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*Research Article*

# Dynamic Decision Model of Real Estate Investment Portfolio Based on Wireless Network Communication and Ant Colony Algorithm

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From reform and opening to the comprehensive construction of a well-off society, the rapid growth of the national economy and the advancement of urbanization have promoted the rapid development of China's real estate industry. The real estate industry has become a pillar growth point in the development of the national economy. At the same time, China's real estate markets also continue to mature. However, due to the short development time of my country's real estate market, imperfect management mechanism, irregular organization, and other issues, coupled with the fierce competition and internationalization of the market investment environment, the risk of investment accumulation in the real estate industry is also increasing. Therefore, in real estate investment decision-making, it is of far-reaching significance to study how to control real estate investment risks and promote the healthy and stable development of the real estate industry. The purpose of this article is to build a set of investment portfolios based on the ant colony algorithm to diversify risks and obtain returns, so that the constructed investment portfolios will minimize the risk when the return reaches a certain amount of time. This article first gives a general introduction to wireless network communication and then analyzes the risk of real estate project investment. First, the variance is used as a measure of risk to establish a dynamic model of the real estate development project portfolio, and the ant colony algorithm is introduced to the investment risk of real estate development projects. In the dynamic analysis, an improved portfolio model was established, and the two were compared through case analysis. The experimental results show that under the condition of the same net present value and investment payback period, the ant colony algorithm based on variance is invested in lot H. The ratio is obviously higher, and the capital investment ratio of lot H based on the ant colony algorithm is obviously lower. The difference between the two is 30.1%.

## 1. Introduction

*1.1. Background.* With the development of the economy, the rapid development of the national economy and the process of urbanization have promoted the rapid development of China's real estate industry. At the same time, China's real estate market continues to mature. In order to improve competitiveness and reduce risks, most companies actively carry out investment portfolios, including property-type investment portfolios, investment regional portfolios, investment timing and investment cycle portfolios, investment subject portfolios, and business model portfolios. The ant colony algorithm is an intelligent optimization algorithm that simulates the foraging behavior of ants in the biological world. The artificial ant colony algorithm has successfully solved a series of problems in life, such as the secondary allocation problem and the investment portfolio problem, and achieved good optimization results.

*1.2. Significance.* In today's diversified and multiproject investment development in the real estate market, in the multiproject decision-making process of real estate investment, how investors can control real estate investment risks and take advantage of real estate investment opportunities to obtain the greatest investment benefits from investors, and society is also important for the development and growth of the real estate market. It has far-reaching significance. The ant colony algorithm has few restrictions on the problem to be solved, so its application range is very wide. In recent years, scholars have used intelligent optimization algorithms to solve investment portfolio problems, but the application and research of ant colony algorithm in this area are relatively few. Therefore, this article applies the improved ant colony algorithm to the research of solving the investment portfolio problem, which has certain theoretical significance and certain practical significance.

*1.3. Literature Review.* With the progress of society, more and more people have conducted research on wireless communication networks. Among them, Du et al. has studied the traditional analysis and design of a network control system (NCS) with state quantification in a single wired/wireless network environment. They studied the quantitative control of NCS triggered by distributed events in a mixed wired/wireless network environment. In order to reduce the communication burden of each channel, a distributed event trigger mechanism and multiple quantification schemes are first proposed [1]. However, in large-scale wireless networks such as wireless mesh networks, the capacity gain of full-duplex communication has not been fully studied. For this reason, Wang et al. have studied a network capacity measurement called transmission capacity for full-duplex wireless networks. It captures the maximum transmission throughput in a unit area, subject to a certain probability of interruption. The key challenge in deriving transmission capacity is to characterize the aggregate interference of a typical link in a full-duplex wireless network, which is completely different from that in a half-duplex wireless network [2]. As one of the most promising technologies in the 5G era, device-to-device (D2D) communication based on macro and small cellular networks can improve spectrum efficiency and increase system capacity. Tong models cross-layer and colayer D2D communication in a two-layer macrosmall cell network. In order to avoid the complex interference of cross-layer D2D, he proposed a mode selection scheme with a dedicated resource sharing strategy. For cotier D2D, we formulated a joint optimization problem of power control and resource reuse, with the goal of maximizing the overall power outage capacity [3]. On the basis of deterministic optimization model, a lot of research on evacuation optimization has been carried out, but the randomness or uncertainty of evacuation in the real world has not been fully considered. Inspired by the good performance of heuristic algorithms in solving combinatorial problems, Liu et al. proposed an improved quantum ant colony algorithm (QACA) to exhaustively optimize the evacuation path of people from dangerous areas to safe areas [4]. Today, path planning has become an important research field. Cao uses an improved ant colony algorithm to solve the path planning problem, and the convergence speed can be improved by improving the algorithm. After determining the initial parameters, the author uses the ant colony algorithm and its improved algorithm to plan an optimal path from beginning to end in a known environment [5]. In the related research carried out by Sousa et al., building fragility is expressed by strength: the specific distribution of damage exceeding probability of various damage states. The latter contribution has been demonstrated in the context of building portfolio loss estimation, which shows that the proposed concept of conditional vulnerability function provides a link between earthquake intensity and the uncertainty in the probability of damage exceeding [6]. For the above situation, Orlando and Parker focus on assessing the financial status of insurance companies issue variable annuity (VA) portfolios. Two multivariate models of underlying real estate and interest rates are considered. The first model uses a single total rate of return for a basket of assets. Second, the rate of return of $n$ is assets in the joint modeling basket. For simplicity, assume that an insurance company can implement a static hedging plan to manage risk [7]. Xu et al. proposed a large CVaR-based portfolio selection model with weight constraints. It includes the standard CVaR-based portfolio selection model as a special case, and it also uses the penalty quantile regression technique to solve the new model. The actual data obtained illustrates the effectiveness of the proposed model [8]. Pedersen et al. consider using distributed storage (DS) to reduce the communication cost of content delivery in wireless networks. Erasure codes are used to store (cache) content in many mobile devices. When the device storing the data left the unit, Pedersen et al. solved the repair problem and introduced a repair plan. Then the derived expression is used to evaluate the communication cost of DS using several erasure codes [9]. However, the shortcomings of these studies are that they have not properly dealt with the risk of investment portfolios and have not summarized the maximization of profits.

