

# Research on credit decision scheme of small and micro enterprises based on genetic algorithm

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**Abstract:** After the 21st century, China's small and micro enterprises have sprung up like mushrooms. Due to their small size, they often do not have fixed assets to mortgage loans, so they can only apply for credit loans with high risks for banks. Based on the risk assessment score of enterprises, this paper puts forward an objective function based on the expected return of credit business of commercial banks. Because the number of independent variables is too large, this paper proposes a solution method based on genetic algorithm, which converts a large number of data into binary in order and connects them head to tail to obtain gene sequence. When the population size is 10 and the number of iterations is 1000, the convergence effect is good. By decomposing the optimized solution and reversing code according to the rules, the optimal lending strategy for 123 enterprises is obtained. Considering that the total amount of capital is fixed, if the optimal lending strategy exceeds the total amount, it will be deleted from the enterprises whose adaptive function value is the smallest and the credit rating is d until the total amount requirement is met.

## 1. Introduction

As an important part of China's market economy, small and micro enterprises are the important foundation of the national economy and social development, and they have played an important role in increasing employment and improving people's livelihood. Small and micro enterprises are numerous and widely distributed. In recent years, China's small and micro enterprises are facing the biggest challenges and difficulties in the development process of their capital shortage and financing difficulties.

First of all, because of their small size, small and micro enterprises have low ability to resist risks. Service industries such as catering, retail, tourism and entertainment are vulnerable to major emergencies. Once it is hit hard, its offline business is suspended, which makes it unable to bear the fixed operating costs such as rent, manpower, raw materials and equipment. In addition, due to the inherent disadvantages of insufficient capital reserve, it is easy to lead to the situation of lack of funds, difficulty in turnover and broken cash flow. If a large number of small and micro enterprises appear this phenomenon, it will cause systemic risk of the whole industry to a great extent.

The main financing channel of small and micro enterprises still relies on financial intermediary, that is, bank loans. However, due to the lack of mortgage assets in small and medium-sized enterprises, banks need to establish corresponding credit strategies for enterprises in order to meet the capital needs of small and micro enterprises.

## 2. Problem analysis

Under the condition that the total amount of annual credit is fixed, the credit strategy of banks to enterprises should be in line with the principle of maximizing their own income on the basis of ensuring that high-quality customers will not be lost. Considering the simple interest method, the bank's income mainly comes from the loan interest of customers, and there will be a certain probability of customer default risk and user loss risk caused by the change of loan utilization. From this, we can construct the fitness function based on the optimal objective, that is, the bank's expected return for each enterprise. In this paper, the loan amount and annual interest rate are encoded and spliced, 123 enterprises are regarded as a population, and the evolutionary individuals

are decoded by genetic algorithm, and the optimal loan amount interest rate scheme for 123 enterprises is obtained. When the sum of the loan lines of 123 enterprises is less than or equal to the total amount of annual credit, each enterprise can obtain loans; when the sum of the loan lines of 123 enterprises exceeds the total amount of annual credit, firstly, select the customers with low adaptability from the customers with enterprise credit rating of D, and then eliminate the customers of C, B and A in turn until the total amount of loans meets the requirements. In addition, the credit rating of an enterprise is also reflected in the fitness function as a correction coefficient. When there is no evaluation of enterprise credit rating, it is necessary to delete the relevant correction factors of credit rating in the fitness function of bank income and re-establish the function.

### 3. Parameter selection

We divide the evaluation index into three categories and seven sub items, and evaluate the company's operation from three aspects: the company's capital situation, whether there is a stable supply and demand relationship, and whether the enterprise is honest in the transaction.

There are three small indicators under the financial indicators to roughly describe the assets of the company

1) Profit margin  $P$ : Profit margin refers to the proportion of total profit divided by total expenditure. Because these companies are in different industries and have different volume and cash flow characteristics, they can not directly compare the net profit. The profit margin is one of the important indexes to measure the operating condition of an enterprise.

2) Time ratio of rising profit: This is an indicator proposed by ourselves, which is equal to the proportion of the time when the first derivative of cash flow trend is positive in the total time. Since the starting time of business data of different enterprises is different, it is inconvenient to compare the annual data of three years. Therefore, we use this index to describe the development prospect of an enterprise.

3) Time ratio of cash flow early warning: This is also an indicator proposed by us, which is equal to the proportion of the time when an enterprise's cash flow is in negative value to the total duration. Negative cash flow means that a company is frequently in arrears and may also mean that a company has a large backlog of inventory. If the company is unable to collect the accounts receivable, clear the backlog of inventory or obtain bank loans in the short term, it is likely to face bankruptcy risk. By observing a company's negative cash flow, we can see whether the company has enough capital to repay the loan, so as to reduce the risk of the bank.

### 4. Establishment of model

The decision model is based on the expected return of credit provided by banks to 123 enterprises. It is a multivariate nonlinear function with a total of 246 independent variables of 123 groups of credit lines and interest rates, which is solved by genetic algorithm. First, the expected return of the bank is determined. For banks, when determining the amount and interest rate, the most direct problem is: high risk enterprises are likely to not pay back the money; raising interest rates will inevitably lead to the loss of customers. According to the above fitting results of the convective loss rate, a function expression  $f(I)$  with interest rate as variable is obtained. So we can get the basic expression of the expected return

$$\max \left\{ \sum E(r) = L * i - L * \theta - f(i) \right\} \#(1)$$

Considering the credit rating of enterprises and the degree of industry affected by emergencies, it is necessary to introduce the adjustment coefficient of risk score respectively  $\alpha, \gamma$ , So the expected return expression is modified to

$$\max \left\{ E(r) = \sum L * i - L * (\theta - \alpha - \gamma) - f(i) \right\} \#(2)$$

$$s. t. \begin{cases} 10 \leq L \leq 100 \\ 0.04 \leq i \leq 0.15 \end{cases} \#(3)$$

