Science Arena Publications
Specialty Journal of Accounting and Economics
ISSN: 2412-7418
Available online at www.sciarena.com
2019, Vol, 5 (2):1-13

Portfolio Optimization Using Black Hole Meta Heuristic Algorithm

Kaveh Mehrani[1], Amirmehdi Mirshahvalad[2]*, Ebrahim Abbasi[3]

[1] Associate Prof. of Accounting, Accounting and management Department, University of Tehran, Aras International Campus, Tehran, Iran.
[2]Ph.D. Student in Finance, Finance and management Department, University of Tehran, Aras International Campus, Tehran, Iran.
[3]Associate Prof. of Finance, Finance Department, Alzahra University, University of Tehran, Aras International Campus, Tehran, Iran.

*Corresponding Author

Abstract: *The aim of this research is optimization portfolio by using black hole algorithm in Tehran security exchange and comparing with Markowitz. In this research, the semi variance approach is used due to its ability in measuring downside risk and it is tried to reduce the appropriate portfolio risk. This research is conducted in the period 2012 to 2017. The method of this research is applied in terms of the aim of research and it is descriptive-correlational research base on the data collection manner that retrospective approach, post-event and through analysis the observed data, we try to optimization portfolio by using black hole algorithm. The results of research show that we conclude by using black hole algorithmic that all years the black hole method has obtained results the same as Markowitz's results and can be the suitable pattern for optmization portfolio.*

Key words*: Portfolio Optimization, Undesirable Risk Aversion, Black Hole Algorithm, Markowitz Method*

INTRODUCTION

The issue of assets selection and formation assets portfolio always has been one arguable issue in financial theories. Until the late of twneties centuries, the main financial theories were stated in case and nonsystematic manner. Markowitz (1952) provided the first portfolio theory for risk reduction and efficiency assessment risk assests (mean variance model) and the variety portfolio. This theory with the balance assumption in the market cause develop positive financial theories such as james (1985)'s capital market line plan, capital assets pricing model 1964 by Sharp, Lintener and black, the work market assumptions Ogen Fama (1965), Black–Scholes Option's pricing model in 1973 and Amous verski, Daniel Kahtman and riched Taller identify investor's non-logic behaviour and provide behavioural-financial theory in 80, 90 decade. The dominant paradigm in financial theroy is base on the maximization the expected desirable return and risk avoidance. While the experimental studies in real world have many criticism in the recent years to modern financial theory and human assumption (Zanjirdar et al, 2015).

Investment theories in the recent decades have considerable advancements and have achieved to many applied formulas in their historical development. It is said that trade and investment follows the historical velocity theory, that is, trade volume and investments in twenties century follow the special developments and it is increasing rapidly. There is no doubt that the current technologies usage and the future changes in its, will have effect on the speed, volume, trade usage manner in the near future. These changes cause to use different criteria for adpoting decision by investor in comparison with last periods. Portfolio means that combination of assets that is formed by an investor for investment. This investor can be an indivisual

or an institute. Technically, portfolio includes set of real and financial assets that invested by an investor. Study all portfolio aspects is called portfolio management (Tehrani, 2015).

Investment management include two main discussion that is Security analysis and Portfolio management. Security analysis includes estimation separate advantageous of investments. While Portfolio management includes analysis investments combination, managements and maitainance set of investments. In the recent decades, the process of investments issue has changed from stock selection methods (Security analysis) to Portfolio management. The issue of selecting the optimized set from assets, is one of the famous issue in capital market that has the special importance also in macro & micro economics issues. In macroeconomics, investments is considered as one of the important indexs and play important roles in the growth and developemnet economic. Also in microeconomics, the importance investments decisions arise from this issue in which investor transfer the current consumption to future consumption in order to more consumption. In fact, the optimized decision for investments increase the investor's expected desirability amount for future consumption. The desired function of each person is determined according to the personal preference that necessarily is not similar with other persons. Risk and efficiency are criteria that investor desirability amount determines from the selection set of asset investments. The set of asset each investor is selecting is different according to its condition, time horizon, risk and cash flow rate (Tehrani, 2015).