*1.4. Innovation.* The innovations of this article are (1) when making real estate investment decisions, what type of real estate to choose for investment and how to make portfolio investment, how to dynamically manage portfolio investment, and how to determine the appropriate investment ratio for different risk tolerance. (2) The ant colony algorithm is applied to the research of real estate investment portfolio. In other applications, the ant colony algorithm is often used as a method to solve the combination optimization problem, and this article is dedicated to digging into the internal ant colony algorithm features and advantages, find out the similarities between ant foraging and real estate investment behavior, apply the algorithm's own characteristics to simulate real estate investment behavior, and get a better real estate investment portfolio.

## 2. Portfolio Decision Method Based on Ant Colony Algorithm

*2.1. Ant Colony Algorithm.* Ant colony algorithm is a probabilistic algorithm used to find optimal paths. The basic idea of applying the ant colony algorithm to solving the optimization problem is: using the walking path of the ants to represent the feasible solution of the problem to be optimized, and all the paths of the entire ant colony constitute the solution space of the problem to be optimized. Ants with a shorter path release more pheromones. As time progresses, the accumulated pheromone concentration on the shorter path gradually increases, and the number of ants that choose this path increases. In the end, the entire ant will be concentrated on the best path under the action of positive feedback, and at this time, the corresponding is the optimal solution of the problem to be optimized.

*2.1.1. Form Description.*

$$\mathrm{GA} = (P(0), N, L, S, G, P, F, T). \tag{1}$$

In formula (1), $P(0)$ represents the initial population, $N$ represents the total number in the group, $L$ represents the length of the binary system, $S$ represents the selection strategy, $G$ represents the genetic operator, $P$ represents the operation probability of $G$, $F$ represents the adaptation degree function, and $T$ represents the termination rule.

*2.1.2. Performance Evaluation.* The online performance is represented by the average value from the first generation to the current generation. Suppose $X_E(S)$ is the linear performance of strategy $S$ under environment $E$, and $F_E(T)$ is the objective function or average fitness function corresponding to environment $E$ at the time $T$ or $T$ generation; then

$$X_E(S) = 1/T \sum_{L}^{T} F_E(T). \tag{2}$$

Online performance represents the average value of the performance value of the algorithm from the beginning to the current time period, reflecting the dynamic performance of the algorithm [10].

Offline performance is the cumulative average of the best performance. Let $X_E^*(S)$ be the linear performance of strategy $S$ under environment $E$; then

$$X_E(S) = 1/T \sum_{L}^{T} F_E^*(T). \tag{3}$$

Then

$$F_E^*(T) = \mathrm{BEST}\left(F_E^{(1)}, F_E^{(2)}, \cdots, F_E^{(T)}\right). \tag{4}$$

Offline performance represents the cumulative average of the best performance values of each evolutionary generation during the running of the algorithm, and it reflects the convergence performance of the algorithm.

*2.1.3. Algorithm Flow.* The optimization process of ant colony algorithm is actually controlled by three variables, namely state transition rules, pheromone local update rules, and pheromone global update rules [11, 12].

The algorithm process can be simply described, and each ant traverses all cities according to the state transition rules, looking for its own shortest path, until all ants find their own solutions [13]. After each iteration is completed, the pheromone on all paths is updated and the shortest path generated after this iteration is recorded, until the termination condition is met and the iteration ends. In this process, the state transition probability can be defined as follows:

$$P_{IJ}^{K}(T) = \mu_{IJ}^{a}(T) \upsilon_{IJ}^{b}(T) / \sum_{J=1}^{N} \mu_{IJ}^{a}(T) \upsilon_{IJ}^{b}. \tag{5}$$

Among them, $\upsilon_{IJ}$ represents the visibility between $I$ and $J$, $\mu_{IJ}$ represents the concentration between the two places, $a$ represents the importance of the pheromone concentration between the two places, and $b$ represents the importance of the upper visibility between the two places [14].

Using the memory list to record the list of cities that ant $K$ has walked through, the formula can be updated as follows:

$$\begin{aligned} \mu_{IJ}(T+1) &= w\mu_{IJ}(T) + \Delta\mu_{IJ}(T+1), \\ \Delta\mu_{IJ}(T+1) &= \sum_{K=1}^{M} \Delta\mu_{IJ}^{K}(T, T+1), \\ \Delta\mu_{IJ}^{K}(T, T+1) &= \begin{cases} Q/L_K, \text{exit} \\ 0. \end{cases} \end{aligned} \tag{6}$$

Among them, $\Delta\mu_{IJ}^{K}(T, T+1)$ represents the amount of pheromone left by the movement of the $K$th ant at time ( $T, T+1$) on the path $(I, J)$, $\Delta\mu_{IJ}(T, T+1)$ represents the amount of pheromones of all ants in this process, and $Q$ represents all paths. The sum of pheromone $L_K$ represents the total length of the path taken by the $K$th ant, and $w$ is the attenuation coefficient of the pheromone trajectory.

*2.2. Wireless Network Communication*

*2.2.1. Wireless Sensor Network.* The wireless sensor network is a self-organizing multihop network composed of a large number of cheap microsensor nodes developed in the monitoring area [15]. The sensor network has three functions of data collection, processing, and transmission. A variety of sensors on wireless sensor networks can detect various environmental phenomena, such as vibration, electromagnetic, temperature, humidity, noise, light intensity, pressure, soil composition, size, and speed and direction of moving objects [16, 17]. Possible application areas can be summarized as follows: military, aviation, disaster relief, environment, medical, healthcare, household, industry, and other sectors. The classic scenario of wireless sensor network applications is shown in Figure 1.

