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Designing the Best Stock Portfolio of Tehran Stock Exchange Using the Bee Colony Algorithm

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Abstract

Proper selection of investment projects in the capital market, including stock exchanges, is one of the most important issues of the day. The right choice of designs requires appropriate investment opportunities on the one hand and appropriate analysis tools and techniques on the other. An appropriate choice can help ensure investor and increase market efficiency. In most cases, there are beneficial investment projects but there is no access to financial resources for them. In an efficient capital market, the operational dimension of the capital is at the disposal of the best investment options and the next priorities are the other resources. Therefore, in planning investment, in addition to evaluating and choosing projects individually, attention should be paid to the interaction and interaction effects of the projects. In other words, we need to take this approach to the choice of plans that do not consider it as an activity that is in void and apart from other goals and decisions, but all the important and important issues involved in choosing a project. Statistical Society The research consists of 112 major stock exchange companies in terms of stock liquidity and data analysis through Meta-heuristic algorithms.

Key words: stock basket, optimization, Meta-heuristic algorithms, honey bee algorithm

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Introduction

Typically, the problems of selecting portfolios are solved through linear models and equations, although the solutions obtained through these methods are real numbers and difficult to execute, since each asset has the minimum transaction cost. Methods that consider the minimum transaction costs. Based on linear portfolio optimization models, although there have not been any studies of minimal transaction costs problems based on the Markowitz model, so far, this model has not been considered the best-known and most widely used models. Based on the Markowitz model, the portfolios obtained through algorithms are much more efficient. And the proposed method is more optimal, and the solutions presented in the short run are acceptable. A model based on a multi-objective decision method is highly recommended, due to its adaptability and ease (Shohadaei, 2015 and Karimova et al., 2018)

Proper selection of investment projects in the capital market, including stock exchanges, is one of the most important issues of the day. The right choice of designs requires appropriate investment opportunities on the one hand and appropriate analysis tools and techniques on the other. An appropriate choice can help ensure investor and increase market efficiency. In most cases, there are beneficial investment projects but there is no access to financial resources for them. In an efficient capital market, the operational dimension of the capital is at the disposal of the best investment options and the next priorities are the other resources. Therefore, in planning investment, in addition to evaluating and choosing projects individually, attention should be paid to the interaction and interaction effects of the projects. In other words, we must take this approach towards selecting schemes that do not consider it as an activity that takes place in a vacuum and apart from other goals and decisions, but all the important and important issues involved in choosing a project. One of the most problematic issues in investment firms is the choice of an optimal portfolio of feasible and economical investment projects. However, this combination should be tailored to the constraints, goals, and strategies The organization and considering the importance of the objectives. When the number of projects is high, the number of alternatives that can be chosen will be very high, and it is very difficult to evaluate each alternate according to the criteria that should be considered in the selection process. So far there are many patterns for The solution to the problem of an optimal asset pool is provided, each with designing conditions and constraints. The primary model was proposed using second-order programming.

Generally, the investor is considering the choice of portfolios for multiple and controversial goals such as returns, risks, and liquidity. On the other hand, the investor has his own preferences about the goals (Jones, 2014). The review of the research literature suggests that goals that are not used in the portfolio selection question are to minimize risk and maximize the plurality of portfolio efficiencies. In this research, we try to design a multi-objective model for optimization of goals, returns, risk, liquidity, and skewness coefficients in order to select optimal portfolios.

The designed model is non-convex and cannot be optimized with operational algorithms. Therefore, the colony algorithm has been used to optimize the model.

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The stock market, according to its characteristics, contributes to the identity of small and large investors, in which shareholders tend to choose the best shares that generate more returns, and for this purpose, by obtaining the information necessary to select the best stock, to select the best The stock is also a basket of stocks that, if fluctuations, have an overlap to reduce the risk. This has led researchers to use or invent various ways to optimize stock portfolios. The foundation of the stock market is based on Markowitz's theory. Markowitz, by presenting Portfolio risk measurement methodology, calculates the expected risk and expected returns, and models are based on expected returns and portfolio risk characteristics. Today, due to the variety of options chosen for the optimal stock portfolio, it requires a thorough expertise, experience and research that has inevitably led to the use of mathematical models, software and new methods. In this research, using one of the newest meta-search methods that uses the genetic algorithm, an algorithm is proposed to find the optimal solution of the portfolio optimization problem. The above-mentioned meta-logic algorithm is capable of searching for the short space of time in a short time and finding the exact solution in the neighborhood of the answer, which is very close to the exact answer. (Mohammad Estakhri, 2015)

Getting to the optimal stockpile and choosing the most appropriate share in the stock portfolio, considering that a non-linear multi-criteria problem is one of the issues at the NP-hard issues. In the research, the selection and selection of 112 companies that overlap risk are selected through field research and the use of stock experts. Using mathematical models and modern scientific methods to have successful choices in the stock market will motivate shareholders to invest more confidently in the stock and provide momentum management on their stock to generate more profit.

Review of literature

Investment and financial resources

Investment management covers the two main issues of "securities analysis" and "portfolio management".

The portfolio analysis involves guaranteeing the benefits of a single investment portfolio. While portfolio management involves analyzing the mix of investments and managing the maintenance of a set of investments, in the last decade, the trend of investment issues has led to the selection of portfolios for stock portfolio analysis into portfolio management. (Vahidzadeh, 2017)

The issue of choosing the optimal asset portfolio is one of the capital market theories, which is also of particular importance in macroeconomic finance issues as an important indicator and plays a decisive role in economic growth and development. In the microeconomy, the importance of investment decisions is due to this issue. Which, in fact, is a person who is investing in today's consumption, hoping to spend more on the future in the future. The optimal investment decision will increase the investor's likelihood of future use. The utility function of each individual is determined according to his preferences. Which will not necessarily be the same with other people. Risk and returns are the criteria that determine the utility of the investment portfolio selection.

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Financial Market

Financial Market is a formal and organized marketplace in which the transfer of funds from individuals with a surplus of resources to individuals and funders is obvious. In this market, the majority of lenders are households and most of the applicants are funds and corporations.

The financial market provides the necessary facilities for the transfer of savings from natural and legal persons and others who provide productive investment opportunities and require financial resources. The transfer of these funds leads to the creation of financial assets in all cases, which is, in fact, a proportion the future earnings of personal assets (legal) that issues securities (Shabahang, 2015)

Risk and return on investment

The most important concepts in decision making are investment, risk and return. Each share or portfolio of stocks, if purchased and sold at a certain time from the time it is bought, maintained, and sold, also yields a certain return. This returns includes price changes and the benefits of ownership. The term "rate of return" (or rate of return) is used to describe the rate of increase or decrease in investment during the asset holding period when future returns are predicted and multiplied by the probability of occurrence of each of the predictions, each of which is aggregated together. It will be "profit and return rate".