Investment can be interpreted and explained in different dimensions and concepts but the most comprehensive its interpretation can be stated such as " money commitment or investment for financial purchase tools or other assets, in order to profitable and useful returns in the interest format, dividend or acknowldege in tools value (capital ineterest). From different kinds of investments, can refer to investment in stock market. Investment in stock market includes its special components but certainly investment in stock market is the lowest risk and the most efficiency is the different knid of investment. Surely, investment in stock market if it is not analyzable and consciously can have high risk so the most important factor in different investments, specially investment in stock market " risk management and increasing investment efficieny". Portfolio theory and selection the optimized portfolio after the first efforts markowitz (1952), always as one of the research attractive field for researcher as well as investors in financial markets. The issue of portfolio selection and or portfolio optimization include designing the suiatble model optimization and selection suitable criteria for stock selection. From the first criteria that by Markowitz was used in traditional model portfolio, the rate of expected efficiency and variance portfolio efficiency rate. The logic usage in this model was that variance as one dispersion criteria can be critics the amount of risk one portfolio (Shiri ghahi et al 2016).

Investment is one of the most important well-known discussions in all economic countries that has important places for real person and all authority countries. That's why in the recent two decades, financial market development and providing new tools in attracting more capitals is one of the suitable strategies in international level. However, with new financial tools(such as derivative tools) and their wide usage in developed countries, yet many developing countries, specially, Islamic countries, they can ot use them for attracting capital or fund raising. Therefore, traditional financial markets like stock market main structure financial markets of these countries (such as Iran) and allocate the main activities investor's and stock favors in initial and secondary markets.

On the other hand, appearance freedom field and remove some restrictive regulations in economic countries in the past decade, the first signs was remove stable currency rate system in the early seventies decade, it causes financial markets face with more fluctuations in pricing variables. Also, advent money unions and economic global process, cause communicability financial crisis is increased from one market to another market, that is, increasing fluctuation in the financial market. On the other hand, stock price severe faling in many capital markets lead to considerable loss for active factors. Therefore, activity in the financial markets without assurance and risk and measurement the risk amount in different portfolio is important for investors, so, examination and measurement downside risks has the special importance for financial institutes and capitial market activators (Asgharpour et al 2015)

The used innovation in this research use black-hole metaheuristic model for the first time in optimization portfoloio in Iran stock market. Also this model is the newest invented optimized model in the recent years in the quantitative solving numerical problem.

Literature Review

Markowitz model is one of the most famous and usage models for portfoloio selection, that provided in 1952. Markowitz model is the model base on grade 2 planning in which investment can for the definite span or interval, reduce your stock risk and select the portfolio with the lowest stock risk or determine your favorite risk level and maximise the expected return. Therefore, set of points (item portfolios) are created that in terminology is called Efficient Frontier. Markowitz was the first person who used variance or criteria deviation as one criteria for risk. He stated problem as quadratic planning with the aim of minimization variance set of assets with this condition that the expeteced return eqaul with constant value.

Risk avoiding of all investors is the main assumption of this model. This issue has also functional limitations in which total weights assets should be equal to 1. Also weight of each assets in portfolio should be positive and real number. After providing Markowitz model and determine its defects, different changes are done on it by researchers financial and management field and cause to develop of this model but development Markowitz model cause more complexes and its parallelism time-consuming model solving. Therefore, financial researchers decide to find the way for quick solve such these models for speeding to important decisions such as portfolio selection. For the first time in comprehensive research in 2000, Cheng and their colleagues suggest that they can use metaheuristic algorithm for discontinuous solving issue. In this research, use three metaheuristic algotithms genetic, forbidden search, annealing simulation for obtaining Optimized portfolio in real conditions. For modelling in comparison with investment, Soleimani and their colleagues design approach in terms of genetic algorithm that similar to cheng model. Maringer and Keler in 2003by providing an approach, that are obtained metaheuristic algorithm combination annealing simulation and developmentary theory, they solve optimizing portfolio by substitution assets better in portfolio. Guang 2012 can use metaheuristic algorithm optimized crowd particles for portfolio optimization.