After the large-scale wireless sensor network nodes learn all kinds of information, they can interface with the backbone Ethernet through the gateway, which can easily learn a large amount of information about the target object [18]. Different from traditional data networks, wireless sensor networks have the following unique characteristics: (1) In self-organization, the layout and development of the network do not need to be based on any predetermined network installation. Nodes coordinate their behaviors

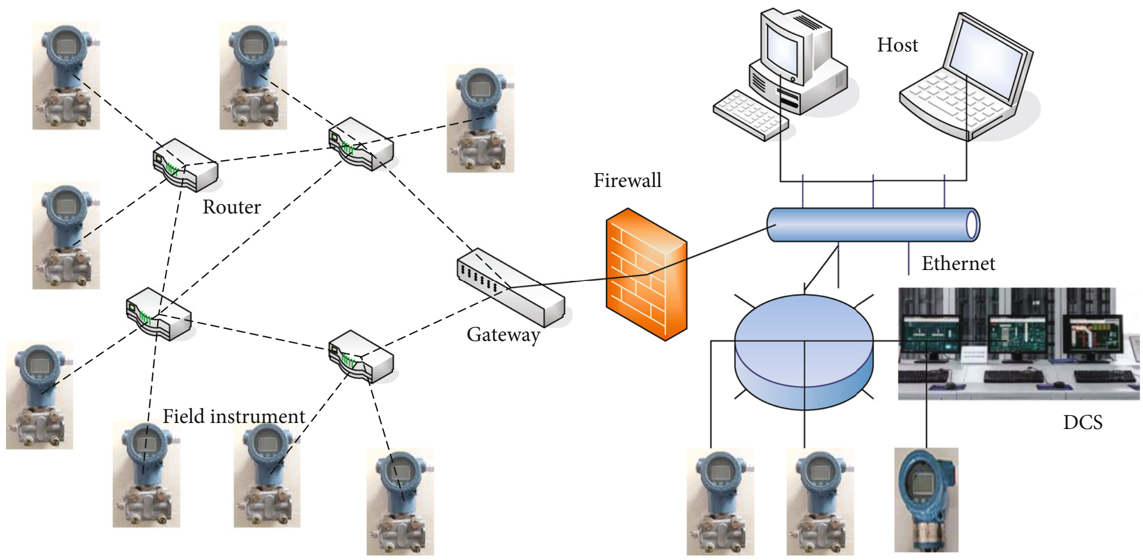


Figure 1: Typical application wireless sensor network scenario.

through multilevel protocols and distributed algorithms, which can quickly and automatically form an independent network [19, 20]. (2) The resources of the node are limited. The flexibility and self-organization characteristics of wireless sensor networks determine the power and processor, and the storage and communication of sensor nodes are very limited. Therefore, most hardware designs and software implementations need to be based on this. (3) Regarding execution, different applications are usually interested in different physical quantities, so the requirements for network system and material design are different, and network architecture and communication protocols are bound to be very different. Therefore, only by planning for each specific application can a high-performance and reliable system goal be achieved, which is also a significant feature of wireless sensor design other than traditional network technology [21].

*2.2.2. Wireless Cognitive Network Technology.* In the cognitive radio network, the channel has the characteristics of frequency selectivity and constant change over time. These characteristics will affect the orthogonality between the spreading codes. In addition, the spreading codes are sometimes not absolutely orthogonal, which will lead to signals between different users interfering with each other. Therefore, channel estimation not only needs to accurately obtain channel response information but also needs to adapt to the fast time-varying channel environment.

The specific method is as follows: In the frequency-selective Rayleigh fading channel, a channel estimation algorithm is based on an instant two-dimensional pilot mode [22]. In the first step of the algorithm, use LS to estimate the first pilot symbol to get the current channel response and save the obtained value. Next, use LS to estimate the regular pilot symbols inserted in the OFDM data symbols [23]. In this way, a new two-dimensional pilot-assisted channel estimation algorithm is obtained. The schematic diagram is shown in Figure 2.

Based on the algorithm, we have the following:

(1) Obtain channel information from pilot symbols. The estimated value that can be obtained by the LS algorithm is

$$\bar{U}_p^i(k) = \frac{Y_p^i(k)}{X_p^i(k)}, k = 0, 1, 2, \cdots, N-1. \tag{7}$$

Among them, $X_p^i$ represents the transmitted pilot symbols, $Y_p^i$ represents the received pilot symbols, and then the LS algorithm is also used for the pilot symbols that are evenly inserted in the subsequent OFDM data symbols.

$$\bar{U}_p^i(m) = \frac{Y_p^i(m)}{X_p^i(m)}, k = 0, 1, 2, \cdots, N_p - 1. \tag{8}$$

(2) Use linear interpolation. The linear interpolation method uses the information of two adjacent pilot subchannels to determine the channel response of the data subchannel located between them, which can be obtained by the above formula:

$$\bar{U}_p^j(ml) = \bar{U}_p^j(ml) + (1-y)e(ml). \tag{9}$$

Among them, $e(ml)$ is an error term, $y$ is a parameter waiting to be determined, and the error can be clearly expressed by the zero-mean Gaussian white noise.

$$y = J_0(2\pi g_{\max} \Delta t T_s). \tag{10}$$

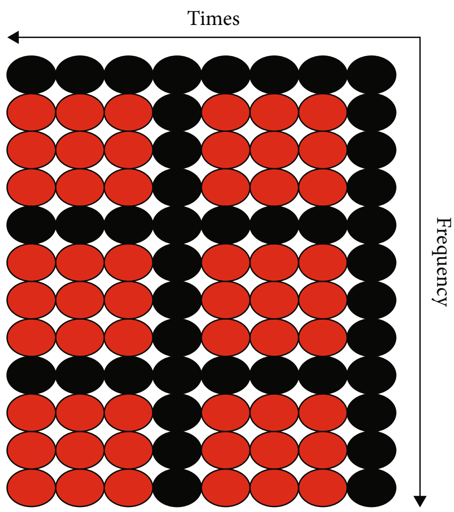


Figure 2: Two-dimensional channel estimation.

$J_0$ represents the first zero-order Nessel function, $g_{max}$ represents the maximum Doppler frequency shift, $t$ represents time, $T$ represents period, and then $e(ml)$ can be obtained as

$$e(ml) = \frac{U_p^{\bar{j}}(ml) - U_p^{\bar{i}}(ml)}{1-y}. \tag{11}$$

Therefore, by linear interpolation, the error term $e(k)$ between two adjacent derivative symbols can be expressed as

$$e(k) = [(L-1)/L]e(ml) + 1/L[(m+1)L]. \tag{12}$$

Therefore, by linear interpolation, the error term $e(k)$ between two adjacent derivative symbols can be expressed as

$$U_p^{\bar{j}}(k) = yU_p^{\bar{i}}(k) + (1-y)e(k), k = 0, 1, 2, \cdots, N-1. \tag{13}$$

Frequency-selective deep fading only affects one or several subchannels in the system. Using the relevant information between the subchannels, the data on the interfered subchannels can be restored, thereby effectively reducing the randomization caused by fading [24]. And through the filter to estimate the attenuation factor of the remaining subchannels, this channel estimation method is very suitable for severe frequency-selective fading channels.

