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The Research on the Aerobics Performance Prediction for College Students Based on IWLS-SVM

Yinfan Li

Jiangsu University, Zhenjiang, Jiangsu, 212013, China.
li-y-f@hotmail.com

Since the aerobics is introduced into the college and university, it becomes popular in teachers and students. In order to develop the aerobics better and improve the level of the aerobics, it is necessary to predict the aerobics performance. Support vector machine method is one of the frequently-used prediction methods. In order to improve the performance of traditional LS-SVM, we put forward an improved LS-SVM algorithm. It is inertia weight LS-SVM (IWLS-SVM) algorithm. According to improving the inertia weight, the algorithm can enhance the performance of the traditional LS-VSM. In the numerical experiments, we apply the algorithm to predict the performance of the aerobics. The experimental results show that the prediction method has better feasible and effective.

1. Introduction

With the development of the aerobics sport, more and more college students participate in the aerobics. Aerobics sport cannot only improve the body posture and enhance the physical fitness, but also can promote the intellectual development of the students. Therefore, the major colleges have carried out the aerobics movement. And many scholars studied the aerobics sports.

Li Yulin (2008) studied the competitive aerobics fitness training. According to analyzing the concept of physical and the composition factors, combined with the characteristics of the competitive aerobics, this paper establishes the content system for the competitive aerobics fitness training. According to consulting massive literatures and investing some aerobics coaches, athletes, music production staffs and the relationship between the music and aerobics, Wang Ying (2013) studied the creating theory and creation process of the aerobics. Liu Xiaoyu (2013) invested and analyzed the situation of sport injury and the causes which occurred in aerobics for the college aerobics students. Zhang Feng (2013) researched on the sport aerobics terminology. According to studying the aerobics terminology, the author introduced emphatically the classification and recording symbols of the aerobics terminology, the current application status of aerobics terminology and the factors which influenced the development of aerobics terminology. Li Lin (2013) analyzed and studied the development situation and influence factors of the university campus sports culture in Hunan province.

LS-SVM is short for Least square support vector machine. This method is a commonly used forecasting method (Zuriani Mustaffa, Yuhanis Yusof, Siti Sakira Kamaruddin, 2014). For example, the prediction of the change in methane concentration (Shu-gang CAO etc. 2008) and the prediction of the day-ahead electricity price (H. Shayeghi, A. Ghasemi, 2014)

In this paper, in order to predict better the performance of the aerobics, we put forward the improved LS-VSM method. The method is IWL-SVM. At the same time, we predicted the performance of the aerobics. The experimental results showed that the prediction method has good feasible and effective. The structure of this paper is as follows. The first part is the introduction. The second part is the SVM and LS-VSM. The third part is the IWLS-SVM. In this part, we put forward the improved LS-VSM method. The improved method is IWLS-SVM. The fourth part is the numerical analysis.

2. IWLS-SVM

Firstly, we introduce the LS-SVM.

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We support that training sample set $T=\{(x_i,y_i)|i=1,2,\cdots,n\}, x_i\in R^n, y_i\in R$. x_i is the input data. y_i is the output data. The optimization problem can be described as:

$$\min C\sum_{i=1}^{n}(\xi_i+\xi_i^*)+\frac{1}{2}w_i^2 \tag{1}$$

Subject to

$$\begin{cases} f(x)=(w,x)+b \\ y_i-f(x_i)-e\geq\xi_i \\ f(x_i)-y_i-e\leq\xi_i^* \\ \xi\geq 0 \end{cases} \tag{2}$$

We construct the Lagrange function

$$L(w,b,e;\alpha)=J(w,e)-\sum_{i=1}^{N}\alpha_i\{w^T\varphi(x_i)+b+e_i-y_i\} \tag{3}$$

So, the LS-SVM regression function model is

$$f(x)=\sum_{i=1}^{N}\alpha_i K(x_i,x_j)+b \tag{4}$$

We suppose that a swam in the Particle Swarm Optimization consists of a particles in d dimensional search space. The position of i th particle at the t th iteration is $x_i(t)=(x_{i1}(t),x_{i2}(t),\cdots,x_{id}(t))$, the velocity is $v_i(t)=(v_{i1}(t),v_{i2}(t),\cdots,v_{id}(t))$, and $v_i(t)=(-v_{\max},v_{\max})$. Each particle can remember the own best position $pbest_i(t)=(pbest_{i1}(t),pbest_{i2}(t),\cdots,pbest_{id}(t))$. The best position among all particles is $gbest_i(t)=(gbest_{i1}(t),gbest_{i2}(t),\cdots,gbest_{id}(t))$. The standard PSO can be written as the following formula

$$\begin{aligned} v_{ij}(t+1)=&wv_{ij}(t)+c_1r_1(pbest_{ij}(t)-x_{ij}(t) \\ &+c_2r_2(pbest_j(t)-x_{ij}(t)) \end{aligned} \tag{5}$$

$$x_{ij}(t+1)=x_{ij}(t)+v_{ij}(t+1) \tag{6}$$

Among them, w is the inertia weight. c_1 and c_2 are the acceleration constant. r_1 and r_2 are the independent random number which is in $[0,1]$.

