Quantitative Modeling of Science and Technology Finance Supporting Industrial Innovation Development Based on Internet of Things Technology

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Objectives: In recent years, science and technology financial support industries are actively supporting the innovation and development of high-tech industries. In order to test the actual effect of S&T financial support industry support plan, a GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is designed by using K-means (K-means clustering) algorithm and GM (1,1) (grey prediction) algorithm, which can quantitatively display the development of S&T financial industry to promote high-tech. The GARCH model is used to quantify the degree of innovation and development of science and technology finance industry in the Internet of Things (IoT) technology. Finally, according to the quantitative data obtained by GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model, the actual effect of science and technology finance industry promoting innovation and development of high-tech is evaluated by FAHP (Fuzzy Analytic Hierarchy Process) model. The results show that science and technology finance industry plays a positive role in promoting the innovation and development of IoT technology.

Key words: iot technology; science and technology finance; quantification; modeling
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The power of science and technology has always been the energy for human society to advance, and also the most solid foundation for a country's economic development.[1] For a long time, western developed countries have always been in the leading position in science and technology, with strong scientific and technological strength, and attach great importance to it.[2] In addition, developed countries have more experience in how to use the power of science and technology to promote economic development, and the form is more diverse.[3] With the entry of the information age and the development of information technology, IoT technology emerges as the times require. The investment in research and development of IoT technology in developed countries has increased steadily, and the competition of IoT technology among countries is very fierce.[4] Although the research on IoT technology investment in China is relatively late, it has not lagged behind developed countries after years of development and it is in the world leading level.[5] As for how to use science and technology to promote social and economic development, developed countries have more rich experience and more perfect theoretical basis.[6] In the process of technological innovation and R&D, due to the need to invest a lot of manpower, material resources and financial resources, for many technology companies, especially small technology companies, relying on their own strength solely cannot maintain this huge upfront investment.[7,8] Therefore, it is necessary to rely on the financial system to enable enterprises to obtain sufficient financial support in order to start R&D work in depth.[9] Developed countries have better financial system, more perfect credit system, more abundant financial institutions and financial services, and more rational combination of technology and finance. However, due to the late start of financial system development in China and the imperfection of various systems, the development of science and technology finance is in a backward stage.[10,11] But with the emphasis of the state on science and technology finance, a variety of support policies and guidance have been issued. In recent years, science and technology finance has developed by leaps and bounds, and all localities have developed outstanding technological finance development models with their own characteristics.[12] Although compared with the past, there has been considerable progress, but after all, the time of development is relatively short, and the scientific and technological financial model of various regions is also unique, there are obvious limitations and a small coverage, which is not conducive to the overall industrial innovation and development of our country.[13] Therefore, based on the IoT technology, in-depth research will be conducted on quantitative modeling of technological and financial support for industrial innovation and development to provide the necessary theoretical basis for further development and improvement. To this end, a GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is designed by using K-means (K-means clustering) algorithm and GM (1,1) (Grey Prediction) algorithm, which can quantify the development of science and technology finance industry to promote high-tech development.[14,15] Using GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model to quantify the degree of innovation and development of science and technology finance industry in IoT technology. Finally, based on the quantitative data obtained above, the actual effect of science and technology finance industry on the innovation and development of high and new technology is evaluated by using FAHP model.[16,17]

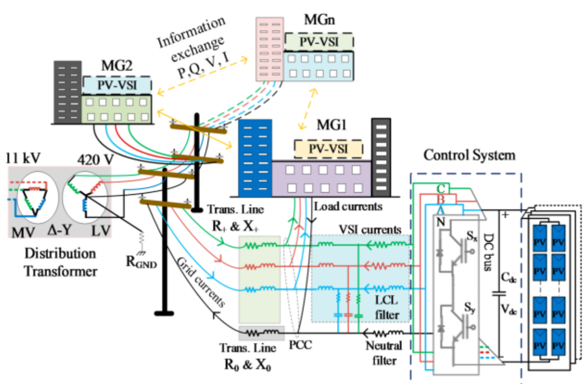
The following innovations are mainly involved: (1) the advantages of K-means (K-means clustering) algorithm and GM (1,1) (grey prediction) algorithm are fully utilized to improve the accuracy of GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model; (2) FAHP (Fuzzy Hierarchical Analysis) model is used to evaluate quantitative data, in order to get a more convincing conclusion.

The organizational structure is as follows: The research background and the organizational structure of the article are mainly elaborated in the first part, and the related research progress at home and abroad is reviewed in the second section. The third section mainly optimizes the algorithm model. In the fourth section, the GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is applied to quantify the data of innovation and development degree of science and technology finance industry in the IoT technology, and the effect of FAHP (Fuzzy Hierarchy Analysis) model is evaluated. The fifth section mainly summarizes the research results.

METHODS

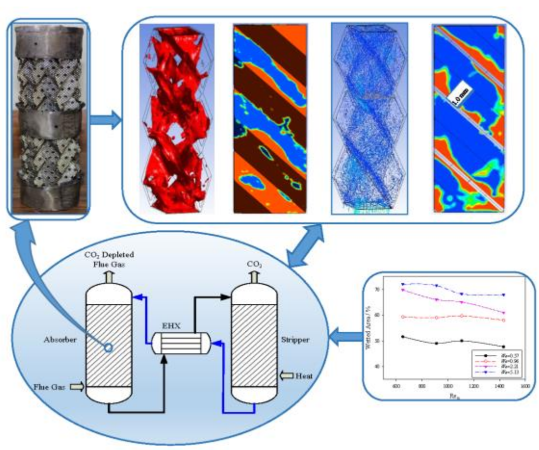
In recent years, with the deepening of research by scholars at home and abroad, it has been found that the technology finance industry can use various types of information to select the most promising science and technology projects at the lowest cost.[18] In this way, the efficiency of capital utilization can be improved and unnecessary waste can be avoided. At the same time, some scholars have suggested that the primary factor for the growth of the economy is the benefits of combining financial and technological innovations (Figure 1). Relevant financial institutions evaluate the R&D capabilities of enterprises and conducted research and analysis on projects, based on which funds are allocated for innovation activities and other necessary assistance.[19]