Calculate returns

If the investor pays the price (P0) to one share at the beginning of a period and receives dividend (P1) at the end of the period, the return on investment (R) for the period, the discount rate equals the current cash flow report with the investment cost. In other words, the return is the ratio of the total change in price and dividend to the initial share price as shown below.

$$P_{0=(P_1+P_0)/(1+R)}$$

Generally, the basic assumption is that dividends will be received at the end of the period. The above analysis can be used to adjust the tax conditions of the generalized basic investor, in which case the equation will be below.

$$R = ((P_1 - P_0)\big(1 - T_g\big) + D_1(1 - T_0))/P_0$$

T_g is income tax and T_0 is tax rate to Income for Investment. This broker's commission and other transaction costs can also be easily calculated. The following equals the above.

$$R = ((P_1 - P_0 - C)(D_1(1 - T_0))/P_0$$

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C is Brokers' Commission and other transaction fees. The equations define the periodic return rate that occurs once in each period. If the continuous composite yield rate is assumed, then the equation will be as follows:

$$R = \ln(\frac{P_1 + D_1}{P_0})) = \ln(P_1 + D_1) - lnP_0$$

Stock basket selection models

Since the middle of the nineteenth century, theologians and classical modelingists have been looking for a way to use a set of predetermined criteria and methods to select stocks and form a basket of stocks that has the highest returns against the lowest possible risk tolerance. Gained. Some of the foremost players include Markowitz, Sharp and Rice.
Then, with the advancement of mathematical and economic sciences, people such as Charles and Cooper sought to use models and mathematical concepts to design models for choosing basket portfolios.

Markowitz model

Prior to Markowitz's (1952) paper, decisions were made on wholly independent securities, and, in principle, the relationship between these papers was not considered. Therefore, when the goal is to increase the expected returns and the risk is taken into account alone, it is natural for anyone to choose a portfolio of securities. Markowitz's theory was, in fact, the introduction of a coherent problem in the field of securities.
Markowitz noted that it would be possible to create a portfolio at a certain level of expected returns, with less risk tolerance. Some believe that Markowitz's big addition is the introduction of the issue of diversifying the portfolio of portfolios. (Sayadi, 2010)

Sharp model

In the Markowitz model, the risk of a stock basket is a function of the variance of each share, its covariance with other stocks and the percentage of the share in the basket. Stock return is the average stock return in the basket. To calculate the basket risk, the variance of each share and its covariance with other stocks must be taken into account. William Sharp devised another method for simplicity calculations. In this way, the yield of each share is obtained from two parts. The first part is the product of the market yield and the coefficient called beta. The second part is independent of the market. Sharp's Sharp Mathematical Modeling Model is presented (Sharp 1978):

$$\max z = (1 - \gamma)E_{\mathrm{p}} - \gamma \mathrm{B}_{\mathrm{p}}$$

St:$\sum_{i=1}^{n} X_i = 1$
$0 \leq \gamma \leq 1$
Ep=$\sum_{i=1}^{n} X_i E_i$

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$Bp=\sum_{i=1}^{n} X_i B_i$

$Bi=\frac{cov(R_i R_m)}{var(Rm)}$

Where

γ : Degree of investor risk taking

E_p: Expected portfolio returns

E_i : Expected revenues of the i plan

X_i : Part of the budget invested in i plan

B_p : Portfolio risk

B_i : Revenue covariance ratio of i plan to market variance

One index model hypothesis significant linear relationship between expected returns and expected market return is based portfolio (Eslami Bidgoli, 2016 and Nurgaliyeva et al., 2018). Covariance model Markowitz and Sharpe linear model are able to determine efficient portfolio, but these models do not help the investor to select the portfolio that fits his preferences (Eslami Bidgoli, 2016).

Arbitrage Pricing Model (APT)

In the 1970s, he founded the Arbitrage Pricing Theory (APT). The basic concept in APT is the existence of a price. That is, two assets (shares) that have the same return risk, cannot be sold at different prices. With this definition, the pricing of securities in a way that generates risk-free profits is called arbitrage.

According to pricing theory, arbitrage divides investors into two categories: first-class smart traders or ultimate or logical traders who are able to offset the mistakes of many investors, and the latter are ordinary traders or irrational traders who often make mistakes in decision-making. For a better understanding of the concept of arbitrage, let's assume that the market is priced at a higher price than its base price, and the successor to this sheet is available in the market; the rational investors through the sale of a borrowed more expensive sheet and simultaneously purchase a sheet of the same share, profit Without risk. Due to the competitive activity of a large number of clever investors or arbitrageurs, the two prices will move toward a single price, and in balance, stocks that are priced above the base value will return to their base price. Thus, through the process of arbitrage, as long as the share of the successor is close, the effect of ordinary traders is eliminated.

A boundary

A boundary is the portfolio that produces maximum returns at a certain level of risk or at least a risk at a certain level of return.

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As an example below, note that each portfolio that runs on the border has the highest return rate with the same or equal risk, with the same return rate for other portfolios that are below the effective boundary.

Therefore, it can be said that portfolio A in this form is superior to the C portfolio. Because it has a lower risk with the same return rate. Similarly, portfolios B outperform the C portfolio. Because both risks are the same, but the return on the portfolio is higher. Because of the benefits of diversification among assets whose solidarity is not complete, we expect an efficient frontier of investment portfolios. There are two exceptions to this rule, one for highly efficient assets and one for very low risk assets.

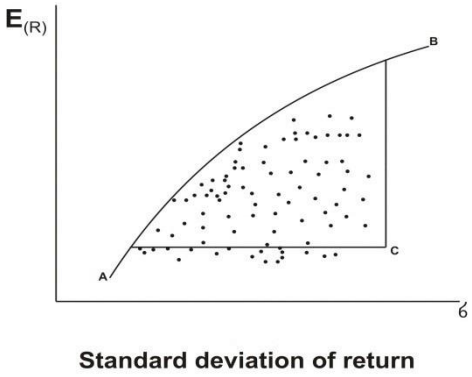

Figure 1: the border for various portfolios

Investors are efficient on the basis of the utility function and how they deal with risk to a point on the A boundary. No portfolio on the A boundary is superior to other portfolios on this border. All of these portfolios have different returns and risks, which increase their expected rate of return as the risk increases. (Abdullah, 2013)