As everyone knows, the inertia weight is the key parameter for particle swarm optimization. This parameter can keep the inertial motion for the particles. And it also controls the influence of the before speed for the current speed. When w is bigger, the particle swarm optimization has stronger global search ability. However, it has higher load calculation. When w is smaller, the particle swam has stronger convergence speed. However, it is possible to fall into the local optimum. If $w=0$, it shows that the speed of the particle has not the memory. The particle swarm will converge to the current global optimal position and loss the ability of searching more optimal solution. In order to make the performance of the traditional LS-SVM optimal, we put forward an improved LS-SVM algorithm. The algorithm is the inertia weight LS-SVM algorithm. According to improving the inertia weight, we improve the performance of the traditional LS-SVM. In this paper, we define

$$w = (1 - \frac{t}{t_{\max}})^2 (w_{\max} - w_{\min}) + w_{\min} \tag{7}$$

$w_{\max}$ is the maximum weight coefficient. $w_{\min}$ is the minimum weight coefficient. $t_{\max}$ is the maximum iterations.

IWLS-SVM algorithm has the advantages of the traditional PSO, such as simple implementation and easy computation. Furthermore, it can enhance the convergence rate and accuracy effectively.

After a series of experiments, the initialization parameters of IWLS-SVM are as follows: $p = 40$, $w_{\max} = 0.9, w_{\min} = 0.4, c_1 = c_2 = 2.05, \varepsilon = 1 \times 10^{-5}, t_{\max} = 800, v_{\max} = 1$

The RMSE is shown as

$$RMSE = \sqrt{\frac{1}{N} \sum_{j=1}^{l} e_j^2} = \sqrt{\frac{1}{N} \sum_{j=1}^{l} (y(x_j) - y_j)^2} \tag{8}$$

$y(x_j)$ is the actual value. y_j is the estimated value. When RMSE is smaller than ε , it shows that γ and σ achieve the optimal.

Step 1: Initialize the parameters: particle size p , presupposed accuracy ε , particle position x , particle velocity v , acceleration constant c_1, c_2 , the maximum speed $v_{\max}$, the maximum weight coefficient $w_{\max}$, the minimum weight coefficient $w_{\min}$, the maximum iterations $t_{\max}$.

Step 2: For $t = 1$, compute the fitness function $F(x)$

Step 3: Update $pbest_i(t)$, , x, v

Step 4: Terminate: ε or $t_{\max}$ attained, perform Step 6, otherwise perform

Step 5: $t = t + 1$, and perform Step 2

Step 6: Output $gbest_i(t)$

The process is shown in the following fi $gbest_i(t)$ gure.