*2.3. Dynamic Management of Real Estate Investment Portfolio.* The real estate investment portfolio dynamic management implementation engineering diagram is shown in Figure 3. It is mainly divided into the following steps.

(1) Investor goals and constraints: determine the investor's investment goals, such as the expected rate of return and the minimum risk acceptance; determine the investor's constraints, such as capital restrictions, investment preferences, and so on

(2) Conditions and expectations of the real estate market: the real estate market is in a dynamic process of change. The real estate market in different regions and different periods has different characteristics. Therefore, it is necessary to carefully analyze the real estate market and predict the expected return rate and risk level of the real estate portfolio investment. The analysis of the real estate market includes qualitative analysis and quantitative analysis. Qualitative analysis mainly includes market efficiency analysis, portfolio management method analysis, analysis of real estate markets in various regions, and analysis of various property types of real estate markets [25]. Quantitative analysis includes basic economic evaluation, modern portfolio theory seeking expected return and risk, probability forecasting, and portfolio optimization

(3) Define the best investment portfolio: investment objectives and investor constraints can be reflected in the investor's indifference curve. The actual limit represents conditions and market expectations, and the tangent point between the indifference curve and the actual limit represents the best advantage of the investment portfolio

(4) Determination of combination strategy: the process is shown in Figure 4

(5) Monitoring and readjustment: monitoring is the process of implementing portfolio management as a continuous potential model to monitor all factors that affect the portfolio. It changes the investor's indifference curve and the actual boundary point, that is, to determine the portfolio size, required performance, and risk tolerance: capital mobility, occupation period, taxation and related laws, and other factors. The adjustment should be an appropriate adjustment of the assets in the investment portfolio to better adapt to market conditions and respond to the requirements and expectations of investors

(6) Evaluation of combined behavior: evaluate whether the portfolio management meets the requirements of investors. If the target portfolio is determined, the manpower and material resources spent on comprehensive real estate analysis and market analysis are worth the effort, and what aspects of portfolio management still need to be improved. There are two commonly used evaluation methods: one is value-added valuation, which uses market share, property selection, or differentiation to adjust the rate of return for each risk. Effective portfolio management will increase the value of real estate investment portfolios. The second is performance measurement, which refers to the measurement of historical returns or expected returns. The historical rate of return is sometimes called the rate of return,

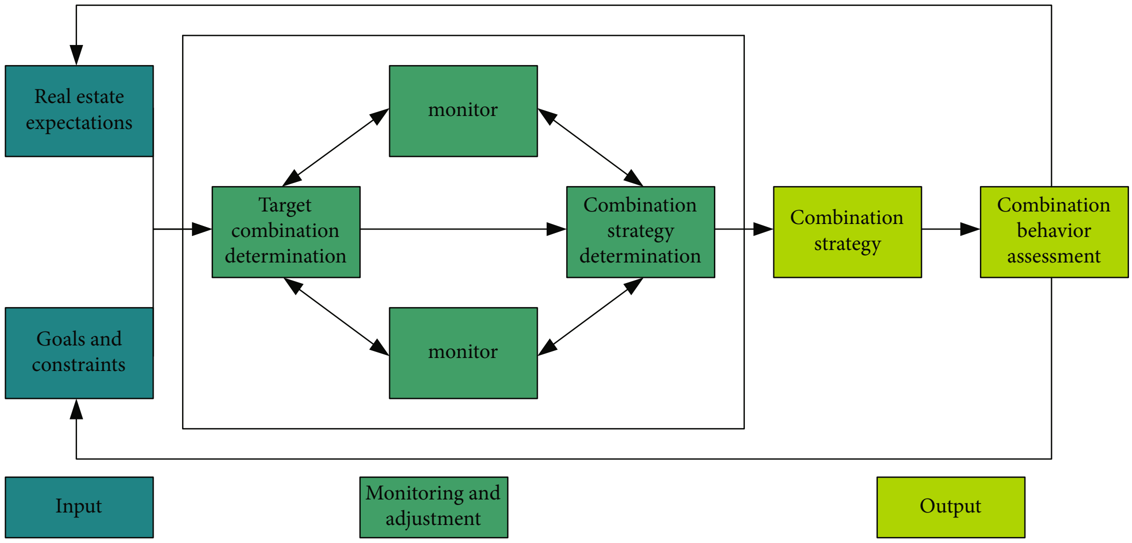


Figure 3: Real estate portfolio management.

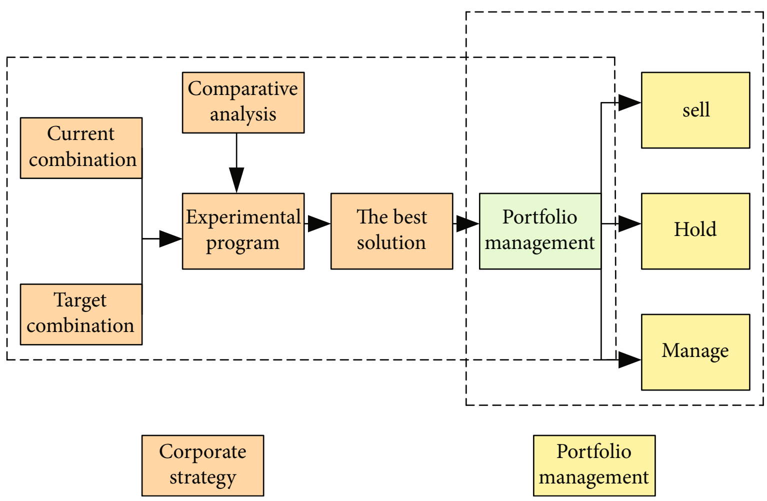


Figure 4: Real estate corporate strategy.

and the expected rate of return is usually the expected rate of return.