Meta-heuristic algorithms

The calculus is used to solve many scientific and engineering issues and covers a very wide range of issues. But despite the high efficiency of precise mathematical methods, there are still many optimization issues that the conventional methods of dealing with them face with many problems, but this is even more evident when the objective function of our problem is discontinuous, multi-criteria, or multi-objective; of course In other cases, one cannot say for sure that the calculus and calculus are able to answer all our ambiguities in the problems, but if the decision variables are not discrete, this method will not be empty. These limitations in solving optimization problems have led researchers to think about the proper solution to these problems, their efforts and research have led to the emergence of algorithms inspired by natural phenomena in recent years, the phenomena that can be seen around it. The best example for this case can be to study the evolution and behavior of creatures, including animals and plants, a phenomenon that lies in the heart of nature, or another example, such as a pattern of gradual cooling of metals in specific circumstances or dozens of cases, and another example to brighten

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up Subject, let's analyze one of these samples in a very precise and specialized way to clearly illustrate the above issues. (Poli, 2014)

Optimization problems in mathematics

The colony's honey bee cell algorithm is in fact an optimization method, which is inspired by the nature of its value doubled. In a general framework, we can show the objective function of a problem in the form of a multivariable function without limitation as follows (Qatei, 2013)

$$f(x)min$$

The problem variables in the form of decision vectors are as follows:

$$)x_n‘…‘x = (x_1$$

Here, if n = 1, the optimization problem is a single-valued one, and if it is n> 1, then the problem becomes multivariable. In some cases, all the variables of the decision are continuous, in this case the function will be determined by considering the upper and lower bounds:

$$x_i \in R : x_i^L \leq x_i \leq x_i^U$$

In some cases, the variables are discrete and can only accept certain values. Examples include the following sets.

$$k \}‘x_i‘…‘1‘ \quad x_i \in X_i = \{x_i$$

$$1\}‘ \in \{ 0x_i$$

Problem variables can include both discrete and continuous forms, but the objective function may be continuous or discrete. Many of the practical problems in the domain of optimization are limited in practice by the fact that decision variables appear in the form of constraints in the form of equations and inequalities.

$$p‘…‘ (x) = 0 \quad i = 1h_i$$
$$q‘…‘ \ (x) \geq 0 \ i = 1g_i$$

In multidimensional problem optimization, we may also want to minimize target functions simultaneously:

To find the optimal answer using innovative algorithms, we use the test-and-error method; here the purpose of the heuristic is to "find" or "search" by test and error. There are no guarantees in this way to find a solution, however, many other well-known methods may be more effective and efficient. In general, innovative algorithms are considered locally based methods, because their searches focus on local variables; yet, innovative algorithms can still be considered among the best ways to solve optimization problems, especially when time constraints are important in solving problems.

The meta-heuristic word represents the most advanced algorithms. In fact, Meta at the beginning of the word means beyond. The word metaheuristic means finding the optimal solution by applying techniques at advanced levels as well as using test and error methods. Generally speaking, meta-curiosities are considered as advanced techniques, which in fact

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involve the combination of lower-level techniques for a broader, yet more focused, survey of search space.

In recent years, the methuristicist word refers to all modern algorithms and high levels, including evolutionary algorithms (EAs) such as Genetic Algorithm (GA), Progressive Freezing Algorithm (SA), Banned Search (TS), Ant Colony Algorithm (ACO), Particle pool optimization (PSO), firewall algorithm (FA) and Harmonic Search Algorithm (HS).

There are two main concepts in meta-innovative algorithms (Gholami, 2011).

The bee algorithm is based on a search algorithm group, which was first developed in 2005; this algorithm simulates the behavior of eating habits of baker groups. In its initial version, the algorithm performs a local search algorithm that searches for a random (random) It can be combined and can be used to optimize the combination with functional optimization.

In this section, the standard honey bee colony standard algorithm is presented briefly. (Eshqi, 2015)

Search for food in nature

A honey bee colony can be distributed in many directions and in different directions to utilize food supplies. Flowering pieces with a large amount of nectar and pollen, which can be collected with little effort, attract a large number of bees. A colony search of a colony process is started by the honey bees that are sent to search for promising florets (with high hopes for nectar or pollen). Guinea worm moves to another bulwark in the form of a stool. During the harvest season (flowering), the colony continues to search for a number of colony populations as bee colonies. When the search for all the gardens ends, every bee will continue to search. When the search for all the gardens is completed, every bee that runs on a roller coaster that holds a good quality nectar and pollen performs a special dance. This dance is known as rotary dance. Information about the direction of the flute (relative to the hive), the distance to the garden and the quality of the garden is transferred to the other bees. This information sends the bees and followers to the garden. (Gholami, 2016; Musabirova et al, 2017) Most of the bees follow the flowers that are more promising, and there is more hope to find nectar and pollen in them. When all the bees go to a similar area, they are again randomly distributed due to their dance around the bulwark so that eventually not a garden, but the best flowers within it, determines the position. The belt algorithm examines each point in the parameter space consisting of possible responses as a food source. Guarded bees. Simulated brokers randomly simplify the space of the responses and report the quality of the visited positions by means of a merit function. Simplified answers are ranked, and other bees are new forces that look for the space of the answers in their surroundings to find the highest ranking places called the garden. Alternatively, the algorithm searches for other gardens to find the maximum point of the function (Daryakin & Ahmadullina, 2017).

Some uses of the bee algorithm in engineering:

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- ✓ Neural network training for typology
- ✓ Timing of tasks for manufacturing machines
- ✓ Information categorization
- ✓ Optimizing the design of mechanical components
- ✓ Multiple optimization
- ✓ Fuzzy logic controllers for athlete robots

Introduced Bee algorithm

As mentioned, the Bumblebee algorithm is an optimization algorithm inspired by the natural behavior of bee honey to find the optimal solution. The pseudocode represents the algorithm in its simplest form. This algorithm requires adjusting a number of parameters: the number of bee colonies (n), the number of newly hatched bees for the best places (np) c, the number of bees hired for the other (mc) the selected location (nsp) the initial size of the land (ngh), including the location and its neighbors, and the benchmark for stopping the algorithm. (Vahidzadeh, 2015)

The algorithm begins with the n beeps that are randomly positioned in the search space. The eligibility function of the places visited by the bees is evaluated in step 2.
Initial population initialization with random solutions
Assessing the suitability of the population.
Hire bees for new places (more bees for best places e)
Choose the most suitable bee from any piece of land.
Allocation of remaining bees for random search and assessment of their merits

End of the loop

In stage 4, bees of the highest rank will be selected as "selected bees" and the places visited by them will be selected to search for neighborhoods. Then, in steps 5 and 6, the algorithm directs searches in the neighborhoods of the selected locations and assigns more bees near the best e locations. Bees can be selected directly on the basis of the suitability of the places they have visited. Alternatively, the merits are used to determine which bees will be selected. Neighboring searches bring the best places e that offer more promising solutions than other selected bees, by sending new bees more to follow them in more detail. Along with the view, this difference is a key to the operation of the Bumblebee algorithm.