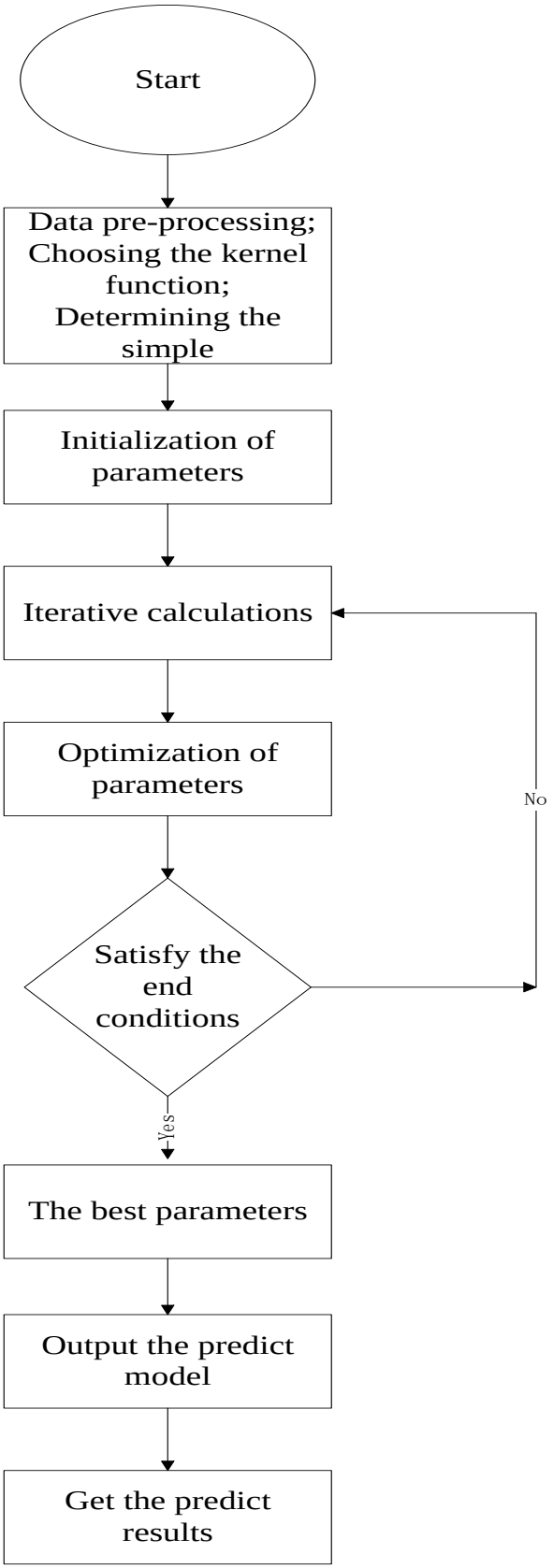

Figure 1: The Prediction Process Figure of IWLS-SVM

3. Numerical Analysis

In this paper, we score for the aerobics. Firstly, we select 35 students to show the aerobics performances. And there are experts scoring for these students from the above five aspects. Then we calculate the average value. Among them, the performances of the 25 students make as the training set. And the performances of the 10 students make as the sample set. The performances of the 25 students are as follows.

Table 1: The scores for the samples

No	body shape	overall strength	coordination	endurance	flexible	average value
1	8.7	8.1	6.7	7.6	9.1	8.04
2	8.6	8.6	9.2	6.2	7.0	7.92
3	8.4	8.1	7.9	9.6	8.1	8.42
4	9.4	7.5	6.8	8.2	8.4	8.06
5	8.3	8.7	6.7	7.7	6.9	7.66
6	8.9	7.8	8.2	8.2	7.0	8.02
7	7.8	9.1	8.4	6.8	6.9	7.80
8	8.0	7.3	9.6	9.2	9.4	8.70
9	8.2	8.4	9.2	6.6	6.8	7.84
10	6.7	7.9	7.0	7.5	9.2	7.66
11	6.2	8.1	8.2	8.1	7.8	7.68
12	6.1	8.2	8.5	6.8	7.9	7.50
13	6.9	8.4	6.9	8.7	8.9	7.96
14	8.1	8.8	7.8	6.6	8.4	7.94
15	6.8	6.9	8.4	7.2	7.6	7.38
16	7.3	8.0	8.2	9.0	9.1	8.32
17	6.9	7.2	8.2	7.3	9.2	7.76
18	7.2	7.4	6.9	7.6	7.9	7.40
19	8.3	8.0	8.0	9.1	7.0	8.08
20	7.5	8.0	6.9	8.5	7.8	7.74
21	8.3	6.5	7.8	8.2	9.0	7.96
22	7.5	8.3	8.4	7.4	8.2	7.96
23	7.0	7.6	7.5	6.9	7.5	7.30
24	8.2	8.1	8.2	8.3	7.9	8.14
25	7.6	7.4	8.2	9.2	7.5	7.98

We use the IWL-SVM to predict the data and get the forecast values. Then, we compare the forecast values with the performances of other five students. The results are as follows.

Table 2: The predicted values and the error

NO	Actual values	Predicted values	Error
26	7.91	7.96	0.0062
26	7.28	7.33	0.0068
28	8.73	8.78	0.0057
29	8.45	8.41	-0.0047
30	9.20	9.16	-0.0043
31	8.31	8.25	-0.0072
32	8.65	8.69	0.0046
33	9.21	9.14	-0.0076
34	8.43	8.50	0.0083
35	9.28	9.22	-0.0065

We draw the actual values and the predicted values in one picture. The results are shown as the figure.、

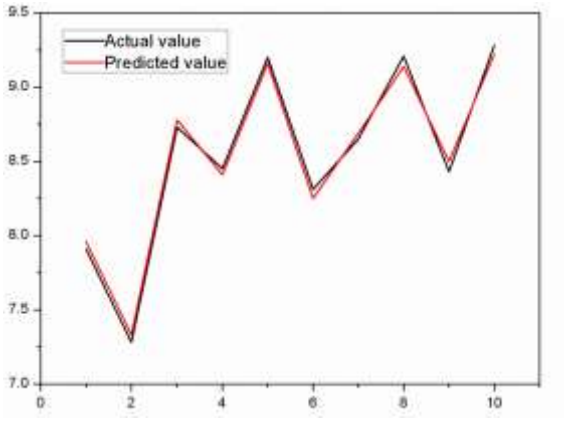

Figure 2: The actual values and the predicted values

From the Figure 2, we can see that the fitting effect of actual values and predicted values is better. The two curves basically coincide. It shows that the IWLS-SVM method is feasible and effective.

4. Conclusions

In order to predict effectively the performance of the college aerobics, this paper improves the SVM method and forecasts the performance of college aerobics. This paper does the following work. Firstly, we introduce the aerobics sport in colleges and the related background of SVM. Secondly, we put forward the improved LS-SVM method. The method is IWLS-SVM. Lastly, according to the numerical analysis, we predict the performance for the college aerobics. Then we validate the method is accuracy and feasibility.

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