*2.4. Real Estate Portfolio Model Based on Ant Colony Algorithm.* The assumptions of the portfolio model are as follows: (1) Investors are risk averse. (2) Investors can obtain the expected rate of return and variance of different types of real estate and make decisions based on comprehensive consideration of risks and rates of return. (3) Funds are unlimited, and investors do not need to consider the constraints of funds [26].

Under such model assumptions, firstly introduce the investment portfolio into the real estate portfolio investment decision, and secondly improve the model based on the attitude of real estate investors towards risks. Because the real estate business investment does not consider short selling, the model further improved the improvement, and finally a unity of dimensions.

The model introduced into the real estate investment portfolio is

$$p1\begin{cases} \min \kappa_p^2 = \sum_{a=1}^{n}\sum_{b=1}^{n} x_a x_b \kappa_{ab} \\ \text{s.t.} \sum_{a=1}^{n} x_a x_b \geq r_p \\ \sum_{a=1}^{n} x_a = 1. \end{cases} \tag{14}$$

In Equation (14), $n$ represents the number of real estate investment plans, $x_a$ represents the investment ratio of the $a$th real estate, $r_p$ represents the expected benefits, and $\kappa_p^2$ represents the risk value of the investment portfolio. In addition, $\kappa_{ab}$ represents the $a$th and the first $b$ covariance of expected real estate returns.

Since, in actual operation, different real estate investors have different attitudes towards risk, investors need to choose the investment ratio according to their attitude towards risk to achieve their desired risk and return goals [27, 28].

On the basis of $p1$, $p2$ introduces the risk coefficient $\mu$, which transforms the risk-return multiobjective model into a single-objective model. The size of the $\mu$ reflects the attitude of investors towards risk. The $p2$ model can choose the investment ratio according to the investor's attitude towards risk. Different risk attitudes will result in different investment ratios. Under a certain risk factor, a certain investment ratio may be an inferior solution, while under another risk factor, this investment ratio may be the optimal solution.

$$p2\begin{cases} \max\ (1-\mu)\sum_{a=1}^{n} x_a r_a - \mu \sum_{a=1}^{n}\sum_{b=1}^{n} x_a r_a \kappa_{ab} \\ \text{s.t.} \sum_{a=1}^{n} x_a = 1. \end{cases} \quad (15)$$

Among them, $\mu$ is the risk preference coefficient. $\mu = 0$ stated that investors value returns very much and do not care about risks. As a neutral risk person or risk enthusiast, the return on investment portfolio is the highest [29]. $\mu = 1$ stated that investors value risk very much and have no requirements on the size of returns. Such investors are very cautious and have the lowest risk in their investment portfolio. If the risk preference coefficient belongs to $[0, 1]$, then the value of the data increases as the degree of investor treatment of risks increases, which represents the attitude of investors at different stages to risk [30].

The investment portfolio model does not consider the behavioral constraints that do not allow short selling, which will greatly restrict the application of the model. $p3$ is a real estate portfolio model considering short selling is not allowed:

$$p3\begin{cases} \max\ (1-\mu)\sum_{a=1}^{n} x_a r_a - \mu \sum_{a=1}^{n}\sum_{b=1}^{n} x_a r_a \kappa_{ab} \\ \text{s.t.} \sum_{a=1}^{n} x_a = 1 \\ x_a \geq o \\ a = 1, 2, \cdots, n. \end{cases} \quad (16)$$

The previous model risk used variance. Here, we introduce the investor's attitude coefficient to risk, transforming the risk-return multiobjective model into a single-objective model. In order to unify the dimensions of return and risk, the risk here uses standard deviation [31].

$$p4\begin{cases} \max\ (1-\mu)\sum_{a=1}^{n} x_a r_a - \mu \sqrt{\sum_{a=1}^{n}\sum_{b=1}^{n} x_a r_a \kappa_{ab}} \\ \text{s.t.} \sum_{a=1}^{n} x_a = 1 \\ x_a \geq o,\ a = 1, 2, \cdots, n. \end{cases} \quad (17)$$

Markowitz studied the risks and returns of various securities in the securities market, carried out quantitative research on them, introducing variance to represent the level of investment risk and expected return to represent the level of return on investment, and proposed Markowitz portfolio theory. The mean-variance model of the portfolio is also the most commonly used calculation model. Under certain assumptions about the market, the effective boundary of the portfolio is found by studying the mean and variance of the returns of individual securities, that is, the portfolio of securities is to minimize the risk under a certain level of return or maximize returns at a certain level of risk tolerance. Markowitz's research on securities investment portfolio also found that diversified investment portfolios should also choose different securities with smaller correlation coefficients for investment portfolios to diversify investment risks. To maximize the utility expected by investors, not only the rate of return on investment but also the investment risk must be considered. To achieve the optimal portfolio of securities market investment according to relevant conditions, Markowitz uses mathematical statistics and quantitative analysis methods in a comprehensive and detailed manner and explains how to determine the optimal investment portfolio based on investment objectives.

Although Markowitz explained the principle of risk diversification in the theory of investment portfolio scientifically, there are still many defects in the application of actual securities investment portfolio. The first is that the model is based on certain assumptions, but these assumptions are generally difficult to achieve in reality, and the second is the determination of parameters such as the rate of return, variance and correlation coefficient in the model, and the difficulty of estimating these larger parameters, and again, the calculation of the model is more complicated. At present, there is no effective and simple model calculation method. Therefore, the application of this model in reality has certain limitations.