Figure 1
combination of finance and technological innovation



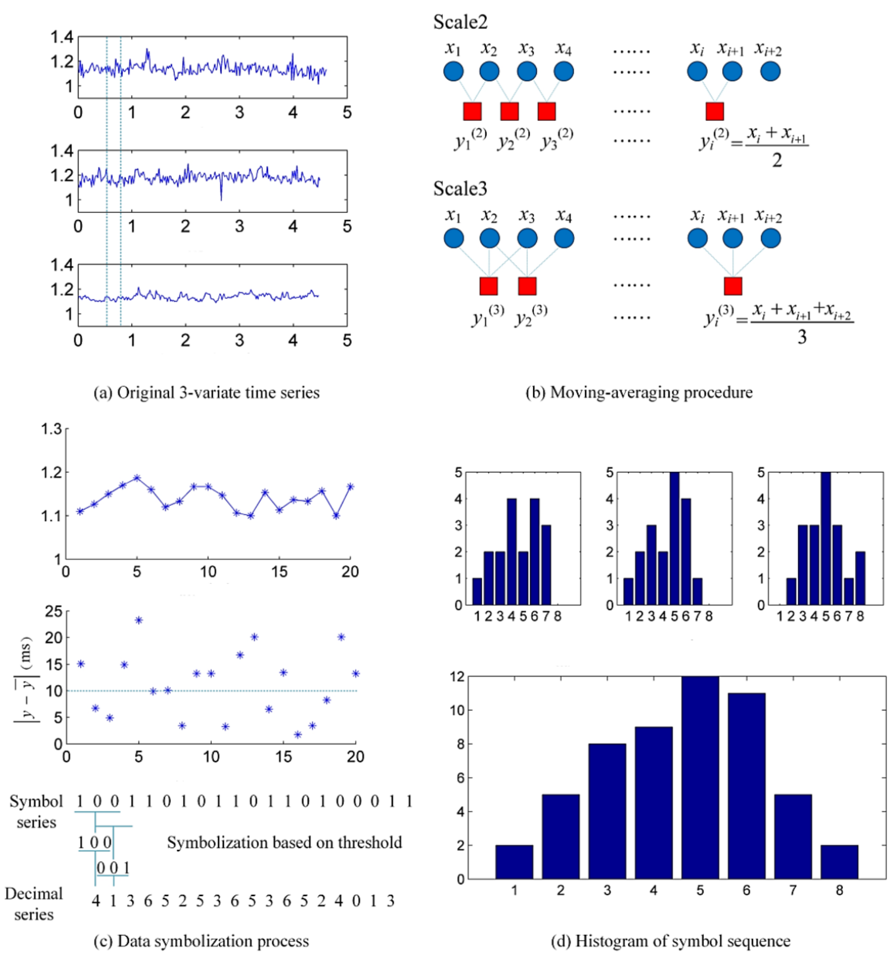
By the beginning of this century, researchers had studied the financial innovation in science and technology industry macroscopically, and had found that the two mutually interacted and developed together.[20] Subsequently, some scholars carried out an example certification for this viewpoint. Researchers have different opinions on what kind of financial system can maximize the promotion of industrial innovation. It is believed by some scholars that market risk decentralization mechanism can effectively control risks, so market-oriented financial system can maximize the promotion of industrial innovation and development. Some scholars investigated and analyzed the high-tech enterprises in Europe, and concluded that the market-led financial system has a better promotion effect than the bank-led financial system. However, regardless of the above views, it is confirmed that the financial industry of science and technology plays a positive role in promoting the innovation and development of high-tech. Therefore, taking the IoT technology as the research object, , a GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is designed by using K-means (K-means clustering) algorithm and GM (1,1) (grey prediction) algorithm, which can quantify the development of science and technology finance industry to promote high-tech. And the GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is used to quantify the degree of innovation and development of science and technology finance industry in IoT technology. K-means (K-means clustering) algorithm is a hard clustering algorithm based on unsupervised learning mode, which is often used to mine the implicit relationship between different objects. GM (1,1) (Grey Prediction) is an algorithm specially used for precise prediction of uncertain factors. The key of the algorithm is to study the rule association between known information and unknown information. GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model uses K-means (K-means clustering) algorithm and GM (1,1) (Grey Prediction) algorithm to improve ARCH (Econometric Regression) model to obtain an econometric model that can quantify the economic development (Figure 2). The specific implementation method is as follows:

Figure 2
algorithm is often used to mine the implicit internal relations between different objects



Firstly, the present situation of innovation and development of the IoT industry in China is studied and analyzed in depth, so as to provide factual basis for the conclusion that science and technology financial industry plays a positive role in promoting the innovation and development of high and new technology. Then taking 30 IoT companies which have obtained investment in science and technology finance industry and listed in A-share as the research object, the overall profitability of these 30 IoT enterprises is obtained by collecting the annual financial information published by listed companies. Then, GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is designed by using K-means (K-means clustering) algorithm and GM (1,1) (grey prediction) algorithm, and it is used to quantify the degree of high-tech development promoted by science and technology finance industry (Figure 3). Finally, based on the quantitative data, the practical effect of science and technology finance industry in promoting the innovation and development of high-tech is evaluated by using FAHP (Fuzzy Analytic Hierarchy Process) model.

Figure3
actual effect of promoting the innovation and development



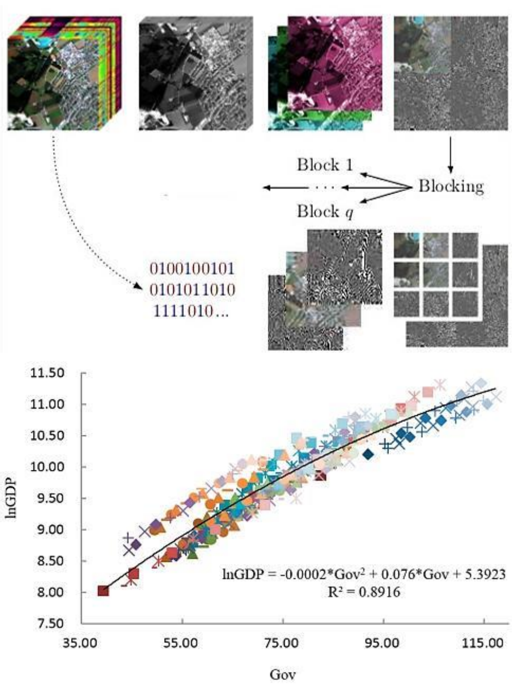
There are two main difficulties in the quantitative modeling of the practical role of science and technology financial support industry in the development of IoT technological innovation: (1) how to obtain valuable information from fragmented financial data; (2)

how to improve the accuracy of quantitative display of enterprise's capital allocation data and comprehensive technical efficiency data. To this end, a GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is designed by using K-means (K-means clustering) algorithm and GM (1,1) (grey prediction) algorithm, which can quantitatively display the development of high-tech promoted by science and technology finance industry.

K-means Algorithm

K-means (K-means clustering) algorithm is a hard clustering algorithm based on unsupervised learning mode. Firstly, the algorithm collects statistics of neighbor users who have the same preferences as target users. Then, according to the algorithm, the next choice made by neighbor users is analyzed and recommended to target users (Figure 4).

Figure 4
schematic diagram of the algorithm model

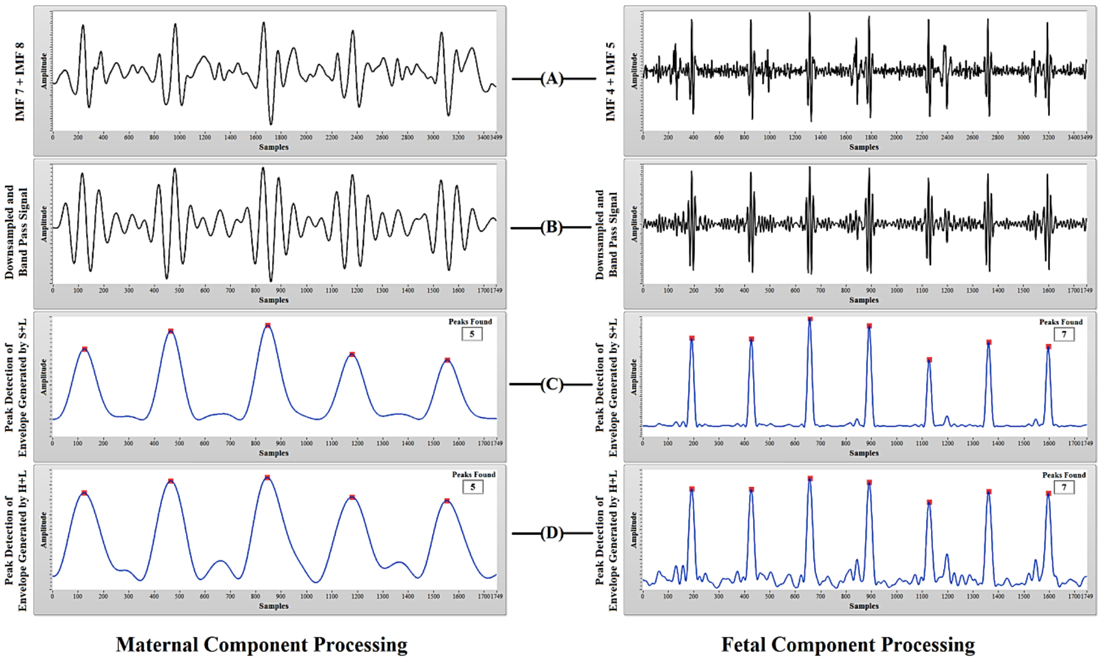


The input data of K-means (K-means clustering) algorithm is usually expressed as an $m \cdot n$ user-evaluation matrix R, m is the number of users, n is the number of items, and R_{ij} is the score value of i user for j item:

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots \\ r_{i1} & r_{i2} & r_{i3} & r_{i4} \\ \dots & \dots & \dots & \dots \\ r_{n1} & r_{n2} & \dots & r_{nm} \end{bmatrix} \quad (1)$$

K-means (K-means clustering) algorithm is developed by studying and analyzing two kinds of classification problems. It is developed by continuous research and analysis on two types of classification problems, and is transformed into mathematical expressions as: Let $E = F_1 * F_2 * K * F_n$ be the n-dimensional finite vector space, where F_j is the finite discrete symbol set. The element in E $e = \langle V_1, V_2, K, V_n \rangle$ is an instance, among them $V_j \in F_j, j = 1, 2, K, n$. Let P and N be two sets of instances of E and F, called positive and negative sets respectively (Figure 5).

Figure 5
positive and negative examples



The amount of information required to determine is expressed by the following formula:

$$E(E) = -\frac{P_i}{P_i + N_i}\log\frac{P_i}{P_i + N_i} - \frac{N_i}{P_i + N_i}\log\frac{N_i}{P_i + N_i} \quad (2)$$

If attribute A is used as the root of the decision tree, A has V values V_1, V_2 … V_v which divides E into V subsets. Suppose E_i contains P_i positive examples and N_i counterexamples. The information entropy of subset E_i is $E(E_i)$.

$$E(E_i) = \frac{P_i}{P_i + N_i}\log\frac{P_i}{P_i + N_i} + \frac{N_i}{P_i + N_i}\log\frac{N_i}{P_i + N_i} \quad (3)$$

The information entropy after the attribute A as the root is $E(A)$:

$$E(A) = \sum_{r=1}^{v}\frac{P_i + N_i}{P + N}E(E_i) \quad (4)$$

Therefore, the information gain $I(A)$ with the attribute as the root is:

$$I(A) = E(E) - E(A) \quad (5)$$

ID3 selects the attribute A that makes $I(A)$ maximum ($E(A)$ minimum) as the root node (Figure 6). Let the sample set S have a total of C samples, and the number of samples per class is $P_i = (i = 1, 2, 3, K, e)$. If the attribute A is the lowest level of the decision tree, with V values of V_1, V_2, …, V_v, it divides E into V subsets $[E_1, E_2, K, E_v]$. Assuming that the number of samples containing j in E_i is $P_{ij} = 1, 2, K, c$, then the information amount of subset E_i is $E(E_i)$:

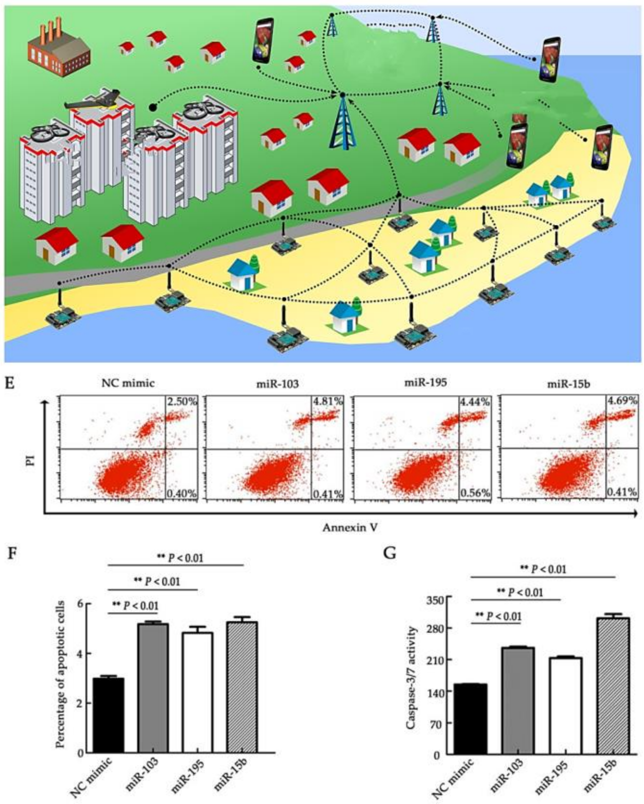
$$E(E_i) = -\sum_{j=1}^{c}\frac{P_{ij}}{|E_i|}\log\frac{P_{ij}}{E_i} \quad (6)$$

The information entropy classified by A is:

$$E(A) = \sum_{i=1}^{v}\frac{|E_i|}{E}E(E_i) \quad (7)$$

Selecting the attribute A minimizes $E(A)$ in Equation (7), and the information gain becomes more.

Figure 6
similarity is measured by the cosine Angle between vectors



In order to improve the calculation accuracy of K-means (K-means clustering) algorithm effectively in the practical application process, it is often necessary to filter the noise data of K-means (K-means clustering) algorithm. The calculation method is as follows:

$$\frac{\Delta x}{\Delta t}=\frac{x(k+1)-x(k)}{k+1-k}=x(k+1)-x(k)=a^{(1)}[x(k+1)] \quad (8)$$

It is noteworthy that the traditional K-means (K-means clustering) algorithm tends to have greater randomness when it chooses the initial clustering center. Therefore, if k centers of gravity are chosen to be close to each other, it is easy to fall into the local optimal results.

GM(1,1) Algorithm

GM (1, 1) (Grey Prediction) algorithm is a computer calculus algorithm which can effectively predict and correct un certain factors. In specific research, the data predicted by GM (1, 1) (Grey Prediction) algorithm are basically random and disorderly. Therefore, it is necessary to define gray prediction orderly in order to achieve the fundamental purpose of accurate prediction of unknown data. The steps of GM (1,1) model establishment are as follows:

Suppose there exists an original data sequence $X^{(0)}=\left\{X^{(0)}(1),X^{(0)}(2),X^{(0)}(3),\ldots X^{(0)}(n)\right\}$, in which there is always such a ratio relation $\lambda(t)=\dfrac{X^{(0)}(t-1)}{X^{(0)}(t)},t=2,3,\mathrm{L}\ \ ,n$. Moreover, the numbers in the data series are in the form of normal distribution within $(e^{\frac{-2}{n+1}},e^{\frac{2}{n+1}})$. As long as the data sequence satisfies the above situation, GM (1, 1) (Grey Prediction) algorithm can be directly used in the data sequence. Conversely, if the data sequence wants to use GM (1, 1) (Grey Prediction) algorithm, it needs to preprocess the values in the data sequence. The data sequence preprocessing process is as follows:

The gradient corresponds to the first derivative, and the gradient operator is the first derivative operator. For a continuous function $f(x,y)$, its gradient at position (x,y) can be expressed as:

$$\nabla f(x,y)=G(x,y)=\left[G_x\, G_y\right]^T=\left[\frac{\partial f}{\partial x}\,\frac{\partial f}{\partial y}\right]^T \quad (9)$$