Dominic & Sherris (2012) in research with title " selection insurance stock securities portfolio by using multicriteria decision making approach state that insurance related stock security market one asset class substitution increasingly important that risk and analysis return are different form the other assets. Measuring sample work risk and return for sample works insuarnce related stock security on the expected loss and expected return more than rate without risk. Multicriteria decision making introduces successful technique for optimized selection stock and use AHP and ELECTRE methods for adopting optimized decisions.

Smith in his studies (2014) examines different aspects of Portfolio active management by using stock supplying funds between 1996 and 2013 years. Consistent with this idea that sectional return dispersal, proxy is for current alpha in the market, therefore, our results show that stock supplying funds have reached to the strongest his performance during high dispersal. The performance virtue, certainly bring many dangerous adjustments. Portfolio managers may use from the current month dispersal for planning until know that investment approach is active or inactive in the next month. We also estimate active stocks for stock supply funds until reach to average 53%. In averadge, we document annual cost ratio for management active stock supply funding to about 7%. This number considerably near to active costs ratio that formerly has been reported for mutul funds stocks that this number may be considered as a documents for the equal pricing for portfolio management services.

Sun and colleague (2016) provided minimized model for portfolio selection problem in the research with title "portfolio optimization many periods under measuring possible risk". They obtian analytical solutions and numerical simulations, excellence multiperiod model during one period and regarding with market index. The first research about optimized portfolio in Iran stock exchange market by metaheuristic algorithm can refer to Abdol Alizade and their colleagues who use genetic algorithm for solving issue efficient portfolio in Iran stock exchange market. In this study, four different states are defined for genetic

algorithm and the problems are solve for different states. In 2011, Raei and his colleague use Harmonic searching algorithm for optimizing portfolio in Iran Stock exchange market (Raei and Ali Beigi, 2011). In this study, approach semi-variance-average is used and the efficient Portfolio boundry is obtained, by finding 50 point by algorithm. Many researches are done for using metaheuristic algorithm. The former reaerches had shown that metaheuristic algorithm can solve it with the proper exact in comparison with exact solution math problems.

Najafi and Moshkhian (2015) provided the model in the research with title "modeling and providing the optimized solution for optimization investment portfolio many peroids with genetic algorithm" until can overcome on the stated limitations and near to the real world.

Therefore, following the model with title investment portfolio optimized model many possible period average-semi variance-value in conditional danger exposure with considering cost, provide transaction and after its modeling, it is solved by using genetic algorithm. In this reserarch, use from data 24 stocks from stock Tehran Securities Stock company from December 2008 until Agust 2013 as model inputs for solving the model. The results has shown that this algorithm is appropriate and has necessary efficiency for sloving this class of appropriate issues.

Khanjarpanah et al (2016) in the research with title " prediction power increase stock market by using flexible planning" provide the new model on the basis modern portfolio theory and by adding limitations such as the number of stocks and flexibility weight stock in portfolio. By applying limitation stock weight flexibility, state is created that there is flexible and uncertainity in parallelism limitation that Fuzzy relations are used for modeling this flexibility. In addition above uncertainity, stock return also has uncertainty for recognition. Therefore, fuzzy approach has been used for struggling with uncertainty that both flexible programming and the possible that are the subset of fuzzy programming, has been used for converting model to the one simple issue. 30 accepted companies in Tehran security stock exchange have been used for solving model and its assess, that is, the one month return of these comoanies are considered. The rsults of provided models suggest that in the lower reliability level, can obtain the high profit with low risk by selecting a reasonable portfolio.