## 3. Experimental Design and Result Analysis

*3.1. Real Estate Investment Portfolio Plan Design.* A real estate development company has eight locations A, B, C, D, E, F, G, and H to choose from in a city, which can carry out (1) residential development, (2) industrial properties, (3) office buildings, (4) leisure tourism, (5) land development, and other five types of real estate development project construction. The economic evaluation indicators of each project type in different locations are shown in Table 1. The company only invests in one type in a lot. Try to determine the investment portfolio plan for real estate development projects (among them, the net present value (10 million

Table 1: Evaluation of various indicators of each investment plan.

| Project | Lot | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|---|
| Residential development | N | 26.22 | 19.64 | 56.66 | 16.63 | 54.30 | 64.98 | 22.67 | 26.22 |
| | R | 69.91 | 59.33 | 66.44 | 40.65 | 23.73 | 21.33 | 48.14 | 50.03 |
| | I | 4.60 | 6.20 | 2.50 | 3.50 | 3.90 | 6.20 | 6.40 | 2.80 |
| Industrial property | N | 44.51 | 63.09 | 60.10 | 44.55 | 46.75 | 5.13 | 23.24 | 44.51 |
| | R | 62.77 | 19.72 | 39.99 | 63.80 | 68.95 | 15.57 | 42.15 | 26.92 |
| | I | 4.50 | 8.00 | 5.50 | 4.20 | 6.90 | 7.50 | 7.70 | 5.10 |
| Office building | N | 5.17 | 29.85 | 63.67 | 54.52 | 27.72 | 37.49 | 54.18 | 5.17 |
| | R | 32.36 | 35.11 | 63.47 | 25.12 | 63.76 | 68.78 | 24.41 | 26.32 |
| | I | 6.40 | 4.30 | 5.20 | 4.30 | 5.90 | 6.40 | 7.70 | 2.20 |
| Leisure travel | N | 18.22 | 56.29 | 16.33 | 51.40 | 60.31 | 34.51 | 39.10 | 18.22 |
| | R | 13.81 | 37.87 | 38.88 | 41.81 | 25.67 | 40.16 | 63.76 | 62.54 |
| | I | 2.60 | 7.10 | 4.30 | 4.80 | 3.70 | 5.10 | 3.70 | 7.50 |
| Land development | N | 21.60 | 11.99 | 40.08 | 35.31 | 7.69 | 37.55 | 62.14 | 21.60 |
| | R | 22.44 | 59.51 | 45.70 | 29.73 | 44.28 | 62.66 | 27.03 | 46.82 |
| | I | 7.50 | 7.70 | 7.00 | 2.10 | 7.30 | 7.90 | 5.60 | 3.00 |

Yuan) in the indicator is represented by N, the internal recovery rate (%) is represented by R, the payback period (year) is represented by I, and the capital investment ratio is represented by C).

*3.2. Real Estate Investment Portfolio Results.* Through the statistics and analysis of the data in Table 1, the calculation results of the ant colony algorithm based on variance as the risk measurement index are shown in Figure 5.

In order to find the gap through comparison, the calculation result of the static ant colony algorithm is shown in Figure 6.

By comparing Figures 5 and 6, it can be found that under the same net present value and investment payback period, the capital investment ratio of ant colony algorithm based on variance is obviously higher, while the capital investment ratio of ant colony algorithm based on ant colony algorithm is significantly higher [32, 33]. Obviously low, the difference between the two is 30.1%.

It can be seen from Table 2 that the calculation speed of the ant colony algorithm using variance as the risk measurement index is slightly slower, but the rate of return has been greatly improved compared with the basic ant colony algorithm, the same amount of capital is invested, and the profit obtained is also relatively large [34, 35]. It can be said that the ant colony algorithm, which uses variance as the measurement index and changes over time, is superior to the basic ant colony algorithm in solving the problem of real estate development project portfolio, and its efficiency is increased by 26.11%.

*3.3. Real Estate Investment Portfolio Based on Improved Genetic Algorithm.* Through the improved genetic algorithm to solve the real estate investment portfolio model [36, 37], the results can be obtained as shown in Table 3.

Based on the preliminary analysis of the data, since land A is not suitable for open housing, it will not be discussed here. The development site of land C is too risky, and the real estate company will not consider it. Through the search of market information and data, the data results obtained are shown in Figure 7.

By running the program, the portfolio ratios of various real estate investment types under different risk aversion coefficients can be obtained. The data results are shown in Figure 8.

Figure 9 shows the curve of adaptability as the investment ratio changes with the progress of the genetic algorithm search when taking different values. Here, only the function graphs when $u = 0$, $u = 0.5$, and $u = 1$ are given.

It can be seen from the data in the figure that this model optimizes both the risk and return objectives at the same time and obtains different combinations of "return risk." Using this model, real estate investors can make investment decisions according to their own conditions and risk preferences and change the size of the variable input value indicating that real estate investors gradually weaken the importance of investment income and continue to increase the importance of risk.

## 4. Discussion

This paper is dedicated to research and designs an optimized calculation model, and it is based on ant colony algorithm and applies it to the complex analysis and processing of real estate investment. It not only expands the application scope of ant colony algorithm but is also a new attempt to study the complexity of the real estate investment market. By simulating the investment behavior of investors in the real estate investment market, mining ant colony algorithm as an important tool for studying the complexity of the system has certain potential in the study of the complexity of the

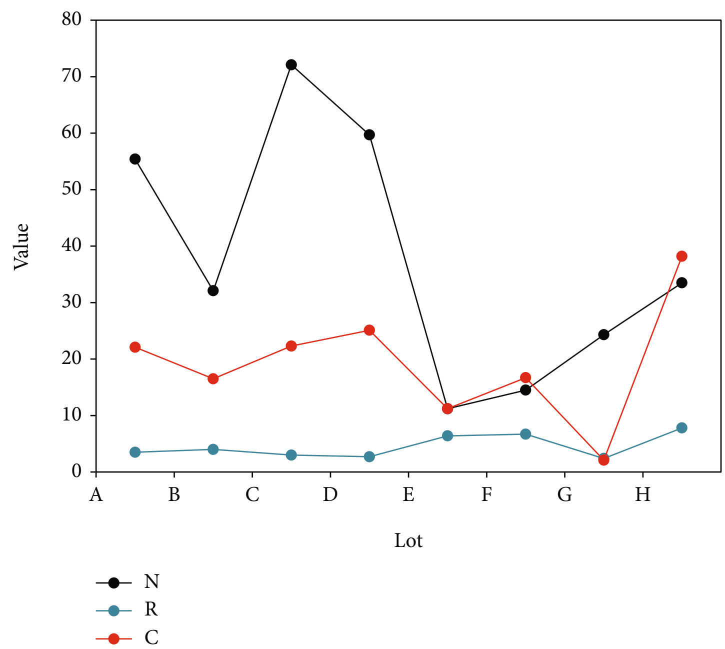


FIGURE 5: The calculation result of the ant colony algorithm based on variance as the risk measurement index.

