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# Optimization SVM Algorithm and it's Application in Agricultural Science and Technology Project Classification

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**Abstract:** To describe Optimization SVM algorithm, Author applies it to the classification of agricultural science and technology project, algorithm depends on of the limitations which the experience of selected parameters, presents a particle swarm optimization (PSO) pattern search algorithm to search for optimal parameters, and applied it to the project of agricultural science and technology classification. Experimental results show that algorithm is an efficient method of SVM parameter optimization, the author puts algorithm into agricultural science and technology in the process of classification shows that algorithm is not only high efficiency, and the optimal parameters is to achieve a higher accuracy rate. *Copyright © 2012 IFSA.*

**Keywords:** SVM, Particle swarm optimization, Kernel parameter selection.

## 1. Introduction

Support vector machine is Vapink et al' achievements. Which is according to statistical learning theory of structure risk minimization principle, in order to solve the small sample learning problems, and is to provide a unified framework [1]. In addition, the support vector machine is a convex quadratic programming which is to ensure that the extremum as a global optimal solution. In recent year, support vector machine SVM has have a successful application such as in text classification, biological information, remote sensing image analysis, fault recognition and prediction, time series prediction and other fields [2, 3]. Support vector machine (SVM) the core of is the kernel function, and the parameter of

kernel function selection decision support vector machine classification performance, so it is very important to select the parameters. Previous SVM parameter selection is based on experience or Meng Cai, with considerable limitations. In order to overcome this shortcoming, Chapella is proposed based on the gradient descent method for selecting the parameters of support vector machines [4], Qi Liang ant colony's algorithm is proposed based on support vector machine SVM parameter selection method [5], Wang Xing ling and the car was put forward which is based on the grid for bin parameter optimization method [6], these methods in the corresponding experimental literature in proved that the method is effective, but these algorithms the limitation still exists big, easy to fall into local minimum, a large amount of calculation, low efficiency defects. Agriculture is the foundation of national economy, agricultural foundation is beneficial to the people's livelihood, agricultural is related to national security and the people's livelihood. To solve the 3 farming's problem is very importance and necessity. innovation and transformation is the driving force in agricultural science and technology to integrated, the linkage development of agricultural science and technology service, accelerate industrialization process, stimulative farmer is added continuously close, agricultural science and technology project investment is to solve "3 farming's problem" core. On the project of agricultural science and technology to classify (i.e., to determine which items to rise to promote action), can for future agricultural science and technology project investment play a very good reference. In the domestic few intelligent algorithms in agricultural science and technology project classification of the application report, so the research which is in this area is very urgent.

In view of this, Author presents a particle swarm pattern search algorithm to optimize the parameters, the algorithm combines the particle swarm optimization algorithm and pattern search advantages, making the algorithm in efficiency and performance than particle swarm optimization algorithm and pattern search algorithm has been greatly improved, for selecting the parameters of support vector machines provide a effective method. At the same time experiment results show that the optimized SVM algorithm, and it is in project of agricultural science and technology in the process of classification is not only high efficiency, and search for the optimal parameters is to achieve accuracy rate.

## 2. SVM Algorithm and its Parameters on the Performance of Support Vector Machine Effect

Vapnik et al presented another design best practice in the years of research which is based on statistical learning theory on linear classifier. It's principle is linearly separable, and then extended to the linearly non-separable case. Even extends to the use of nonlinear function, this classifier known is the support vector machine (Support Vector Machine, SVM). SVM main idea can be summed up in two points: (1) it is for linearly separable situation carries on the analysis, the linear indivisible, by using the nonlinear mapping based on the low dimensional input space linearly non-separable samples into a high dimensional feature space so that the linear separability, which makes the high dimensional feature space. Using a linear algorithm for the nonlinear feature of sample linear analysis possible; (2) it is based on Structural Risk Minimization Theory which is to construct the optimal segmentation hyper plane, making the learning for global optimization in the whole sample space, and the expected risk to a probability satisfies certain upper bound.

The SVM method is through a nonlinear mapping P, the sample space mapped to a High dimension, even to infinite dimensional feature space (Hilbert space), so that in the original sample space nonlinearly separable problem is transformed into the feature space of a linearly separable problem. Simply say, is ascending and is ascending dimension. The sample to high dimension space do mapping, this will normally increase in computational complexity, even will cause the" dimension disaster", and people seldom inquire this. But as a classification, regression problems, probably in the low dimensional sample space can not be linear processing sample, in the high dimension feature space can be realized through a linear hyper plane linear partition (or regression). General ascending dimension will bring

computational complexity, the SVM method to resolve this problem: the application of nuclear function expansion theorem, it need not know the nonlinear mapping of the explicit expression; because it is in the high dimensional feature space in the establishment of linear learning machine, so with the linear model, not only almost do not increase the computational complexity, and to some extent to avoid "dimension disaster" all thanks On the kernel function expansion and the theory of computation.