However, at Stage 6, for each piece of land, the best bees will be selected to form the next bovine population. There is no such limit in nature, this limitation is introduced here to reduce the explored points, at a stage? The remaining bees in the population are randomly assigned around the search space to look for new potential solutions. These steps are repeated until a stopping point is met. At the end of each replication, the colony has two parts in its

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new population (Abcher, 2016)

This algorithm has the following key benefits compared to other similar optimization methods:

• Unlike most traditional methods, this does not require a derivative. In fact, the derivative action or gradient causes slowdown and localization.

• It has less sensitivity than the nature of the matching of the target, that is, the constraint or continuity. In another sense, it does not have much dependence on the system under study, and with increasing constraints, the problem will be good.

• In the proposed method, the control parameters of the algorithm are less and hence the possibility of self-regulation. With this technique, the dependence of the algorithm decreases over the exact adjustment of its parameters.

• According to chaos theory, it has the ability to escape from local points.

• Easily implemented and programmed with basic mathematical operations.

Methodology

The research methodology is documentary - library. This means that all the necessary information from the sources written in the books, writings and previous research available in the libraries or the archives of the organizations is written and there is no need to refer to the people and to ask questions or to observe or to interview. Then, the result of this research is a research It is applied because of solving one of the current issues of investment management in companies and investment institutions.

It's not correct to claim that an optimization algorithm is the best way to solve optimization problems, as newer algorithms emerge each year by covering the weaknesses of previous approaches. Perhaps GA and later PSOs were the best optimization algorithms of their kind. Although it is still possible to see their use in a large number of articles. These methods are sometimes used as benchmarks for comparing performance in new methods.

Some researchers believe that there is no reason for an evolutionary optimization method to be better than the other, because any method should be able to find the right solution due to its evolution. The point here is that some methods, like their real models, evolve in nature. For example, in the genetic evolution that inspires real genes, evolution and evolution are evolving over many years. That's why GA needs more repetitions to find the right answer.

جامعه آماری

The present study was conducted on the basis of the information since 2013 to 2015. The statistical society of this research is determined by taking into account the limitations that are used to increase the reliance of the investigated research, as follows:

1- Companies since the beginning 2013 in Tehran Stock Exchange and by the end of 2015 are also on the list.

2. The information about these companies is available for the entire period of interest. Companies whose performance information has not been available for all 36 time periods has been removed.

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3. Their shares have always been traded during the period under review. Companies are considered to have been traded on average for more than ten days each month on a month-by-month basis.

Considering the above limitations and reviewing the information about listed companies in Tehran Stock Exchange, 112 companies have been considered and considered as statistical community.

Data collection method

Regarding the input data of this research, the monthly returns for 36 periods, the relevant data were collected using the Tehran Stock Exchange website and Rahavard Novin Software. The following is a brief description of the company names and operations carried out on They are mentioned:

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Table 1. The names of companies in the Stock Exchange

Number of sections	Composite return	Real return	Expected return	Risk	Expecting to take risks	β coefficient	Sharp ratio	Rating of liquidity	days	Companies	Year
4.00	1.24	5.63	5.64	1.71	3.29	0.28	134.21	39	6.00	Azarab	2013
4.00	1.17	4.02	4.71	14.44	0.33	-3.89	-15.98	12	6.00		
2.00	1.04	2.01	2.04	3.68	0.56	3.77	-63.39	167	4.00		
4.00	1.04	1.01	1.04	2.52	0.41	0.12	-92.94	20	6.00		
4.00	0.98	-0.47	-0.18	9.06	-0.02	-0.72	-26.01	18	6.00		
3.00	0.73	-9.77	-9.47	8.83	-1.07	1.55	-28.62	16	6.00		
3.00	1.09	2.83	3.04	8.13	0.37	1.31	-29.55	7	7.00		
3.00	0.90	-3.39	-3.34	3.89	-0.86	-4.43	-63.38	22	7.00		
3.00	1.20	6.39	6.59	7.95	0.83	1.11	-29.79	22	6.00		
3.00	0.95	-1.72	-1.62	5.49	-0.30	1.13	-44.65	72	6.00		
3.00	0.98	-0.63	-0.47	6.90	-0.07	0.81	-36.55	49	6.00		
4.00	0.44	1.02	1.80	0.45	-0.31	0.25	141	187	4.00	Alborz Daroo	2014
4.00	0.96	1.04	1.31	0.97	-0.04	0.74	187	164	6.00		
4.00	-1.40	0.95	1.77	-1.39	0.67	-0.78	164	180	5.00		
4.00	-0.29	0.99	0.27	-0.29	0.07	-1.08	180	194	5.00		
4.00	0.84	1.03	1.82	0.85	0.21	0.47	194	224	5.00		
4.00	5.05	1.22	4.46	5.12	0.41	1.15	224	228	5.00		
3.00	0.05	1.00	3.54	0.09	-0.73	0.02	228	232	3.00		
3.00	-1.78	0.95	2.01	-1.77	0.16	-0.88	232	220	5.00		
3.00	-0.41	0.99	1.19	-0.41	0.27	-0.34	220	232	5.00		
3.00	-1.33	0.96	1.34	-1.33	-0.34	-0.99	232	212	5.00		
3.00	-4.05	0.88	1.86	-4.04	-0.18	-2.17	212	208	5.00		
3.00	0.79	1.02	1.09	0.79	0.64	0.73	208	187	4.00		
1.05	4.00	1.40	1.22	3.34	0.20	6.95	5.00	164	-33.70	Iran Khodro	2015
1.20	4.00	4.84	4.73	1.53	0.88	5.50	6.00	5	-41.96		
0.88	4.00	-2.89	-3.03	3.57	-0.47	6.14	6.00	75	-38.81		