A gradient is a vector whose amplitude and direction angle are:

$$|\nabla f|=|G(x,y)|=[G_x^2+G_y^2]^{\frac{1}{2}} \quad (10)$$

$$\phi(x,y)=\arctan(\frac{G_y}{G_x}) \quad (11)$$

The approximate expression of the gradient is:

$$G_x=f[i,j+1]-f[i,j] \quad (12)$$

$$G_y=f[i+1,j]-f[i,j] \quad (13)$$

Usually, in order to reduce the amount of calculation, the absolute value is usually approximated by the gradient magnitude.

$$|G(x,y)|=|G_x|+|G_y| \quad (14)$$

It is assumed that the variable I_x and the variable I_y are used to represent the first-order partial derivative of the image I on two different aspects of the Cartesian coordinates x axis and the y axis. Then the function $w(x,y)$ can be used to represent a two-dimensional Gaussian smoothing function on Cartesian coordinates. The calculation process of this function is shown in the following two formulas:

$$M = \sum_{x,y} w(x,y) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} \quad (15)$$

$$R = \det M - k \cdot (traceM)^2, k = 0.04 \sim 0.2 \quad (16)$$

The specific number of R at each corner of the image can be obtained by solving formula (28). Then the image corner points can be obtained by matching the corners calculated by the normalization method. The matching equation is as follows:

$$NCC = \frac{\sum_i (I_1(x_i,y_i)-u_1)(I_2(x_i,y_i)-u_2)}{\sqrt{\sum_i (I_1(x_i,y_i)-u_1)^2 \sum_i (I_2(x_i,y_i)-u_2)^2}} \quad (17)$$

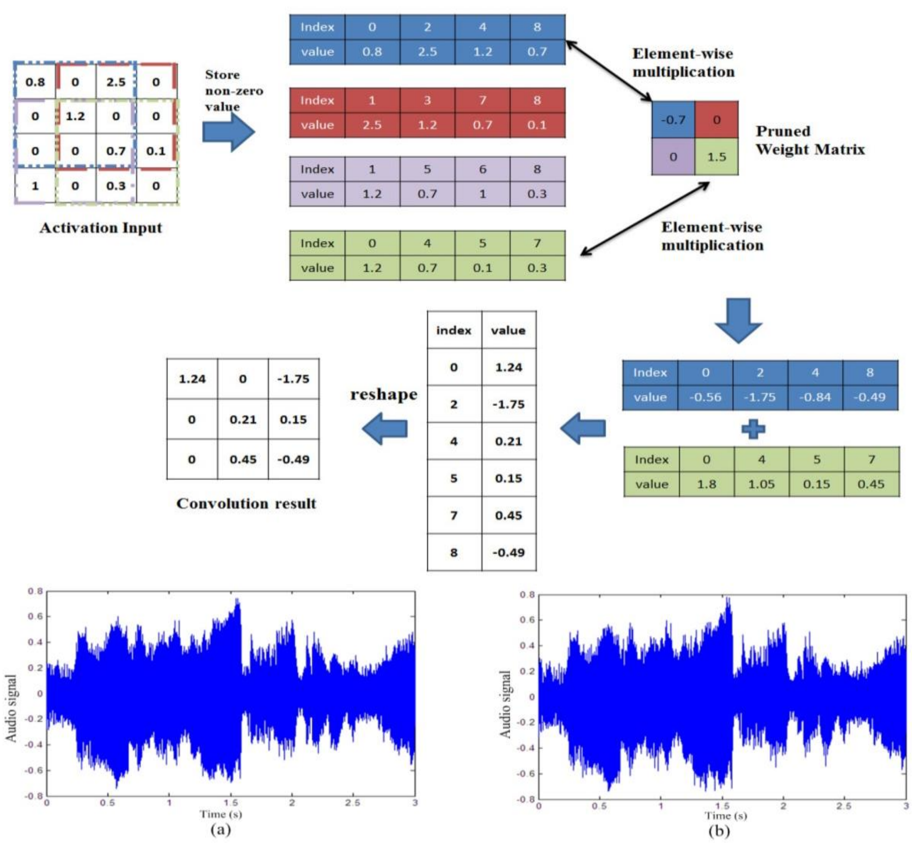
After data sequence preprocessing is completed, a new sequence can be obtained according to formula $X^{(1)}(k) = \sum_{n=1}^{k} X^{(0)}(n)$ as follows:

$$X^{(1)}(k) = \sum_{n=1}^{k} X^{(0)}(n) \quad (18)$$

The randomness of this newly formed sequence is much weaker than that of the original data, and the stationarity needs to be greatly increased (Figure 7). Its differential equation is as follows:

$$\frac{dX^{(1)}}{dt} + aX^{(1)} = u \quad (19)$$

Figure 7
evaluation function used in grey prediction algorithm



a is the grey number of development and u is the grey number of endogenous control.

Let $Y_n = [X^{(0)}(2), X^{(0)}(3), \ldots, X^{(0)}(n)]^T$, $\hat{\alpha}$ be the parameter vector $\hat{\alpha} = \begin{pmatrix} a \\ u \end{pmatrix}$ to be estimated.

$$B = \begin{bmatrix} -\frac{1}{2}(X^{(1)}(1) + X^{(1)}(2)) & 1 \\ -\frac{1}{2}(X^{(1)}(2) + X^{(1)}(3)) & 1 \\ \cdots & \cdots \\ -\frac{1}{2}(X^{(1)}(n-1) + X^{(1)}(n)) & 1 \end{bmatrix} \quad (20)$$

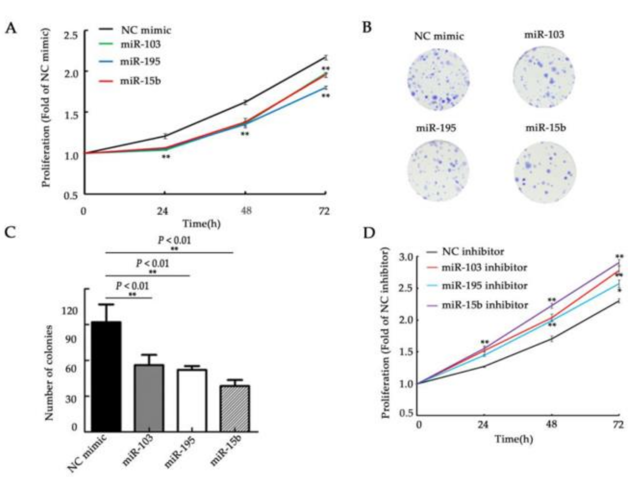
Then the model can be expressed as $Y_n = B\hat{\alpha}$, and $\hat{\alpha} = \left(B^T B\right)^{-1} B^T Y_n$ can be obtained by least square method. By solving the differential equation, the discrete time response function of grey prediction can be obtained (Figure 8):

$$\hat{X}^{(1)}(t+1) = \left[X^{(0)}(1) - \frac{u}{a}\right]e^{-at} + \frac{u}{a}, t = 0,1,2\ldots,n-1 \quad (21)$$

$\hat{X}^{(1)}(t+1)$ is the cumulative predicted value, and the predicted value is restored as follows:

$$\hat{X}^{(0)}(t+1) = \hat{X}^{(1)}(t+1) - \hat{X}^{(1)}(t) \quad (22)$$

Figure 8
after preprocessing, the data is processed by a cumulative generation process