In most cases, the Guess kernel function classification has a well effect [7]. The Guess kernel function has two parameters that is *c* and *σ*, Choose a different *c* and *σ* Performance of different classifiers can be constructed *c* is to control the degree of punishment of the error sample, when *c* is a smaller value indicated that the wrong sample punishment degree is low, the classification hyper plane is simple and the experience larger error; if *c* value tends to infinity, then all constraint conditions must be met, then the mean of all training samples to correct classification, which will lead to the classification hyper plane, large amounts of calculation of complex, time-consuming. So *c* is the choice of value should be combined with specific applications, to meet the classification accuracy at the same time, as far as possible, take a small value, and make the decision function.

While *σ* is actually altered implicitly change the mapping function, thereby changing the sample data subspace distribution complexity but also determines the linear classification can reach the minimum error [8]. *σ* value is too small, in all test samples into support vector, produce" over fitting phenomena; if *σ* has high value, support vector machine SVM classification performance will decrease significantly, the test sample classification ability is almost zero, all the samples were convicted of a class. If *σ* value is appropriate, the number of support vectors was decreased, and the classifier on the test samples of classified capabilities will be greatly enhanced.

## 3. PSOSVM Parameter Optimization

### 3.1. PSO Algorithm

In the PSO algorithm, each member of the group was called the particles, each particle flight in a multi-dimensional search space, and constantly according to the particle's own experience, particle neighbor experience or whole groups experience and update their location and speed, in order to find the optimal solution of the problem. The corresponding iterative formula is:

$$v_i^l = w \times v_i + c_1 \times rand_1^l \times \left( pBest - p_i^l \right) + c_2 \times rand_2^l \times \left( gBest - p_i^l \right), \quad (1)$$

$$p_i^l = p_i^d + v_i^l \quad (2)$$

Among them, *w* is the relatively large inertia weight. A relatively large *w*, it has global search ability, relatively small *w* will lead to a rapid convergence. $C_1$ and $C_2$ are the0 learning factors $rand_1^l$, and $rand_2^l$ are the random number, which is in [0, 1]; *p* is the current position of the particles, said the parameters of support vector machine, *c* and $\sigma$ current value. $v \in [v_{\max}, v_{\min}]$ is the particle velocity. Decide the next generation *c* and $\sigma$ updates the direction and size. In order to improve the convergence speed of the algorithm, using contraction factor $\chi$ rate of evolution equations (type (3)):

$$v_i^l = \chi \left\{ w \times v_i + c_1 \times rd_1^l \times \left( pBest - p_i^l \right) + c_2 \times rd_2^l \times \left( gBest - p_i^l \right) \right\}, \quad (3)$$

### 3.2. Pattern Search Algorithm

The Pattern search algorithm was called as the Hooke-Jeeves method, the algorithm has two main mobile process: one is the detection of moving, another is a mode of mobile. The detection of moving along the axis direction; mode mobile is along the adjacent two detection points on the move. Two processes can also be understood as: one is to determine the beneficial search direction; the two is to accelerate the process, is also in the beneficial direction to accelerate the search.

PSO algorithm is a pattern search algorithm has a wide range of global search ability; search from the group sets out, with implicit parallelism; search using the evaluation function value inspiration; fast convergence, parameter adjustment is simple; scalable, easily combined with other algorithms etc [9]. But in the late algorithm, local search ability, feedback information utilization.

Pattern search has the advantages of the pattern search method objective function need not be differentiable, is a direct method, and the iterative is relatively simple, especially the strong local search ability. Pattern search method is better than that of PSO algorithm has the learning precision, but the existence of more iterative times, large amount of calculation, easy to make the object function to fall into local minimum point and global search capacity.

Author combined two algorithms, put forward a kind of efficient and accurate parameter method - PSO pattern search algorithm.

### 3.3. PSO Pattern Search Algorithm

From the overall point of view, PSO algorithm is a feasible and robustness optimization algorithm [9]. From the local convergence angle consideration, pattern search algorithm is locally convergent and sensitive to initial values, so the PSO algorithm using pattern search can make PSO from falling into local minimum point defects, and improving the convergence speed and the precision. PSO pattern search algorithm is the core idea: first the PSO algorithm is global search, find a better parameter, by using pattern search in the better parameters near the local search, if the search results did not meet the precision requirement, then perform global search, until you find the optimal parameters.