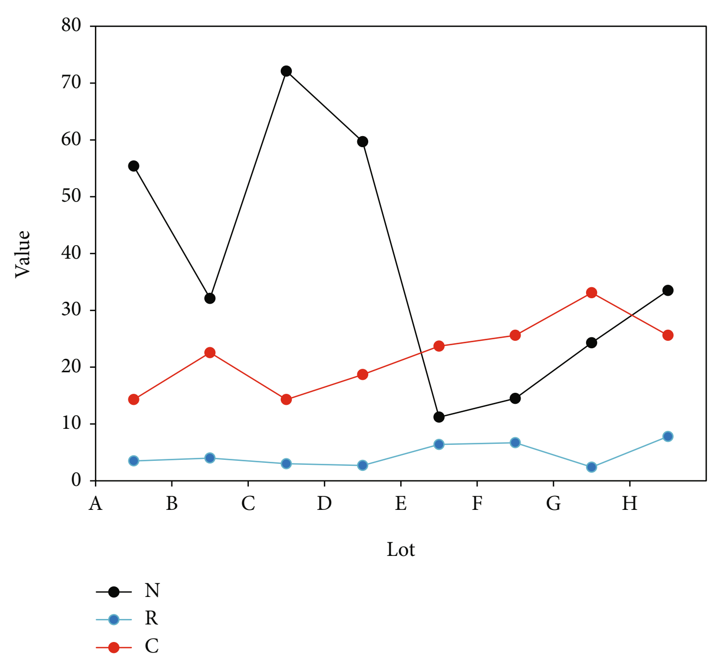


FIGURE 6: The calculation results of the ant colony algorithm under static conditions.

TABLE 2: Comparison of the calculation results of the two algorithms.

| Algorithm | Ant colony algorithm | Ant colony algorithm based on variance |
| --- | --- | --- |
| Operation hours (s) | 99 | 134 |
| Calculation results | 17.6 : 14.3 : 24.3 : 20.6 : 20.4 : 14.5 : 26.5 : 22.3 | 20.3 : 14.3 : 15.4 : 21.1 : 23.9 : 19.4 : 18.4 : 15.5 |
| Present value of investment income | 4573.32 | 5132.58 |

Table 3: Index values of various real estates.

| Type | A<br>Residential development | B<br>Residential development | C<br>Industrial property | D<br>Industrial property | E<br>Office building | F<br>Office building | G<br>Leisure travel | H<br>Leisure travel |
|---|---|---|---|---|---|---|---|---|
| Average rate | 7.16% | 12.15% | 14.44% | 15.48% | 8.54% | 10.23% | 10.39% | 10.86% |
| Variance | 0.0014 | 0.0033 | 0.0016 | 0.0050 | 0.0015 | 0.0031 | 0.0042 | 0.0054 |
| Standard deviation | 4.32% | 5.88% | 4.62% | 6.88% | 3.79% | 5.53% | 6.45% | 7.21% |

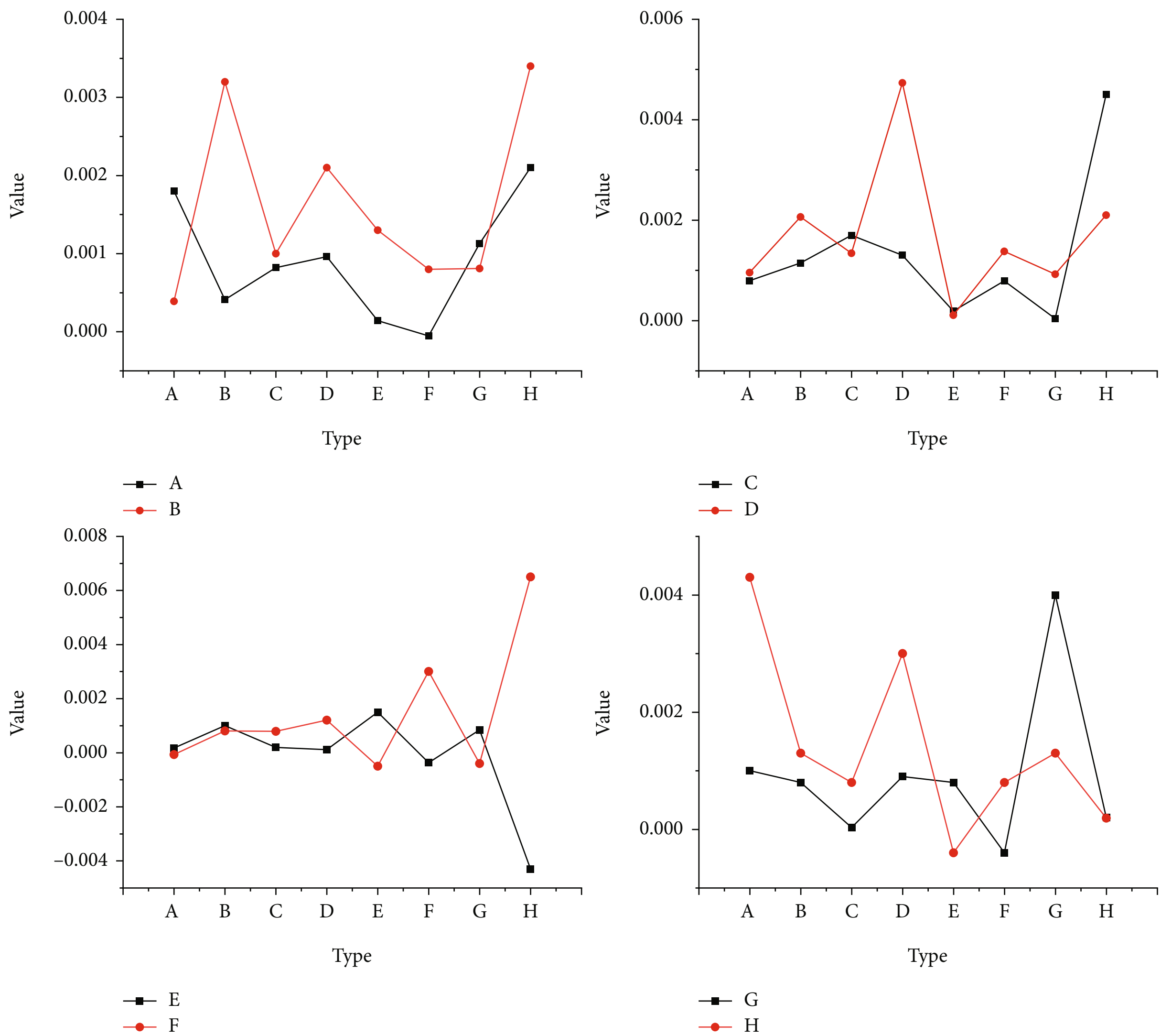


Figure 7: Covariance of yields of real estate in various regions.