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0.80	4.00	-5.46	-5.50	0.71	-1.62	3.37	6.00	4	-71.43		
0.84	4.00	-3.97	-4.20	3.30	-0.52	7.67	7.00	7	-31.22		
1.10	4.00	2.61	2.52	-0.28	0.52	5.00	5.00	15	-46.57		
1.02	3.00	1.05	0.54	2.30	0.09	12.26	7.00	14	-19.76		
1.19	3.00	6.18	5.84	-5.28	0.60	10.23	7.00	8	-23.19		
1.06	3.00	2.15	2.02	-0.01	0.34	6.39	6.00	2	-37.73		
0.85	3.00	-5.27	-5.28	-0.30	-3.08	1.71	6.00	1	-145.29		
0.91	3.00	-3.09	-3.20	1.04	-0.54	5.75	6.00	12	-42.87		
1.02	3.00	0.84	0.77	-0.06	0.18	4.64	5.00	133	-52.21		
1.00	4.00	0.06	1.10	0.06	-0.08	0.06	-214.96	5.00	83	Eghtesad Novin Bank	2015
1.16	4.00	3.72	6.53	3.87	-0.32	0.59	-35.47	6.00	47		
1.11	4.00	2.70	6.96	2.87	5.76	0.41	-33.43	5.00	139		
0.92	4.00	-2.14	7.17	-1.94	-2.20	-0.27	-33.11	6.00	39		
1.05	4.00	1.12	3.01	1.15	-0.20	0.38	-77.75	6.00	132		
0.85	4.00	-4.05	4.57	-3.97	-1.82	-0.87	-52.43	5.00	83		
0.94	3.00	-1.98	5.96	-1.86	0.17	-0.31	-41.16	7.00	50		
1.02	3.00	0.75	4.62	0.82	1.76	0.18	-52.44	7.00	58		
0.93	3.00	-2.36	5.46	-2.26	-1.24	-0.41	-45.00	6.00	59		
0.90	3.00	-3.48	2.37	-3.46	-0.42	-1.46	-103.94	6.00	44		
1.09	3.00	2.84	5.27	2.93	0.25	0.56	-45.66	6.00	38		
1.02	3.00	0.59	1.05	0.59	-0.04	0.56	-230.54	6.00	52		

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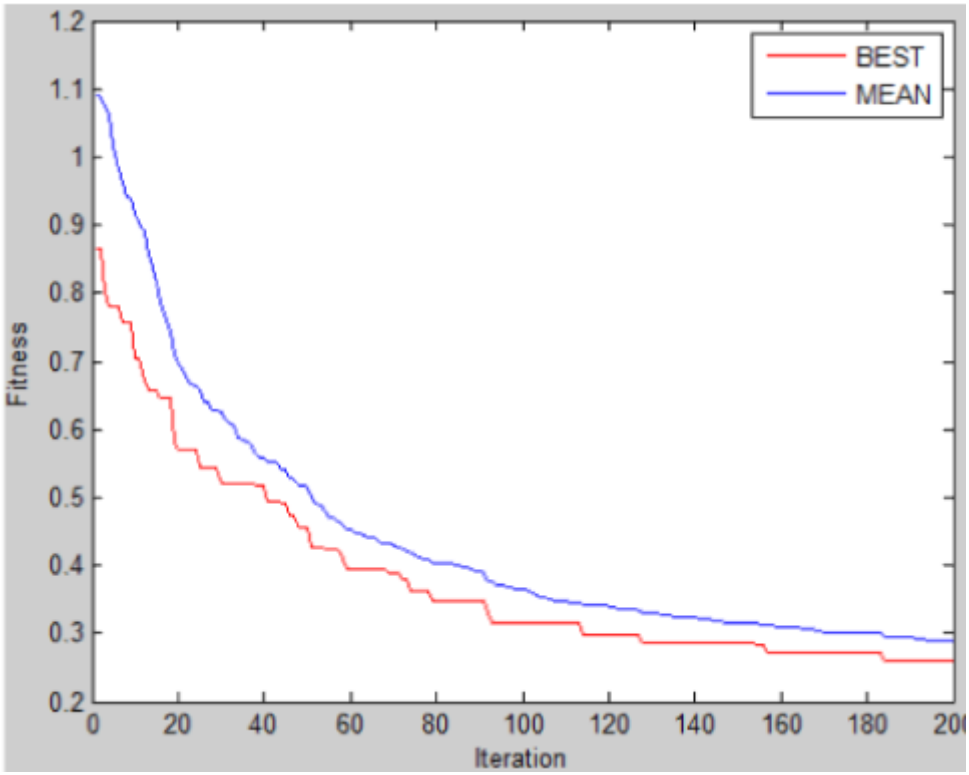
Revista Publicando, 5 No 16. (2). 2018, 471-482. ISSN 1390-9304

Data analysis

Bee algorithm and Markowitz model are used for data analysis.

Table 2. Analysis of data according to the Beehive algorithm

Case 8= 0.76 Case 9= 0.76 Case 10= 0.76 Case 12= 0.70 Case 13= 0.70 Case 15= 0.66 Case 18= 0.62 Case 22= 0.61 Case 26= 0.59 58Case 27= 0. 8Case 28= 0.5 58Case 31= 0. 56Case 34= 0. 53Case 37= 0. 53Case 38= 0. 50Case 45= 0. 49Case 46= 0. 49Case 47= 0. 49Case 48= 0. 48Case 49= 0. 48Case 51= 0. 48Case 53= 0. 48Case 54= 0. 45Case 59= 0. 45Case 66= 0. 45Case 70= 0. Case 77= 0.76 34Case 79= 0. 34Case 93= 0. 34Case 96= 0. 34Case 98= 0. 31Case 108= 0.	
BEST FITNESS = 0.23021	
Time = 18.0849	