The original data sequence with variable $X^{(0)}$:

$$X^{(0)} = \{X^{(0)}(1), X^{(0)}(2), \mathrm{K}, X^{(0)}(n)\} \quad (23)$$

The first-order cumulative generation module $X^{(1)}$ is generated by the cumulative generation algorithm.

$$X^{(1)} = \{X^{(1)}(1), X^{(1)}(2), \mathrm{L}, X^{(1)}(n)\} \quad (24)$$

In this formula, $X^{(1)}(k) = X^{(1)}\sum_{i=1}^{k} X^{(0)}(i)$

Differential equation composed of first-order grey module $X^{(1)}$:

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b \quad (25)$$

According to the definition of derivative, there are:

$$\frac{dx}{dt} = \lim_{\Delta t \to 0} \frac{x(t+\Delta t) - x(t)}{\Delta t} \quad (26)$$

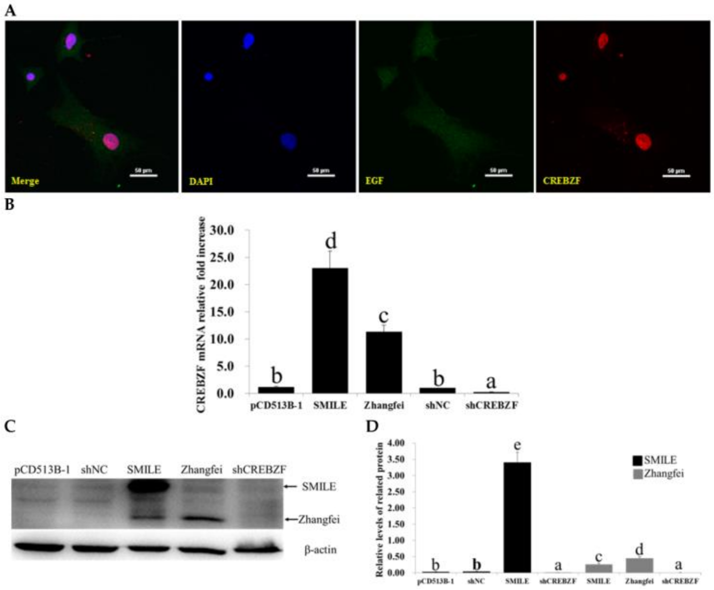
If expressed in discrete form, the differential term can be written as:

$$\frac{\Delta x}{\Delta t} = \frac{x(k+1) - x(k)}{k+1-k} = x(k+1) - x(k) = a^{(1)}[x(k+1)] \quad (27)$$

Among them, x value can only take the mean value of k and k+1 at the time (Figure 9), that is:

$$\frac{1}{2}[x(k+1) + x(k)] \quad (28)$$

Figure 9
The first order accumulation generation module is generated by the accumulation generation algorithm



Differential equations can be rewritten as follows:

$$a^{(1)}[x^{(1)}(k+1)]+\frac{1}{2}a[x^{(1)}(k+1)+x^{(1)}(k)]=b$$

$$k=1, x^{(0)}(2)+\frac{1}{2}a[x^{(1)}(1)+x^{(1)}(2)]=b$$

$$k=2, x^{(0)}(3)+\frac{1}{2}a[x^{(1)}(2)+x^{(1)}(3)]=b$$

$$\vdots$$

$$k=N-1, x^{(0)}(N)+\frac{1}{2}a[x^{(1)}(N-1)+x^{(1)}(N)]=b \quad (29)$$

Written in matrix form, there are:

$$\begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(N) \end{bmatrix} = \begin{bmatrix} -\frac{1}{2}[x^{(1)}(1)+x^{(1)}(2)] & 1 \\ -\frac{1}{2}[x^{(1)}(2)+x^{(1)}(3)] & 1 \\ \vdots & \vdots \\ -\frac{1}{2}[x^{(1)}(N-1)+x^{(1)}(N)] & 1 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix}$$

$$Y = XB \quad (30)$$

$$Y=\begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(N) \end{bmatrix} \quad B=\begin{bmatrix} a \\ b \end{bmatrix} \quad X=\begin{bmatrix} -\frac{1}{2}[x^{(1)}(1)+x^{(1)}(2)] & 1 \\ -\frac{1}{2}[x^{(1)}(2)+x^{(1)}(3)] & 1 \\ \vdots & \vdots \\ -\frac{1}{2}[x^{(1)}(N-1)+x^{(1)}(N)] & 1 \end{bmatrix}$$

Among the above equations, Y and X are known quantities and B are undetermined parameters. Because the variables are only a and b, while the number of equations is $N-1$, and $N-1>2$, the system of equations has no solution. But the least square solution can be obtained by the least square method.

By solving the above equation, there are:

$$x^{(1)}(t)=[x^{(1)}(0)-\frac{b}{a}]e^{-at}+\frac{b}{a}$$

$$x^{(1)}(k+1)=[x^{(0)}(0)-\frac{b}{a}]e^{-ak}+\frac{b}{a}$$

(31)

The prediction value $\hat{x}^{(1)}(k+1)$ obtained by the prediction model must be tested by statistics in order to determine the prediction accuracy level. The posterior difference ratio C is the ratio of residual variance S_e^2 to data variance S_x^2. Obviously, the smaller the residual variance is, the higher the accuracy of the predicted value is. However, the value of the residual variance is related to the size of the original data. In order to obtain a unified measurement standard, the ratio of the two is chosen, that is:

$$C=\frac{S_e}{S_x} \quad (32)$$

From this formula, it can be directly deduced that:

$$S_e{}^2=\frac{1}{N}\sum_{k=1}^{N}[e^{(0)}(k)-e]^2 \quad (33)$$

$$S_x{}^2=\frac{1}{N}\sum_{k=1}^{N}[x^{(0)}(k)-x^{(0)}]^2 \quad (34)$$

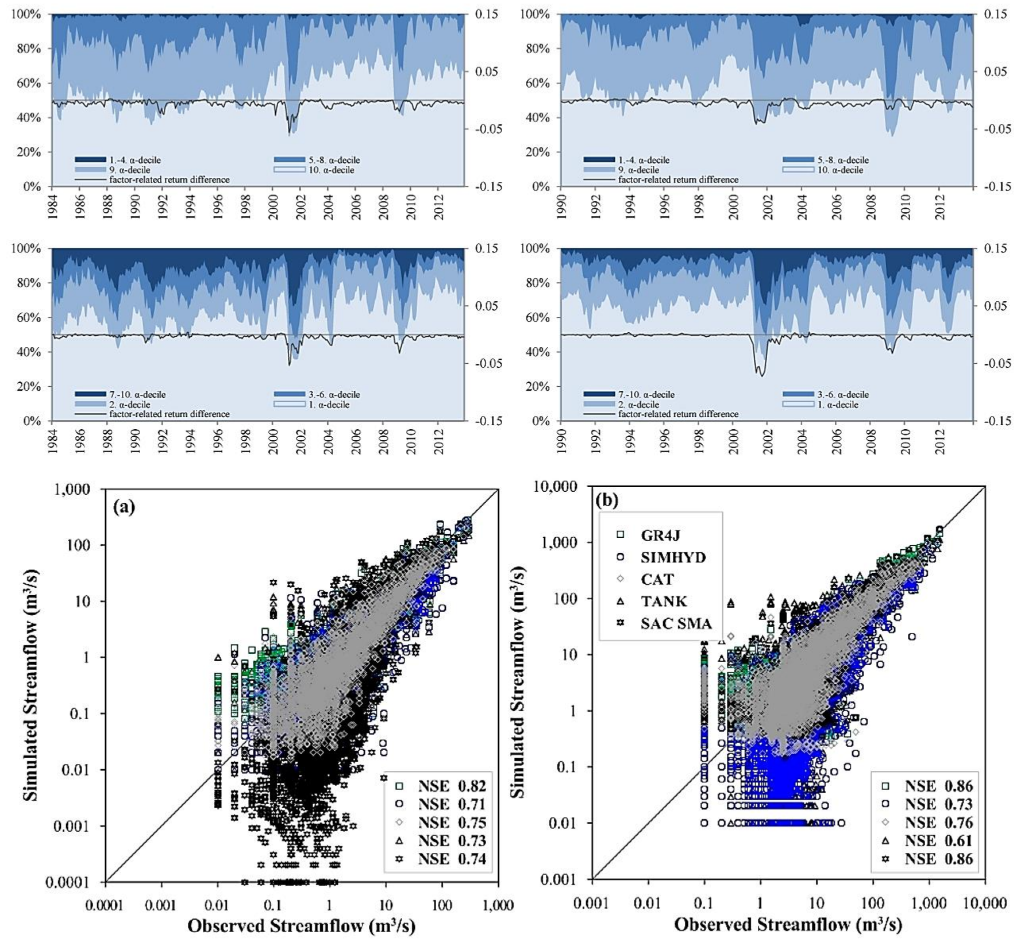
$$P=P\{\left|e^{(0)}(k)-e^{(0)}\right|<0.6745S_x\} \quad (35)$$