Abedian and Shajari (2017) in the research with title" multi indexes method for optimization portfolio selection by using foundational analysis variables in the petrochemical companies member stock exchange organizations" in this article the usage ratios in foundational analysis is considered as effective criteria for selection portfolio.

The importance each of the criteria was measured by the method Antropy Shanon. Then, techniques TOPSIS ELECTRE, SAW will be used for ranking underexamined society that include petrochemical companies member of stock. For this purpose, they used from the averdage thirteen real data, in time periods 2002 to 2014. The results of research show that using different methods multi index leads to different rankings. Finally, we can decide by using ranks averadge methods.

Also Mahdizade and his colleague (2017) in the article with title " priority and optimization portfolio made of Tehran Securrity Stock exchange with approach multicriteria decision making models and idealistic programming "they selected firstly 40 stocks for optimization from Tehran stock and criteria includes return averadge, return variance, return skewness, extension return, stock beta, each profit stock (EPS) and price on profit (P/E), the methods are been used in this research include anarchatical analysis method for determining weight of each criteria in decision making, Vikor & Topsis method is for prioritizing stocks and finally idealistic planing methods for optimizing portfolio. We can refer to the obtained results of this study such as Topsis and Vikor isotropic method. Return averadge and return Variance are the most important criteria that have been examined in this research.

Methodology

The statistic society of research is 50 excellent accepted companies in each year in which in 4 periods 3 month in each list 50 excellent companies jointly accepted companies in Tehran Security during 2012 to 2017. Time domain research years 2012 to 2017. The current research with analysis sectional data method. The stock organization publishes a list as 50 excellence companies at the end of each chapter. For

this research, list of companies that in each desired 4 seasons of year are in joint list, are selected as desired companies.

Determining proper portfolio for investor, is the main issue in the investment world. The optimized portfolio includes selection the best combination from financial assets in the manner that cause, at the possible investment portfolio return is maximaized and portfolio risk is minimized. The main idea of portfolio modern theory is that if we invested in the assets do not have completely correlation together, the risk of assets null each other, therefore, they can obtain a stable return with lower risk (chang and their colleague 2000).

In the Markowitz model according to the investment risk not only base on standard deviation one plan but also according to risk set of investment. The Markowitz mathmatics model is as follow:

$$MinZ:(1-\lambda)(\sum_{i=1}^{N}X_iE_i)+\lambda\sum_{i=1}^{N}\sum_{j=1}^{N}X_iX_jC_{ij}$$

$$ST:\quad \sum_{i=1}^{N}X_i=1$$

$$\lambda, X_i \geq 0$$

Where

λ investor risk avoiding degree

E_i – the expected income the i th plan

X_i – part of budget that is invested in the ith plan

Xj – part of budget that is invested in the jth plan

Cij =j ،(Cov(i= covariance investment I with investment j

Determing the optimized portfolio base on Markowitz model have many complexities such as calculations wide volume and many variables, in the same manner that in the market with N investment plan, equivalent $\frac{N^2+3N+2}{2}$ variable should be calculated. On the other hand, determining risk effect investment on the risk of investment set require covariance calculation and correlation coefficents that can cause the calculations be problem and time-consuming. On the other hand, efficiency distribution plans unlike the model assumption necessarily do not follow from the normal distributions and moreover, in the case, the standard deviation distribution is not computable.

The used method in this research, is applied in the respect of the aim, is correlational descriptive in the respect of the assumption test and is "post event" in the respect of the data collection by using historical informations i.e using the past informations. Information stock price companies are obtained through TSE Client and Rahavard Novin software. Also information related to the theoretic discussions from the library sources includes books, magazines, special site financial management and the gathered accounting.

Research Hypothesis

There is significant difference between efficient boundry optimized portfolio Markowitz model and black hole metaheuristic model.