For multivariate nonlinear programming, we consider using genetic algorithm to solve it. Genetic algorithm is a search algorithm for solving optimization in computational mathematics. It is a kind of evolutionary algorithm. It draws lessons from the concepts of heredity, mutation and natural selection in evolutionary biology. In this paper, in order to improve the accuracy and facilitate transcoding, we first set the quota  $L$  And interest rate  $i$  Each enterprise has 22 bits of binary code. Take the first question as an example, the binary code of 123 enterprises is connected from the beginning to the end, and a 2707 bit individual gene is obtained. When the population size is set at 10, the optimized individuals are obtained after 1000 iterations, and then the optimal strategy of loan amount and interest rate for these 123 enterprises is obtained by decomposition and inverse decoding.

If the total amount of credit is not within the budget, then the bank will start to make loans according to the budget until the total amount is within the budget.

## 5. The solution of the model

In the case of risk score, the risk score is substituted into the expected return formula

$$\max \left\{ \sum E(r) = L * i - L * (\theta - \alpha - \gamma) - f(i) \right\} \#(4)$$

$$s. t. \begin{cases} 10 \leq L \leq 100 \\ 0.04 \leq i \leq 0.15 \end{cases} \#(5)$$

If there is no credit rating, the objective function becomes

$$\max \left\{ \sum E(r) = L * i - L * \theta - f(i) \right\} \#(6)$$

$$s. t. \begin{cases} 10 \leq L \leq 100 \\ 0.04 \leq i \leq 0.15 \end{cases} \#(7)$$

Considering the credit rating, an adjustment factor is set for each credit rating  $\alpha$

Table 1 Introduction of adjustment coefficient

Credit rating	A	B	C	D
Adjustment coefficient $\alpha$	0.06	0.04	0.02	0.00

Then initialize the population of genetic algorithm (see Appendix for code), and the population size is 10. First of all, 123 groups of quota interest rates that meet the scope requirements are randomly generated. In order to expand the accuracy, the quota is expanded by 100 times and the interest rate is increased by 1000 times (for example, the line of 351900 yuan is expanded to 3519, and the interest rate is 6.251% to 6251). By converting the expanded quota and interest rate into binary code and connecting the two ends, 10 genetic factors with 2707 bits were obtained.

Table 2 Genetic Algorithm

1	'0101110100010101000100...'
2	'1000111100101101000101...'
3	'0001000111101000101100...'
4	'0111010010100101000101...'
5	'0101010110110001010010...'
6	'0011100101000110000100...'
7	'0100011010001001100010...'
8	'1000001010010100111101...'
9	'0010110110111101100111...'

10	'0111000011100100111001...'
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Firstly, the adaptive function (expected return value) corresponding to the quota and interest rate represented by each individual in the population is obtained. Then, the adaptability is normalized and arranged from large to small. Two representatives are selected by roulette method. They have 60% probability of crossing, that is, two positions are randomly selected for cross operation to obtain new individuals. There is a 0.2% probability that a new individual will mutate at a random bit. After that, the new individuals replace the old ones and return to the population to participate in the next round of evolution.

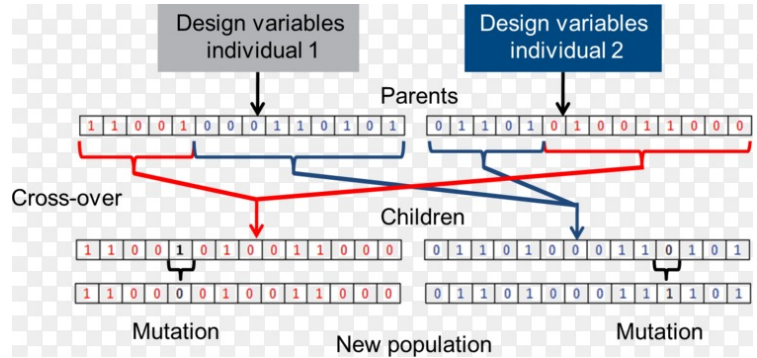


Figure1 Schematic diagram of genetic algorithm

After 1000 generations of iterations, the optimal combination of loan amount and interest rate for each enterprise is obtained as follows (the previous 10 enterprises are taken as examples)

Table 3 Part of enterprise results display

enterprise	quota	interest rate
E1	43.71628	0.089103
E2	59.76013	0.090695
E3	62.12972	0.093489
E4	74.26253	0.089725
E5	57.49783	0.093084
E6	59.98409	0.10428
E7	44.12264	0.097012
E8	62.52834	0.098822
E9	59.99464	0.118638
E10	64.71501	0.100364
...		

## 6. Summary

In this study, although genetic algorithm and other bionic optimization algorithms have the disadvantage that each operation has a small difference, it is impossible to find the "optimal" strategy. However, a nonlinear programming model based on genetic algorithm is given, and the result is relatively objective. The credit correction value is introduced into the nonlinear programming model, which not only ensures the integrity and coherence, but also reflects the influence of enterprise reputation evaluation on the model.

According to statistics, if we want to fully realize the optimal strategy, we need 70.7112 million yuan. If the bank does not have such a large budget, it can first remove the enterprises with credit rating of D, and then exclude the remaining enterprises from small to large according to the value of adaptability function until the requirements are met

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