GARCH Model

GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is developed from ARCH (AutoRegressive conditional heteroskedasticity model) model, it is originally a special method used to establish time series with heteroscedasticity in ARCH model (Figure 10), which can be described by the following formula:

$$y_t=x_t'\beta+\varepsilon_t,\varepsilon_t=\sqrt{\mathrm{h_t}}\cdot v_t,\mathrm{h_t}=\alpha_0+\sum_{i=1}^{q}\alpha_i\varepsilon_{t-i}^2+\sum_{j=1}^{p}\theta_j h_{t-j} \quad (36)$$

Figure 10
A method in the model specifically used to establish time series with heteroscedasticity



$h_t = \mathrm{var}(\varepsilon_t|\varphi_{t-1}), \varphi_{t-1}$ is all the information of time $t-1$ and its previous information. This information is not only the conditional variance, but also an independent and identically distributed random variable, which is independent of each other and meets their own requirements.

$$E(v_t)=0, D(v_t)=1, E(v_t v_s)=0(t\neq s);$$
$$\alpha_0>0,\alpha_i\geq 0,\theta_j\geq 0,\sum_{i=1}^{q}\alpha_i+\sum_{j=1}^{p}\theta_j<1 \quad (37)$$

Assuming that there are different distributions, it is generally considered to be a standard normal distribution, but empirical studies have shown that the distribution of the yield of the coarse-tailed distribution, as well as the use of standardized distributions to adjust the deviation of the tail. The probability density of the standardized distribution t is:

$$f(x,d)=\frac{\Gamma\left(\left(d+\frac{1}{2}\right)\right)}{\left[(d-2)\pi\right]^{1/2}\Gamma(d/2)}\left(1+\frac{x^2}{d-2}\right)^{-(d+1)/2} \quad (38)$$

In order to simplify the operation process, a quadratic polynomial is first used to obtain a standardized distribution probability density.

$$p_2(x)=a_0+a_1x^1+a_2x^2 \quad (39)$$

The difference f is at points x_0, x_1 and x_2, ie using a local coordinate system, let $x_i=0, x_{i+1}=h$ and $x_{i+2}=2h$, then:

$$f(x_i)=a_0+a_1x_i+a_2x_i^2=a_0 \quad (40)$$
$$f(x_{i+1})=a_0+a_1x_{i+1}+a_2x_{i+1}^2=a_0+a_1h+a_2h^2 \quad (41)$$

$$f\left(x_{i+2}\right)=a_0+a_1x_{i+2}+a_2x_{i+2}^2=a_0+a_1\left(2h\right)+a_2\left(2h\right)^2 \quad (42)$$

These three equations with three unknowns can be turned into:

$$a_0=f\left(x_i\right)=f\left(0\right) \quad (43)$$

$$a_1=\frac{-f\left(x_{i+2}\right)+4f\left(x_{i+1}\right)-3f\left(x_i\right)}{2h}=\frac{-f\left(2h\right)+4f\left(h\right)-3f\left(0\right)}{2h} \quad (44)$$

$$a_2=\frac{f\left(x_{i+2}\right)-2f\left(x_{i+1}\right)+f\left(x_i\right)}{2h^2}=\frac{f\left(2h\right)-2f\left(h\right)+f\left(0\right)}{2h^2} \quad (45)$$

It can be obtained that $a_i, i=1,2,3$ and derive formula (46):

$$f'\left(x\right)=a_1+2a_2x, \quad (46)$$

Then the expression is calculated at $x_i=0$, and the result is:

$$f'\left(x\right)=\frac{-f\left(x_{i+2}\right)+4f\left(x_{i+1}\right)-3f\left(x_i\right)}{2h} \quad (47)$$

For point x, f is smooth enough, then the Taylor series expansion of f can be expressed as:

$$f\left(x+h\right)=f\left(x\right)+h\frac{d}{dx}f\left(x\right)+\frac{h^2}{2!}\frac{d^2}{dx^2}f\left(x\right)+\frac{h^3}{3!}\frac{d^3}{dx^3}+\ldots \quad (48)$$

The standard deviation quotient can be obtained by moving the function $f\left(x\right)$ on the right to the left and dividing it by h:

$$\frac{f\left(x+h\right)-f\left(x\right)}{h}=\frac{df\left(x\right)}{dx}+\left\{\frac{h}{2!}\frac{d^2f\left(x\right)}{dx^2}+\frac{h^2}{3!}\frac{d^3f\left(x\right)}{dx^3}+\ldots\right\} \quad (49)$$

Let $h\to 0$, the term in brackets disappear, as defined by the derivative:

$$f'\left(x\right)\approx\frac{f\left(x+h\right)-f\left(x\right)}{h} \quad (50)$$

In this case, the difference quotient $\left(f\left(x+h\right)-f\left(x\right)\right)/h$ is used instead of $f'\left(x\right)$.

$$\left|f'\left(x\right)-\frac{f\left(x+h\right)-f\left(x\right)}{h}\right|=\left|\frac{h}{2!}\frac{d^2f\left(x\right)}{dx^2}+\frac{h^2}{3!}\frac{d^3f\left(x\right)}{dx^3}+\ldots\right| \quad (51)$$

In formula (51), the limit values of arbitrarily smooth f and sufficiently small h are calculated.

$$DF_T \approx \frac{2}{r^2(\cos\varphi)^2}\overline{\frac{\partial}{\partial\lambda}A_mH\frac{\partial u}{\partial\lambda}}+\frac{\partial}{r^2\partial\varphi}\overline{A_mH(\frac{\partial u}{\partial\varphi}+\frac{\partial v}{r\cos\varphi\partial\lambda})} \quad (52)$$