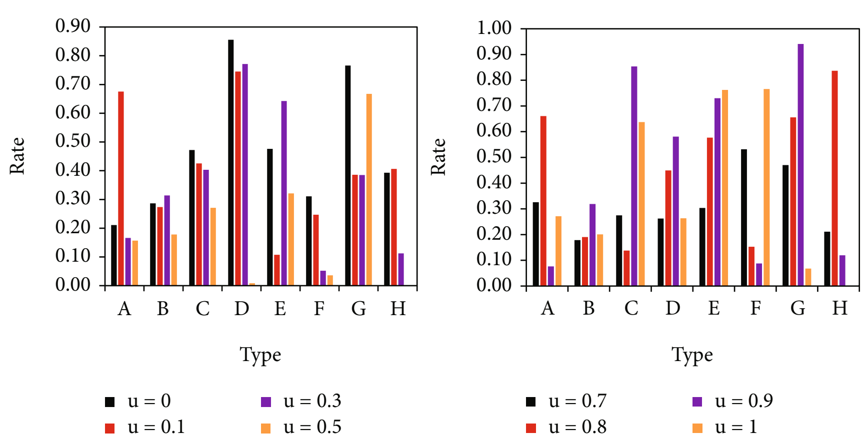


Figure 8: Investment ratio under different risk factors.

financial market. In addition, on the basis of in-depth research on existing investment portfolio models at home and abroad, the model is improved and combined with the special environment of my country's financial market, so that the model is suitable for the investment environment of my country's financial market. For the research of ant

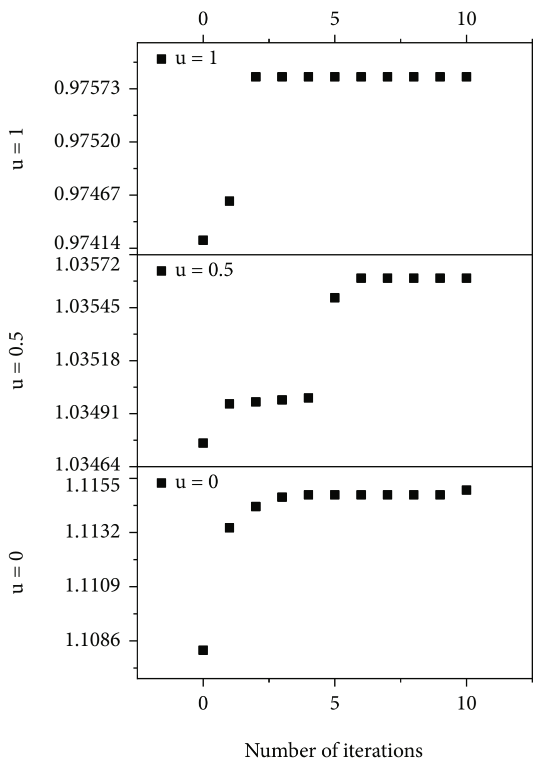


Figure 9: The fitness curve under different investment ratios.

colony algorithm, this article starts with the most basic ant colony, analyzes the optimization method of basic ant colony algorithm, improves it, and successfully combines the improved portfolio model and ant colony algorithm to solve the problem: the optimal solution. In the empirical analysis stage, the improved model is used to obtain two sets of investment portfolios, and the two combinations are analyzed in terms of return, risk, cost, and suitable people. The results show that the results obtained are in line with the actual situation.

Through the analysis of this case, it is shown that a real estate type-based investment portfolio is more effective than a single type of investment. Investors can invest in the same property type on land in different regions or invest in different real estate property types on land in different regions. At the same time, investment portfolios can be made for each project, which can greatly reduce the investment risk of real estate projects and make optimization decisions for multi-project portfolios. In the specific practical investment portfolio decision-making, the development company or investor expects to formulate different investment portfolio strategies according to their own risk preferences and investment goals, chooses the risk value and return target of the project reasonably and flexibly, and substitutes the risk and return target value into it, calculate and analyze the investment portfolio decision, select the best investment portfolio plan, and make the most effective investment decision.

This article uses a case study of the investment decision of a real estate company. First, through market research and qualitative analysis, seven types of real estate investment are determined, and the genetic algorithm is used to solve the investment portfolio according to the investor's degree of risk. Through the analysis of the data, it is concluded that as investors pay more attention to the degree of risk, the proportion of certain types of real estate investment may first decline and then rise, or first rise and then decline, instead of showing a one-way increase or decrease.

## 5. Conclusions

Through case studies, we draw important conclusions: In general, as $u$ increases, that is, as investors pay more attention to risks, the proportion of projects with higher yields and higher risks will gradually decrease, while the rate of return the proportion of projects with smaller risks and smaller risks will gradually increase, but this is not absolute. As $u$ increases, the proportion of certain types of real estate investment may first decline and then rise, or first rise and then decline, instead of showing a single increase or decrease, as in the case of business. This requires investors to conduct more detailed research and quantitative analysis on the combination of plans to determine a more effective investment ratio. The project discussed in this article is based on the combination of investment type and investment location to determine the proportion of the investment portfolio, and the selection of projects is relatively limited, large real estate companies will often face more portfolio choices, and in reality, the real estate investment portfolio should also be combined with investment timing, investment cycle, business model, and other factors. This kind of investment portfolio optimization will have greater value, and of course, it will also be more difficult.

## Data Availability

No data were used to support this study.

## Conflicts of Interest

The author states that this article has no conflict of interest.

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