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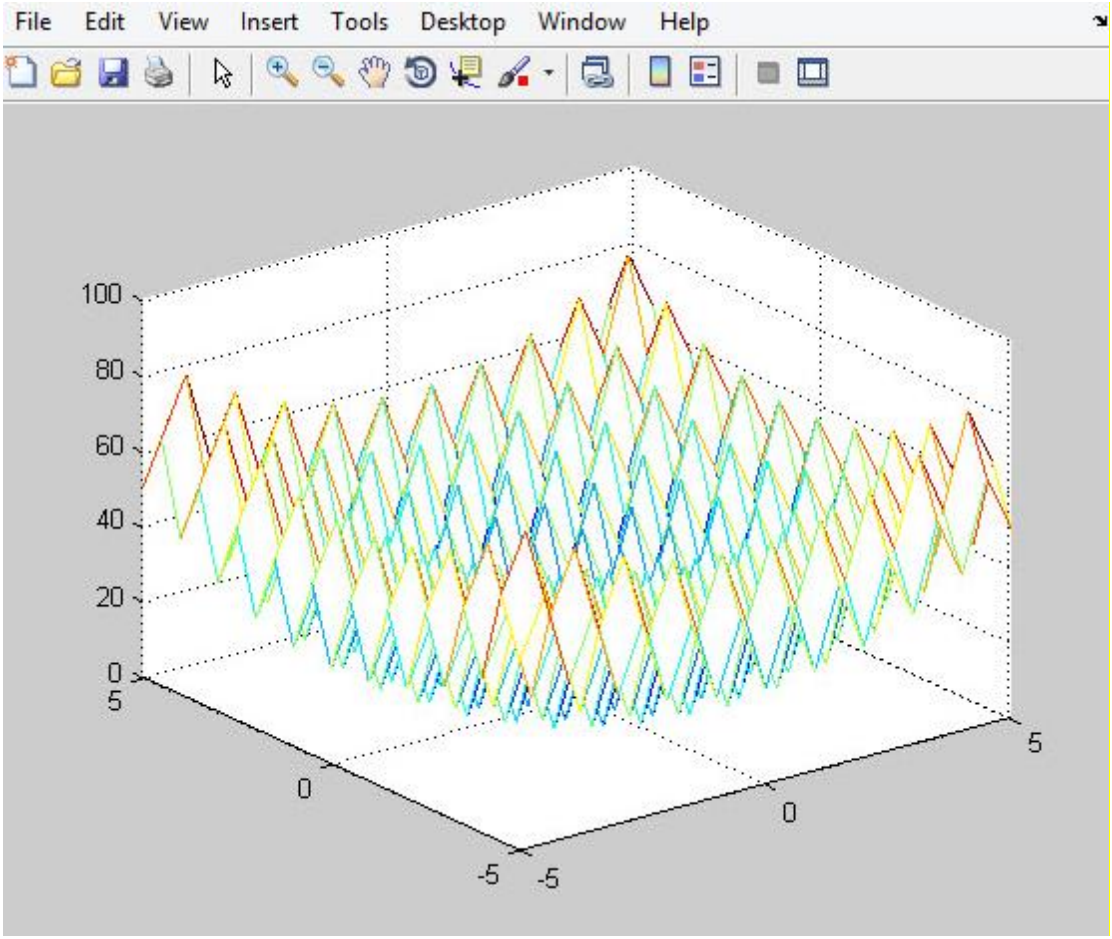

Figure 2. Spss software output

The comparison of the Markowitz model

Markowitz was the first to officially develop the concept of stock market dynamism. He generally showed why and how stock market fluctuation risked it for the investor.

The 1950s can be called the birth of financial knowledge or modern finance theory. During this decade, Garry Markowitz explained the mean of variance in the light of the theory of portfolio, securities. This theory later became the basis of the theory behind itself, so that through this model, the risk for the first time became a quantitative criterion. Of course, it is worth noting that the modern theory of the portfolio of portfolios describes how to optimize the behavior of investors (CAPM), so that the model of capital asset pricing in 1965 and 1966 in Masin, also based on this assumption (sharpe, 1963) it is also based on economic equations.

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Analyzing and interpreting the results of the bee algorithm

Table 3. Results of Bee algorithm

Share of total basket (share of 100)	Company No.
0.2	8
0.66	9
0.62	10
0.63	12
0.62	13
0.5	18
0.31	22
0.65	26
0.63	27
0.02	28
0.51	31
0.08	34
0.2	37
0.75	38
0.9	45
0.51	46
0.79	47
0.77	48
0.61	49
0.32	51
0.73	53
0.57	54
0.69	59
0.14	66
0.39	70
0.31	77
0.76	79
0.17	93
0.6	96
0.53	98
0.59	108
%100	Total

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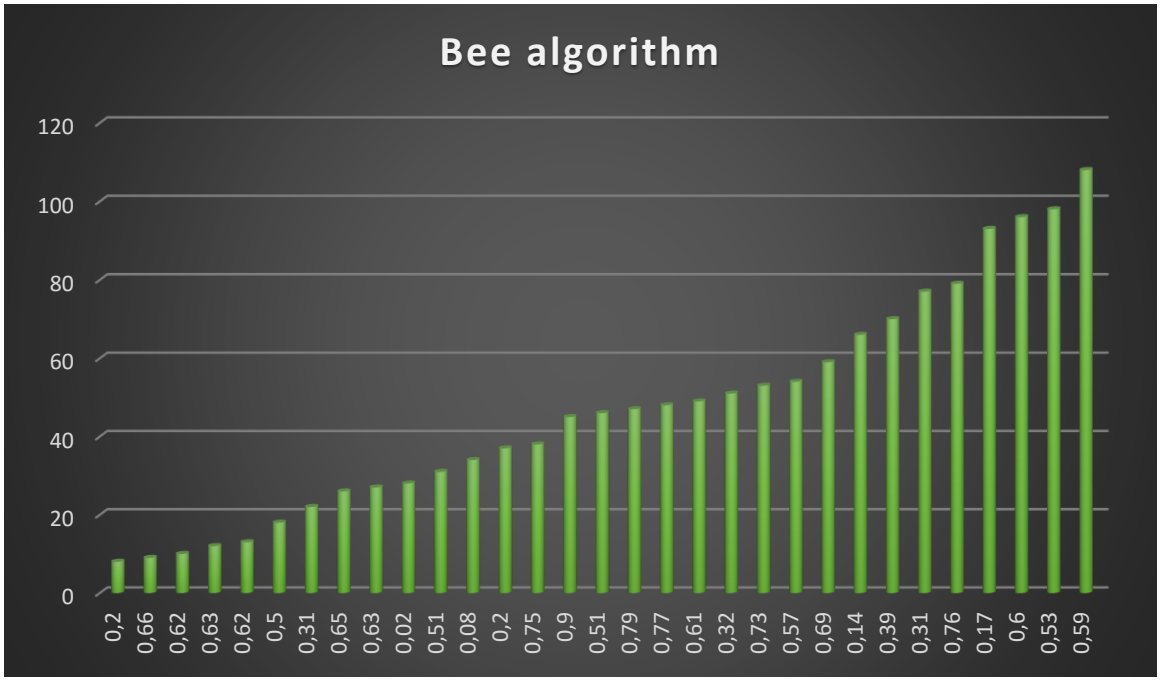

Figure 3. Bee Algorithm Diagram

Analyzing and interpreting the results of the biogeographic algorithm

Table 4. The results of the biogeography algorithm

Share of total basket (share of 100)	Company No.
0.07	3
0.17	8
0.04	13
0.15	16
0.08	17
0.09	18
0.05	30
0.14	31
0.02	32
0.14	38
0.02	40
0.01	47
0.01	48
0.05	50
0.01	54
0.01	61
0.06	64

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Approved 06/10/2018

0.01	71
0.06	72
0.05	73
0.11	79
0.17	81
0.15	83
0.14	86
0.09	88
0.05	89
0.08	92
0.01	94
0.04	98
0.01	99
0.34	100
0.05	108
%100	Total