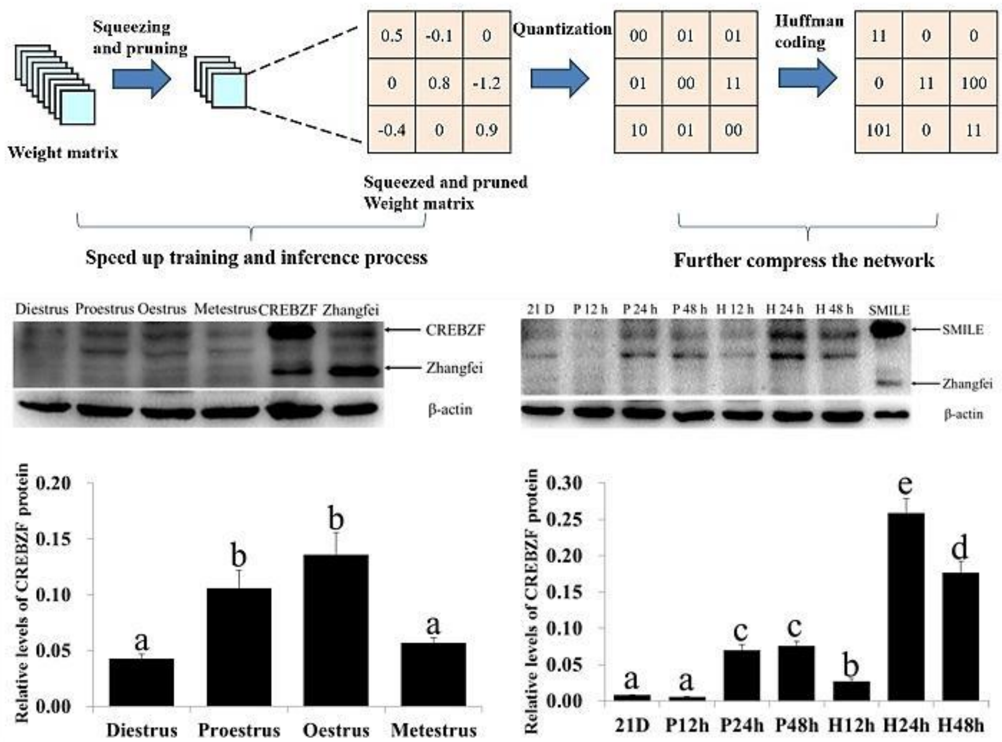
GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is suitable for cases where only a small amount of calculation is needed, which means that it can achieve higher utilization. GARCH model cannot completely deal with the negative correlation between asset return volatility. Therefore, an asymmetric model is introduced to improve it. The improved GARCH model can be expressed by the following equation:

$$h_t=\alpha_0+\sum_{i=1}^{q}\alpha_i\varepsilon_{t-i}^2+\varphi\varepsilon_{t-i}^2d_{t-1}+\sum_{j=1}^{p}\theta_jh_{t-j}, d_t=\begin{cases}1, \varepsilon_t>0\\0, \varepsilon_t\le 0\end{cases} \quad (53)$$

RESULTS

In order to test the practical application effect of GARCH model, 30 IoT (IOT) enterprises in China which have acquired investment in science and technology finance industry and listed in A-share are taken as the research object. The GARCH model is used to quantify the capital allocation values and comprehensive technical efficiency values of these 30 IOT enterprises, the actual effect of science and technology financial industry is evaluated by using FAHP (Fuzzy Analytic Hierarchy Process) model to promote the innovation and development of high-tech (Figure 11).

Figure 11
actual effect of the innovation and development of high and new technology is carried out



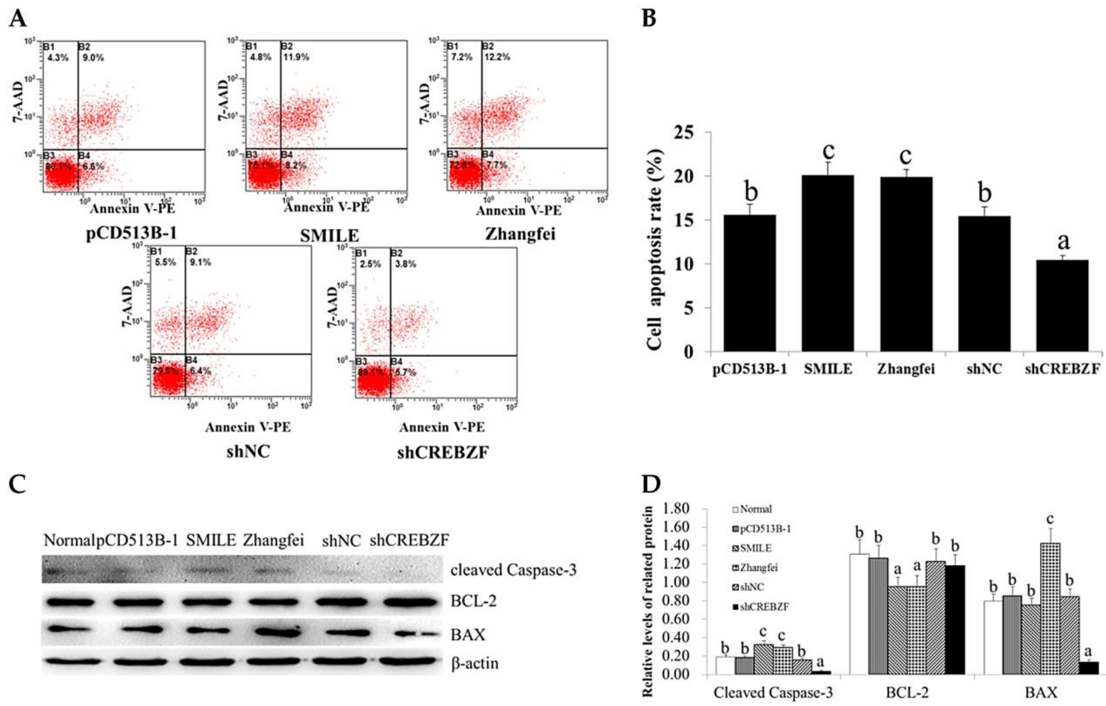
Experimental Subjects

The subjects of this experiment are mainly 30 IoT enterprises which have been invested in science and technology finance industry and listed in A shares from 2015 to 2017. The overall performance of these 30 enterprises is good, and they have received state-level investment in science and technology finance industry. In addition, these 30 companies have no other types of business besides the main business of the IoT.

Experimental Steps

First, Python technology is used to design the corresponding subject crawler to collect the capital allocation data and comprehensive technical efficiency data in the quarterly and annual financial statements of 30 listed IoT enterprises. In the process of collection, XML technology is needed to format the data to avoid unnecessary errors in the calculation process due to the irregular format of the data. These capital allocation data and comprehensive technical efficiency data are then represented in the form of matrix. Then, the GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is used to analyze and visualize these capital allocation values and the comprehensive technical efficiency numerical matrix. Finally, the FAHP (Fuzzy Analytic Hierarchy Process) model is used to evaluate the actual effect of the technological and financial industry to promote the innovation and development of high and new technology (Figure 12).

Figure 12
to evaluate the practical effect of language quality training for young people



Experimental Evaluation

FAHP (Fuzzy Analytical Hierarchy Process) model is a comprehensive evaluation model based on the theory of cognitive science and fuzzy mathematics. The specific forms are as follows:

$$\begin{pmatrix} a_{1,1} & a_{1,2} & K & a_{1,n} \\ a_{2,1} & a_{2,2} & K & a_{2,n} \\ . & . & . & . \\ a_{n,1} & a_{n,1} & & a_{n,n} \end{pmatrix} \quad (54)$$

In the formula, $a_{i,j}$ represents the relative weight of the indicator a_i relative to the indicator a_j.

