SVM Parameter Optimization based on Immune Memory Clone Strategy and Application in Bus Passenger Flow Counting

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ABSTRACT
The performance of support vector machine (SVM) depends on the selection of model parameters, however, the selection of SVM model parameters more depends on the empirical value. According to the above deficiency, this paper proposed a parameters optimization method of support vector machine based on immune memory clone strategy (IMC). This method can solve the multi-peak model parameters selection problem better which is introduced by n-folded cross-verification. Tests on standard datasets show that this method has higher precision and faster optimization speed compared with other four methods. Then the proposed method was applied to bus passenger flow counting. The experimental results show that the method reposed in this paper obtains higher classification accuracy.

Keywords: Bus Passenger Counting, Immune Memory Clone (IMC), Parameters Selection, Statistic Learning Theory (SLT), Support Vector Machine (SVM)

INTRODUCTION
The Support Vector Machine (SVM) is a new machine learning method that based on the Statistic Learning Theory (SLT) (Zhou, Yang, 2006; Bo, Yuchun, Yang-Qing, Chung-Dar, & Weber, 2005). The selection quality of SVM parameters and kernel functions has an effect on the learning and generation performance. In order to find the best parameters for SVM, many researchers have done a mass of study. The parameters in SVM are usually selected by man’s experience, such as n-folded cross-verification (Nello & John, 2006). Recently, there are some automatic parameter selection methods researched such as colony algorithm and genetic algorithm (Chunxiu, Huiren, & Chunxia, 2010; Xiangying, Huiyan, & Feng-
These methods are efficient and automatic for optimizing parameters in a certain degree. But they depend on optimization model construction, and convergence to local optimum sometimes. According to these problems, a parameters optimization method of SVM based on immune memory clone strategy (IMC) is proposed in this paper. The results of experiment show that the proposed method has more efficiency of optimization and higher accuracy rate of classification than other existent methods.

Parameters Optimization Algorithm of SVM Based on Immune Memory Clone Strategy

- **Support Vector Machine**: SVM is based on the principle of structural risk minimization. The ideal of SVM is to search for an optimal hyperplane to separate the data with maximal margin. When the training set is nonlinear, the training vector \( x \) is mapped into a higher dimensional feature space by a nonlinear function \( \phi(x) \), and in the feature space who’s dimension maybe infinite construct the optimal classification hyperplane and the classifier’s decision function. In order to construct the optimal hyperplane, the following optimization problem must be solved:

\[
\min_{w, b, \xi} \frac{1}{2} ||w||^2 + C \sum_{i=1}^{l} \xi_i \\
\text{s.t. } \quad y_i ((\phi(x_i) + w) + b) \geq 1 - \xi_i, \quad \xi_i \geq 0, i = 1, \cdots, l
\]

(1)

where \( * \) is inner product, \( w \) are coefficient vector; \( \xi_i \geq 0 \) are slack variables and \( C \) is a penalty parameter to be chosen by user. Finally, the decision function as follow:

\[
f(x) = \text{sgn} \left( \sum_{i=1}^{n} \alpha_i^* y_i K(x_i, x) + b^* \right)
\]

(2)

where \( x_i \) are Support Vectors (SVs), Lagrange multipliers \( \alpha_i \) satisfy with \( 0 < \alpha_i^* < C \), \( n \) is number of SVs, \( b^* \) is bias value. Equation (2) shows that kernel function and penalty parameter affect the performance of SVM (Hanbing & Yubo, 2011).

- **The Immune Clonal Algorithm**: Clonal selection is an artificial immune algorithm that is applied to optimization problems. Affinity proportional reproduction and affinity maturation are two important features of the clonal selection. An antigen selects some cells to obtain their clone. The selection rate of each cell is directly proportional to its affinity with selective antigen. If an antigen has a high affinity, its offspring number will be large. The mutation rate is inversely proportional to its affinity with an antigen. The immune clonal algorithm includes affinity operator, antibody concentration operator, clonal operator, mutation operator, clonal selection operator and so on.

- **Parameters Optimization Algorithm of Support Vector Machine Based on Immune Memory Clone Strategy (IMC-SVM)**: This paper introduces the memory mechanism and adaptive mutation operator into immune clonal algorithm. The proposed algorithm can both improve searching optimization speed and ensure global searching ability, so it is much suitable for multi-peak value SVM parameters selection problem.

The key of the proposed algorithm for SVM parameters optimization based on artificial immune algorithm is presented as follows:

1. **Coding Schemes Design of Antibody**: The design of antibody gene encoding schemes is based on principle of coarse search first then finer search. In this proposed algorithm, the binary coding is adopted. For example, the parameters of SVM with RBF kernel include penalty C and
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