Computer Simulation Evaluation of Financial Risk Based on Cuckoo Search and SVM Algorithm

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Abstract. With the rapid development of science and technology, there are more and more large-scale transnational enterprises, which also cause many financial risks. The financial risk level of listed companies will directly affect the sound development of the financial market, which requires listed companies to do a good job in financial risk assessment. However, most of the current financial risks rely on financial statements and other forms, which will be difficult to form a good early warning mechanism. Through the cuckoo search algorithm and SVM algorithm, we can form a new intelligent evolutionary algorithm, which can carry out multi group search and adaptive step size. Through the improved method, we can optimize the parameters of SVM model, which will be applied to the company financial risk assessment. Through the improved cuckoo search algorithm, we can improve the accuracy of financial data classification and prediction, which will better improve the financial environment. First of all, this paper analyzes the algorithm based on cuckoo. Then, this paper analyzes the SVM algorithm. Finally, some suggestions are put forward.

Keywords: Cuckoo Search, SVM Algorithm, Financial Risk, Classification Evaluation

1. Introduction

Listed companies are the basic components of the financial market, which has a detailed financial risk early warning mechanism. However, most of the current financial risks rely on financial statements and other forms, which will be difficult to form a good early warning mechanism[1]. Therefore, we must predict the financial operation of the enterprise in advance, which will help managers to make investment decisions and avoid risks. Therefore, we must improve the accuracy of financial risk, which will improve the convergence[2]. Therefore, we need to propose a good idea through SVM model, which will better deal with non-linear classification. However, the accuracy of SVM model needs to improve its core algorithm, which mainly includes grid algorithm, performance evaluation method and evolutionary algorithm[3]. However, in order to further improve the accuracy, we need to improve the cuckoo search method, which can be a better heuristic intelligent algorithm. Cuckoo search algorithm has more characteristics, such as simple, efficient, random search path and so on, which has been applied to engineering optimization.
2. Adaptive cuckoo search algorithm

2.1. Basic cuckoo search algorithm
In nature, cuckoo is a kind of organism that searches for its nest by random or similar random way, which is applied to mathematical algorithm[4]. Through the cuckoo search algorithm, we can abstract the behavior of cuckoo searching the nest of its host, which requires three assumptions.

First, each cuckoo randomly selects its nest to lay eggs, and only one egg is laid at a time.
Secondly, there is an optimal nest location in the host nest of all cuckoos, which will be preserved to the next generation[5]. The flight mode of the cuckoo levy is shown in Figure 1.

![Figure 1. Levy flight mode of cuckoo](image)

Thirdly, the total number of bird nests selected by all cuckoos is fixed to N, and the probability of finding a foreign egg by the owner of each bird nest is fixed to $P_{e} \in [0,1]$.

On the basis of these three assumptions, the path updating formula for cuckoo to search the nest position is shown in Formula 1.

$$\begin{align}
    x^{t+1}_i &= x^t_i + \vartheta \bigoplus L(\lambda) \\
    i &= 1, 2, ..., n
\end{align}$$

Among them, $x^t_i$ is the location of the i-th bird's nest in the t generation. $\bigoplus$ is point-to-point multiplication. $\vartheta$ is the step control quantity. $L(\lambda)$ is the compliance with parameters.

When the nest position is updated, we will generate a random number $r \in [0,1]$. When $r < P_e$, the position of $x^{t+1}_i$ will change randomly, otherwise it will not change. Finally, the optimal nest position is reserved.

2.2. Adaptive step size cuckoo search algorithm
In the basic cuckoo search algorithm, the step length generated by random flight of Lévy will appear the phenomenon of different distance, which will appear as follows. The longer the step length, the lower the search precision and the easier to search the global optimum[6]. The shorter the step length, the higher the search accuracy, but it will seriously affect the search speed. Therefore, we need to automatically adjust the step size. According to the results of different search stages, we can constantly find a balance between the global search speed and search accuracy. Therefore, we introduce the adaptive step adjustment strategy formula related to the optimal nest position distance, as shown in formula 2.

$$\text{step}_i = \text{step}_{\text{max}} + (\text{step}_{\text{max}} - \text{step}_{\text{min}})d_i$$

Among them, $\text{step}_{\text{max}}$ is the maximum size, $\text{step}_{\text{min}}$ is the minimum step size, $d_i$ is the step size adjustment factor.

According to the adaptive step size optimization algorithm, we can get formula 3.
\[ d_i = \frac{|n_{est_i} - n_{est_{best}}|}{d_{max}} \]  \hspace{1cm} (3)

\( n_{est_i} \) is the i-th nest position, \( n_{est_{best}} \) is the best nest position.