The product of each row element of the judgment matrix R is calculated.

$$M_i = \prod_{j=1}^{n} B_{ij}, i = 1, 2, K, n \quad (55)$$

The n root of M_i is calculated,

$$\overline{w_i} = (M_i)^{\frac{1}{n}}, i = 1, 2, K, n \quad (56)$$

$\overline{w_i}$ is normalized, ie

$$w_i - \frac{\overline{w_i}}{\sum_{i=1}^{n} \overline{w_i}}, i = 1, 2, K, n \quad (57)$$

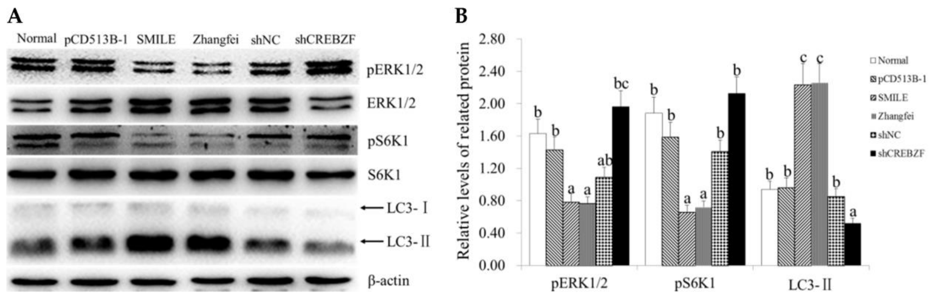
Then the weighting vector

$$w = [w_1, w_2, K, w_4]^T \quad (58)$$

The target criterion layer weight vector is obtained according to the above method be

$$W = (w_1, w_2, w_3, K, w_k) \quad (59)$$

Figure 13
relative weight of the criterion layer index in the criterion layer



w_i is the relative weight of the criterion layer indicator i in the criterion layer.

For the k criterion level indicators, the weights of the measures level indicators under each criterion are:

$$W_k = \left(w_{k1}, w_{k2}, w_{k3}, \mathrm{K}\ , w_{kp}\right) \quad (60)$$

In the hierarchical structure, the comprehensive weighting operator of the measure j under the criterion i is:

$$w_{i,j} = w_i \cdot w_j \quad (61)$$

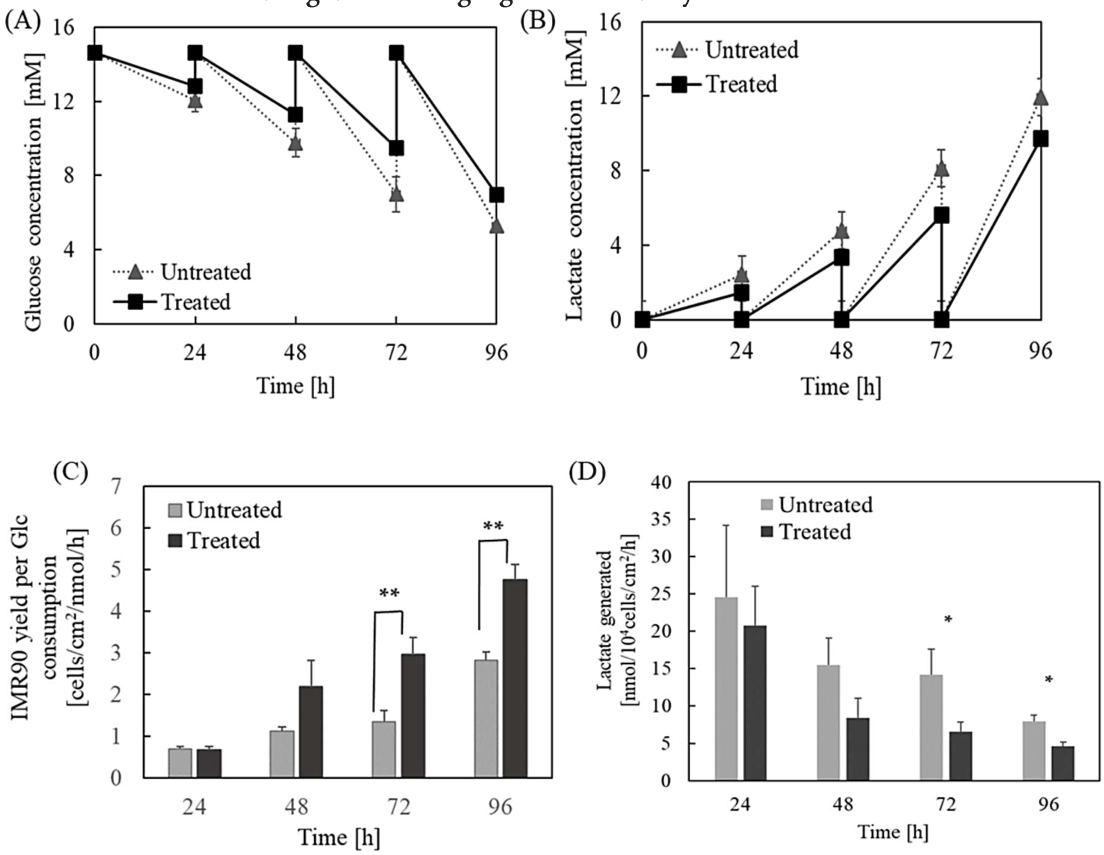
After obtaining the weight of the indicator, it is calculated by calculating the evaluation score. The calculation operator is:

$$Ea = \left(w_{p,1}, w_{p,2}, \mathrm{K}\ , w_{p,n}\right)\left(v_{p,1}, v_{p,2}, \mathrm{K}\ v_{p,n}\right)^T \quad (62)$$

$w_{p,i}$ is the comprehensive weight of the lowest level indicator, and $w_{p,i}$ is its evaluation score.

The evaluation results can be obtained by substituting the data recorded during the experiment into the above equation (Figure 14). The figures show that the science and technology financial industry has played a positive role in promoting the innovation and development of IoT technology.

Figure 14
using data mining algorithm and bayesian network



CONCLUSION

The quantitative modeling of the actual role played by the technology financial support industry is mainly studied in the process of innovation and development of the IoT technology. There are two major problems for it: (1) how to obtain valuable information from fragmented financial data; (2) how to improve the accuracy of quantitative display of the company's fund allocation data and comprehensive technical efficiency data. Therefore, after thorough research and analysis of the related research progress, a GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model is designed by using K-means (K-means clustering) algorithm and GM (1,1) (grey prediction) algorithm. K-means (K-means clustering) algorithm can effectively mine valuable information in fragmented financial data, while GM (1,1) (Grey Prediction) algorithm can effectively improve the accuracy of quantitative display of enterprise capital allocation data and comprehensive technical efficiency data. GARCH (Generalized AutoRegressive Conditional Heteroskedasticity) model, which combines the advantages of these two algorithms, solves two major problems in the process of quantitative modeling. After completing the design of the model, Python technology is use to design the corresponding theme crawler to collect the data of fund allocation and comprehensive technical efficiency in the disclosed quarterly annual reports and annual financial statements of 30 listed IoT enterprises in China. Then the GARCH model is used to quantify the degree of innovation and development of science and technology finance industry in the IoT technology, and the FAHP (Fuzzy Analytic Hierarchy Process) model is used to evaluate the actual effect of science and technology finance industry in promoting the innovation and development of high and new technology. It is shown by the results that science and technology finance industry has played a positive role in promoting the innovation and development of IoT technology.

Human Subjects Approval Statement

This paper did not include human subjects.

Conflict of Interest Disclosure Statement

All authors of this article declare they have no conficts of interest.

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