PSO pattern search algorithm steps are as follows: the first step, the initialization population size, the particle velocity $V_i$ and position $P_i$; the second step, To calculate the particle fitness function, the classification error ( formula 4) is as the particles of the fitness evaluation function. Classification error formula:

$$1-\frac{1}{n}\sum_{i=1}^{n}\left|\frac{T_i}{T_i+F_i}\right|, \tag{4}$$

where $T_i$ is the correct classification of samples; $F_i$ is the wrong number of samples.

The third step, recording minimum fitness function value according to the formula (1) and the formula (3) update the positions and velocities of all particles; the fourth step, the three steps in the decree $P_g = P_g^k \in (c,\sigma)$ as the initial value of pattern search, and given the unit vector $e^j\,(j=1,\cdots,n)$. The initial step length $\sigma^0 = \left(\sigma_1^0,\sigma_2^0,\cdots,\sigma_n^0\right)^T > 0$, acceleration coefficient $\gamma > 0$, coefficient of contraction $\theta \in (0,1)$ and precision $\varepsilon > 0$, Set $k=0$, $y = P_g^{\,k}$, $j=1$;The fifth step, from y set out., in order to parallel to the unit vector $e^j\,(j=1,\cdots,n)$ axial detection mobile:

(1) if $f(y+\sigma_j^k e^j) < f(y)$, order $y = y+\sigma_j^k e^j$, Otherwise turn to (2);

(2) if $f(y-\sigma_j^k e^j) \geq f(y)$, order $y = y - \sigma_j^k e^j$, Otherwise order $y = y$.

The sixth step, order $P_g^{k+1} = y$,if $f(P_g^{k+1}) < f(P_g^k)$, Deal with $P_g^{k+1}$ along the direction of the acceleration $p^k = P_g^{k+1} - P_g^k$ model of mobile, order $y = P_g^{k+1} + \gamma p^k$, $\sigma^{k+1} = \sigma^k$, $k = k+1$, turn the fifth step, or the seventh step; the seventh step, if $|\sigma^k| \leq \varepsilon$, then stop the iteration, and then output results. Otherwise $P_g^{k+1} \neq P_g^k$,order $y = P_g^{k+1}$, $\sigma^{k+1} = \sigma^k$, $k = k+1$, turn to fifth step; when $P_g^{k+1} = P_g^k$, Make $y = P_g^{k+1}$, $\sigma^{k+1} = \theta\sigma^k$, $k = k+1$,turn fifth step; If the maximum number of iterations $|\sigma^k| > \varepsilon$, turn to the second step.

## 4. Optimized SVM Algorithm is Application in Agricultural Science and Technology

We take the city of Chong-Qing agricultural science and technology project data as a set of experimental data, including the comprehensive income and non profit project. Because the datasets and classification nothing or little relation to the property, it must be removed, while retaining close attributes associated with categories. Attribute selection process not only reveals the differences caused by the classification of the important factors, but also reduces the dimension of the input data, reduced to solve the problem of the scale, improve the accurate rate. Using principal component analysis after dimension reduction of attributes are: project progress, project funds in place, the use of project funds, technology innovation, promotion, intellectual property rights, the economic benefits of project.

Author chooses Guess kernel function $K\left(x, x^{'}\right) = \exp\left(-\left\|x - x^{'}\right\|^2 / \sigma^2\right)$ as the kernel function support vector classifier, kernel function $\sigma$ is width coefficient. Initialization setting corresponding parameter range is: $\sigma \in [0, 2]$, $c \in [1, 1000]$.

In the experiment, using PSO algorithm, pattern search algorithm and PSO pattern search algorithm for optimizing parameters and establish classification model to classify detection. Three algorithms of the learning time and accuracy were shown in Table 1 and 2.

**Table 1.** Study time of three algorithms (min).

| PSO | Pattern search algorithm | PSO pattern search algorithm |
|---|---|---|
| 24.55 | 24.14 | 19.68 |

**Table 2.** The detection accuracy rate of three kinds of algorithm (%).

| PSO | Pattern search algorithm | PSO pattern search algorithm |
|---|---|---|
| 94.22 | 95.88 | 99.01 |

From Table 1 and Table 2 shows, the PSO algorithm training time has less training time than the pattern search algorithm, but the PSO algorithm learning accuracy without pattern search algorithms. While PSO pattern search algorithm on the training time and the accuracy is better than PSO algorithm and pattern search algorithm, it reason is in the parameter optimization process, the PSO algorithm at each iteration is all particle position and velocity of the update, the algorithm increases, the search speed rein

in, especially when the particle size is relatively large, its search speed will be slower. While the pattern search algorithm has the strong local search ability and convergence speed. PSO pattern search algorithm takes into account the groups history best position, enhancing the local search ability of the algorithm, in each iteration of the process, use a pattern search algorithm to optimize and upgrade, the better $P_g$ Lead the population to better search, improve search efficiency, thus to ensure that the PSO algorithm rapid convergence under the premise of not affecting $P_g$ strong global search ability. In short, PSO pattern search algorithm PSO algorithm and pattern search algorithm combines the advantages, avoid the disadvantages, so PSO pattern search algorithm is a high performance.