### 2.3. Cuckoo search improvement strategy

In nature, cuckoos lay their eggs only within a certain range of their own location. The habitat morphology and migration mode of cuckoo are shown in Figure 2.

![Figure 2. Cuckoo search improvement strategy](image)

In fact, the spawning radius of each cuckoo is directly proportional to its spawning number and meets formula 4.

\[ C_i(R_i) = \phi \times \left( \frac{C_{eggs}}{\sum_{i} C_{eggs}} \right) \times (V_{max} - V_{min}) \]  \hspace{1cm} (4)

The specific description is as follows: assuming that the flight step length of cuckoo takes a random value from 0 to the search radius, then the step length \( L = a(C_i R_i) \), where \( a \in \text{rand}[0,1] \).

As we get closer to the optimal habitat, we can reduce the number of eggs laid by cuckoos. By reducing the search step, the search accuracy will be improved. Let the number of eggs laid by the ith cuckoo be a positive proportion function of the nest function value, as shown in formula 5.

\[ C_{eggs} = R(C_{eggs}(o)) \times K \times \left( \frac{f_{best}(H_{best}) - f(H_i)}{f_{best}(H_{best})} \right) \]  \hspace{1cm} (5)

Among them, \( f_{best}(H_{best}) \) is the best nest fitness function of all cuckoos.

### 3. Principle of SVM method

SVM algorithm is a new learning method based on statistics theory in 1995. Through SVM, we can predict classification, which is a method of mapping data \( X_i \) to high latitude feature space \( F \) through nonlinear mapping. The regression function is shown in formula 6.

\[ f(x) = (w, \phi(x)) + b \]  \hspace{1cm} (6)

\( \phi(x) \) is a nonlinear mapping from \( R^n \) space to \( F \) space, \( w \) is the weight vector and \( b \) is the offset level.

The structural risk formula is shown in formula 7.
\[ R_{\text{reg}} = \lambda \|w\|^2 + R_{\text{emp}}[f] = \sum_{i=1}^{s} C(e_i) + \lambda \|w\|^2 \]  

(7)

Among them, \( \|w\|^2 \) is the confidence risk, which reflects the complexity of the model. The smaller the value is, the smaller the confidence risk is. \( R_{\text{emp}}[f] \) is the empirical risk, \( \lambda \) is the constant to balance the complexity of the function and the loss error, \( C(e_i) \) is the empirical loss of the model, \( e_i \) is the error value of the sample.

To facilitate the solution, we can transform it into a dual relationship, as shown in Figure 8.

\[
\begin{align*}
\max u = & -\frac{1}{2} \sum_{i,j=1}^{s} (\alpha_i - \alpha^*_i)(\alpha_j - \alpha^*_j)(\phi(x_i),\phi(x_j)) + \sum_{i=1}^{s} \alpha_i^* (Y_i + \epsilon) - \sum_{i=1}^{s} \alpha_i (Y_i + \epsilon) \\
\text{s.t.} & \sum_{i=1}^{s} \alpha_i^* = \sum_{i=1}^{s} \alpha_i \\
& 0 \leq \alpha_i \leq C \\
& 0 \leq \alpha_i^* \leq C
\end{align*}
\]

(8)

Finally, we can use the nonlinear function \( f(x) \), as shown in formula 8.

\[ f(x) = \sum_{i=1}^{s} (\alpha_i - \alpha_i^*)(\phi(x_i),\phi(x)) + b \]  

(9)

4. Conclusions

In recent years, SVM has strong nonlinear mapping ability, which has played an important role in situation assessment. With the successive application of the intelligent algorithm of cuckoo search, it has been applied to the financial risk simulation assessment. Through the combination of cuckoo search and SVM, we can improve the accuracy of financial risk prediction. Through this method, we can reduce the convergence of the prediction, which will improve the regression prediction of financial time series.

References

[1] Lu Lin, Luo Qi. A particle swarm optimization algorithm based on multi group stratification [J]. Engineering Science Edition, 2008, 40 (5): 171-176.
[2] Zheng Hongqing. An adaptive step size cuckoo search algorithm [J]. Computer engineering and application, 2018, (10): 68-71.
[3] Chen Le, long Wen. An improved cuckoo search algorithm for structural optimization problems [J]. Computer application research, 2014, 31 (3): 679-683.
[4] Huang Liangliang. Research on network security situation assessment and prediction methods [D]. Lanzhou: Lanzhou University, 2016: 36-41.
[5] Ouyang Zhe, Zhou Yongquan. Adaptive step size optimization algorithm for Fireflies [J]. Computer applications, 2011, 31 (7): 1804-1807.
[6] Yu Jinping. K-means clustering algorithm based on improved artificial bee colony algorithm [J]. Computer application, 2014, 34 (4):1065-1069.