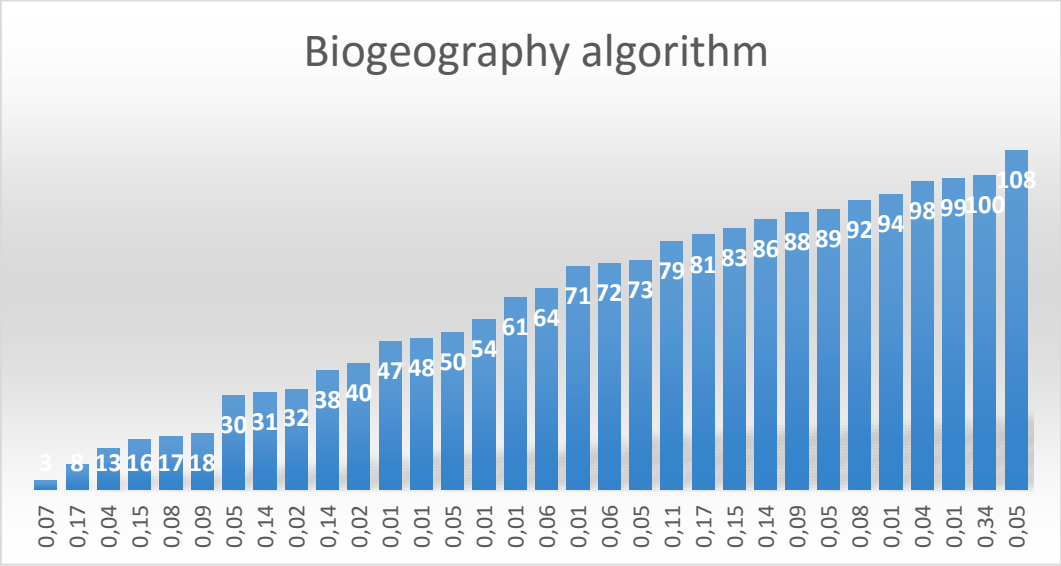

Figure 4. Biogeography Algorithm

Analyzing and interpreting the results of the firefly cream

Table 5. Results of Firefly algorithm

Share of total basket (share of 100)	Company No.
0.2	8

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0.66	9
0.62	10
0.63	12
0.62	13
0.5	15
0.31	18
0.65	22
0.63	26
0.02	27
0.51	28
0.08	31
0.2	34
0.75	37
0.9	38
0.51	45
0.79	46
0.77	47
0.61	48
0.32	49
0.73	51
0.57	53
0.69	54
0.14	59
0.39	66
0.31	70
0.79	77
0.17	79
0.6	93
0.53	96
0.59	98
0.03	108
%100	Total

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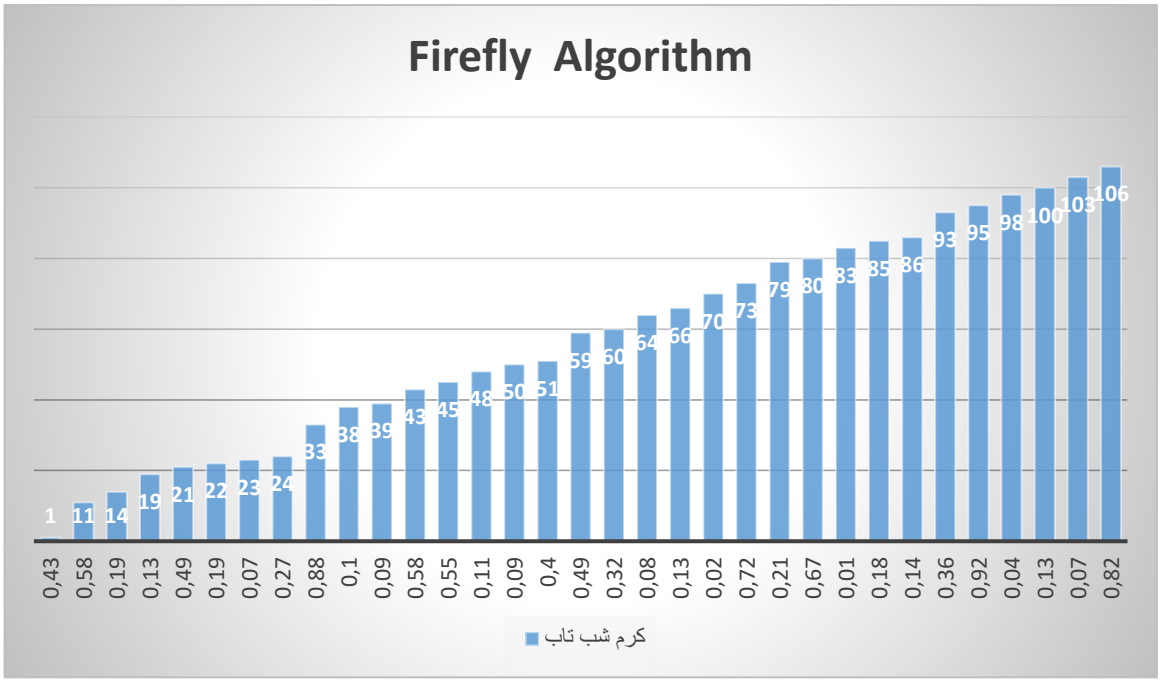

Figure 5. Firefly algorithm

Discussion and conclusion

One of the important issues that arises in capital markets and should be considered by investors, whether natural or legal, is the issue of choosing an optimal portfolio of portfolios. Issues of portfolio selection have long been considered by researchers and investors, as there have been many theories and models for choosing an investment basket.

It should be noted that the majority of users of a scientific research are more likely to follow the results of that research. Therefore, after analyzing the data collected, based on the results of the research findings, we attempt to answer the research question appropriately. First, a summary of the whole research is presented.

The intensity of the competitions in the scientific, social, economic, political and military fields has also doubled the importance of access to information, so the need to design systems that can quickly explore the information of interest to users, emphasizing minimum human intervention, on the one hand and on Bringing in methods of analysis proportional to the volume of bulk data on the other hand, it feels well.

The results of the comparison of the honey bee colony algorithm in this study with other algorithms presented in various papers showed that this algorithm is able to provide the best response with maximum accuracy and convergence rate, and also does not have the optimal local convergence problem. Given that the algorithm has just been introduced, it is possible to combine this algorithm with other algorithms as a future work.

Nature-inspired optimization algorithms as well as intelligent methods of optimization along with classical methods have been successful. These methods include genetic algorithms (inspired by the biological evolution of humans and other organisms), optimization of particle

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communities (based on the migration of birds and fish) and simulated annealing (inspired by the refractory process of metals). These methods have been used to solve many optimization problems in various areas, such as determining the optimal path of automated agents, optimized controller design for industrial processes, and also in the design of intelligent agents.