The use of PSO pattern search algorithm is to find optimal parameters, the optimal parameters are taken around in other parameters are accurate, under the combination of different parameters correspond to the accuracy are shown in Fig. 1, in which the coordinates of the value.

As can be seen from the graph, the optimal parameter combination near parameter combinations while also reached higher classification accuracy rate, but did not mean make use of PSO pattern search to find the optimal parameters can achieve high classification accuracy rate. On one hand, parameters of the classifier performance influence; the other hand, using the PSO pattern search algorithm on the optimal parameters is an effective method.

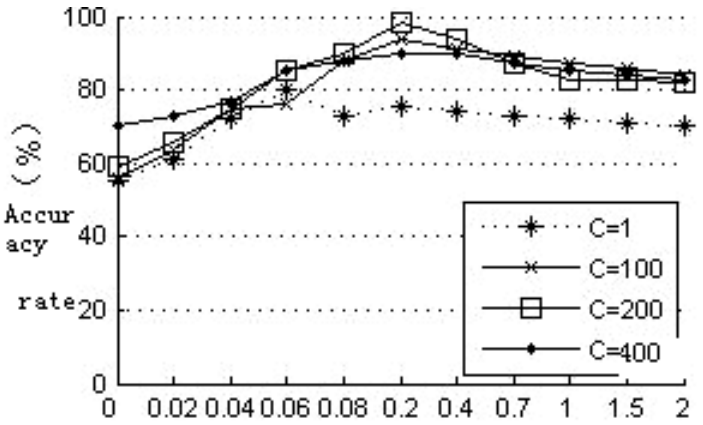


**Fig. 1.** $c$ and $\sigma$ Under different combinations of accurate rate curve.

## 5. Conclusion

PSO pattern search algorithm is combined the advantages the PSO algorithm and pattern search algorithm, Our algorithm has high global and local search ability, to overcome the PSO algorithm as poor local search ability and pattern search algorithm is easy to fall into local optimal, making PSO pattern search algorithm more perfect. The PSO pattern search algorithm is applied to the parameter optimization of support vector machine in Chongqing Province agricultural science and technology data modeling and classification, not only to avoid relying on the experience of selecting the parameters, but also shorten the training time of SVM, but also improve the accuracy rate. So PSO pattern search algorithm is an efficient, accurate parameter optimization method.

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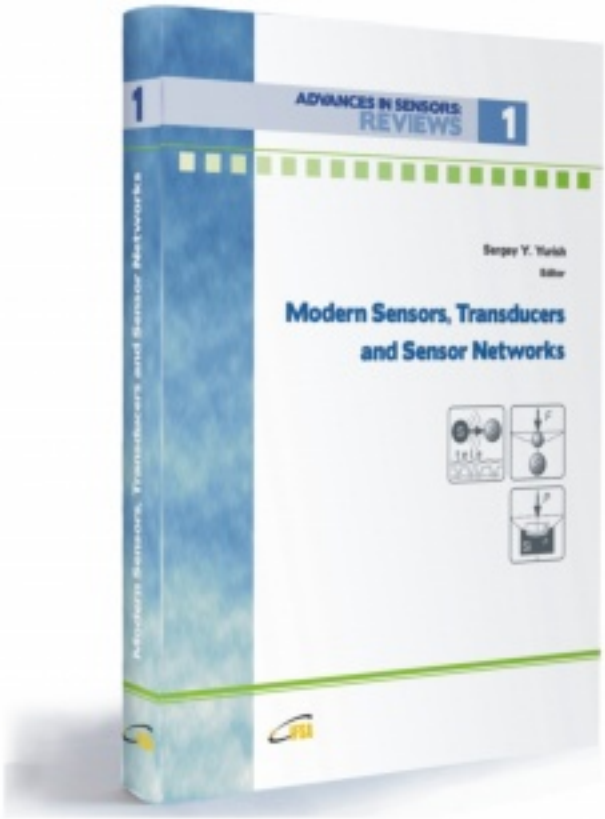


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