selected in each grade is used as the test set, the remaining as the training set. As space is limited, the data is not being burdensome. Under the guidance of teachers, students make program.

## THE PROJECT RESULTS' ANALYSIS IN THE PRACTICAL TEACHING METHOD

The training set data feature vector is extracted by KCPA method. The principle of cumulative variance contribution rate is more than 85%; grid method is used to determine the parameters of c = 0.987, d = 4.197. The relationship S between Principal component number and root mean square error are shown in Table 1.

When the number of principal components is 2, the root mean square error achieves minimum, when the principal component number increases to 3, root mean square error has a modest increase.

Then, the Eq. 13 will reduce the dimensions of the training set and testing set to 2 dimensions, make the complexity of training set and testing set reduced greatly, improve the efficiency of coal mine safety evaluation.

Table 1: Relationships between principal component number and root mean square error

| Principal component number | Root mean square error |
|---|---|
| 1 | 4.023 |
| 2 | 2.543 |
| 3 | 3.034 |
| 4 | 3.166 |
| 5 | 3.342 |

Table 2: Predicted results and actual condition contrast table

| | | Predicted grade | | |
|---|---|---|---|---|
| Number | Actual grade | SVM | PCA-SVM | KPCA-SVM |
| 1 | 5 | 1 | 1 | 5 |
| 2 | 4 | 2 | 4 | 4 |
| 3 | 3 | 2 | 3 | 3 |
| 4 | 2 | 2 | 4 | 2 |
| 5 | 1 | 2 | 1 | 1 |

The training set of support vector machine make train and train support vector machine network test with testing set , the result of the test verify the effect of coal mine safety evaluation which method proposed in this project. The parameters of the Gaussian kernel function is set as $\sigma = 3.497$ punish coefficient is set as C = 1000. This project also uses the SVM method, PCA - SVM method in order to carry out training and testing. Test results of three methods are shown in Table 2.

As can be seen from Table 2, the prediction results of SVM, PCA-SVM, KPCA-SVM have larger difference, the prediction effects of the KPCA-SVM method are consistent with the actual situation, its accuracy is 100%, however, PCA-SVM method is 60%, SVM method is 40%.

## CONCLUSION

Advantages of the practical teaching method are to implement the experience teaching in the computer professional course. Completing practical projects may consolidate the theoretical knowledge of students; improve greatly the students' practical operating skills. This project combines the kernel principal component analysis method with support vector machine method, builds the enterprise safety management evaluation model and verifies prediction effects of KPCA-SVM model based on the security management data of 33 coal mine enterprise. The results show: KCPA method has good capability of nonlinear data extraction and noise reduction, which will improve the SVM training ability and pan ability, verify that KCPA-SVM inaccuracy is better than SVM and PCA-SVM, this project opens up a new way for enterprise safety management evaluation. The practical teaching method confirms to the aim of applied talents' cultivation for the higher vocational colleges in our country.

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