The purpose of this study is to provide the best stock portfolio of Tehran Stock Exchange using the Bee Algorithm.

The selection of stock portfolios is a difficult operation in investment topics. Two important elements in the field of investment, risk and return. Investors are always inclined to increase their returns at a certain level of risk, or at a certain level of return, their risk by presenting his portfolio model, Markowitz showed that with the formation of a basket of current assets, it would be possible to reduce the return on risk at a certain level.

An evaluation of an optimization algorithm is a costly process. In this section, the proposed algorithm proposed for the first bore of the colony honeycomb algorithm is proposed with the proposed algorithm to be designed and implemented for real world issues because the number and distribution of optimizations and their quality are unknown. However, the efficiency of the algorithm must be checked and investigated in the first step to compare with other algorithms. In the testing of algorithms, two performance scales that reject all the multiple optimization articles for comparing the methods can be considered well, which include:

- Stability in the positioning of all known optimizations
- The average number of objective function evaluations to find these optimizations (or the number of runs under the same conditions)

The test set used in the experiment involves maximizing multiple functions. This test set, which is considered for evaluation of the proposed algorithm, has different complexity and local optimization functions than multiple functions. In most articles, this set of test functions is used to evaluate and compare algorithms.

The comparison between algorithms includes the number of optimized finds and the number of evaluations of the optimization function. Therefore, the results of the articles can be easily used to perform comparisons. Another point in simulating is that all the compared methods, other than the proposed methods and colonial competition method, solve the optimization problems based on the operators of the genetic algorithm of the optimization process. However, the proposed algorithm operates based on the Cuckoo optimization algorithm, and because the algorithm has not yet been provided based on the colony honeycomb algorithm that performs multiple optimizations, the proposed algorithm is compared with the basic algorithms in multiple optimization. The parameters of the methods are based on the references that the results of the proposed algorithm are compared with, the efficiency of the algorithms in terms of the number of optimizations found by each method is evaluated with averaging over the number of implementation of each method, which is the number of replicas of the implementation of the algorithms 30 Run time.

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In these methods which are dependent on the threshold of the interval between the answers, when an optimal o_j is an optimal, its distance to a member of the population is smaller than one:

$$(\exists x_i \in pop\ (t = T) | d(x_i, O_j) \leq \epsilon = \cdot.\cdots\circ)$$

As Pop (t = T) represents the total population at the end of each run, and xi is a member of the Pop population (t = T).

The algorithm's stopping criterion is such that if algorithms are stopped after a specified number of duplicates, then no new optimal algorithms are found. This measure of the methods is in the form that initially generates 50 generations of evolutionary algorithms, and then the optimal order is ordered, and if all the optimizations are found, the algorithm ends, and the next 10 generations of the evolution process are done. In the proposed algorithm, given that in all steps of the algorithm, the optimal number is known because it can count the number of optimizations found in each implementation of the algorithm and if, in 10 replays, no new optimal memory is stored, the algorithm stops (the setting Parameter (S) Maximum number of replication algorithms in which replies are not returned to the memory S = 10)

The results of comparing the proposed algorithm with other evolutionary algorithms as well as all the combined algorithms presented in different papers showed that the proposed algorithm is able to provide the best response with maximum accuracy and convergence speed, and unlike other existing algorithms, the quantitative dependence on the parameters of the parameters Primary and maintains efficiency by applying changes in the parameter values and the optimum clustering accuracy is achieved.

A real world problem with the decision on the optimal portfolio composition is the uncertainty of input data. The effect of this uncertainty on the justifiable answer is so that only a small percentage of the variations in the inputs can greatly increase the probability of justifying the answer. Therefore, an approach should be adopted that uncertainties can be considered indeterminate. The approach used in the stock market steady modeling in this research is a proposed colony honeycomb algorithm that has many advantages, including the longevity of the sustainable model, the ability to adjust the levels of protection with respect to the degree of uncertainty.

The decision maker can adjust the levels of protection to a satisfactory sustainable solution according to the sensitivity of the problem and the uncertainty. Using this model, assets were initially selected on the basis of the downward trend in average returns, and then the assets with a lower risk (risk) were given a higher weight. Resilient portfolios have been diversified both in terms of assets and in terms of weight, which is a desirable feature, especially as the portfolios become more diverse with higher levels of protection, which ensures a more stable level of protection. Of course, in terms of diversification, it should also be taken into account that the existence of a greater number of stocks in the portfolio does not always lead to better portfolio performance, but may also impair portfolio performance by entering low-quality stocks. In addition to this model, the set of uncertainties or larger intervals yields more stability.

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The results show that the value of C depends on the investor's preferences and conservatism; large C values may not affect decisions, but the stability of the answer increases.

In this research, a view was made to select the optimal portfolio. In the first step, this view classifies the initial portfolio into smaller portfolios with the Markowitz model. In the second step, the colony honeycomb algorithm was implemented on the class with the highest returns and the lowest risk.

The variance obtained using the algorithm in the stock portfolio is less than the variance obtained from the application of the genetic algorithm method alone.

The returns obtained by the algorithm in the stock portfolio are higher than the returns from using the genetic algorithm alone.

The results and graphs confirmed assumptions, as well as the test and error method for stability assumptions, which the tables of this test also fully validated the assumptions. Finally, it was concluded that if we were to choose alternatives for this algorithm with a genetic algorithm and then an optimal portfolio selection for the input of the colony honeycomb algorithm, or to put it another way, we would be closer to our goal of increasing efficiency and reducing risk. According to the findings of this method, it improves the implementation of the honey bee colony algorithm. Also, the flexibility in the fitness function designed to weigh the return or risk parameter causes the investor to achieve optimal portfolio according to his preferences.

Due to the increasing development of limitations and considerations related to production systems, classical optimization methods have been exponentially raised (NP-hard) with the problem of increasing the dimensionality and thus increasing the time of solving models, so that the problem is called "Hell of the Future" " Has been named. The meta-heuristic methods provide solutions to the Hell problem that can be solved in the management of production systems.

In this research, it has been shown that a combination of an optimization algorithm can be used to solve the Tehran Stock Exchange prediction problem.

In the bee colony algorithm, it was found that these algorithms have a high speed and power in convergence of problems in continuous problems, and it was also determined that changing parameters of the optimization algorithm dynamically performs better algorithms. One of the problems is the local optimal algorithm, which, using 10% of the lower population of each generation, in the next generation algorithm no longer faced with the optimal local problem.

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