Blackhole algorithm (BH) is an innovative method that is inspired and has attracted many attentions due to simple and easy at operation and from the time of his inventions is used for solving many optimized practical. The black hole algorithm is an evolutionary algorithm that was intruce by Hatamlou in 2013 and the firs time is used on the issue data clustering.

This algorithm is inspired from the black-hole phonomenon and are the similar the other algorithms base on population, BH algorithm is started with the intial population from nominated solutions for one issue and optimization aimed function that is calculated for them. At each repetition of black-hole algorithm,

the best selected nominated black-hole is considered and then start to other nominations around themselves that is called star.
If one star is neared very close to black-hole, it is swallowed by black-hole and eradicated for ever. In this respect, one new star (nominated solutions) is produced randomly and placed in search space and start to new search. Like other algorithm base on population, in black hole algorithm, the nominated solutions population (stars) is randomly produced and is placed in space search of issue or function. After initial value, population fitness value, valuation and the best nominated in the society that have the best fitness value is selectes as blackhole and the other form the natural star.
Black hole has the ability to attract stars that surround it. After the initial value black hole and stars, black hole starts to attract the around star and all stars begin to move tword blackhole. The attracted star by black hole is formulated as follow:

$$x_i(t+1) = x_i(t) + rand * \left(x_{BH} - x_i(t)\right) \qquad i = 1,2,\ldots..,N$$

Where in the formula, places star I $_{th}$ is respectively in replication t+1,t . the black hole place is in the search place. Rand is a random number in span [0,1]. N is the number of stars (the nominated solution).
In the stars movment twoard black hole, one star may reached to one place with lower cost than black hole. In this regard, the balck hole move twoard the star place and vice versa. Then black hole algorithm will continue in the new palce and then stars will begin to move twoard a new place.
Moreover, the possible passing from events horizon in the stars movement tword balck hole. Each star that pass horizon event black hole is sucked by black hole. Each time that one nominated (star) dies is sucked by black hole. Another nominated solution is born and randomly is distributed and start to new search. This work is nominated for stable maintaing the number of solution. After all stars movements, the next repetition is happen. The event radius horizon in blackhole algorithm is calculated by the following equations:

$$R = \frac{f_{BH}}{\sum_{i=1}^{N} f_i}$$

Where in formula, f_{BH} is the fitness value balck hole and f_i is the fitness value star i$_{th}$. N the number of stars (nominated solutions). When distance i.e. one nominated solution and the black hole (the best nominated) lower than R. this nominated fall and another new nominated is created and randomly is distributed in searching atmosphere.

Results

In the following figures, the average return 50 excellent companies in periods 2012 to 2017.

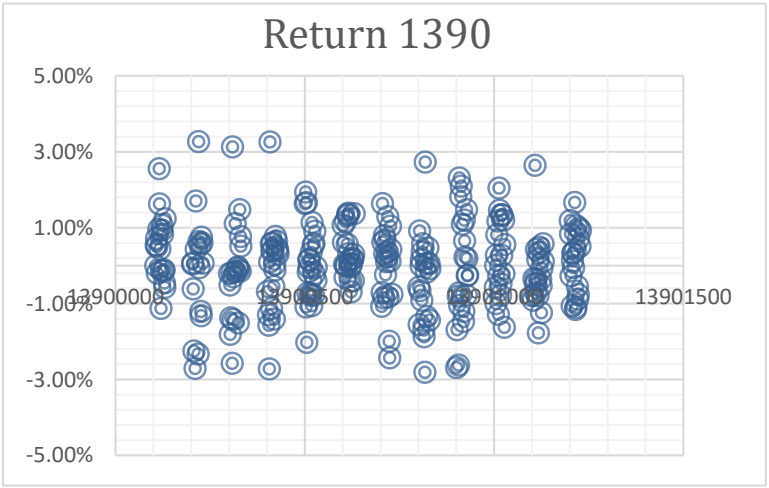

Figure 1: the average stock return 50 excellent companies in 2012

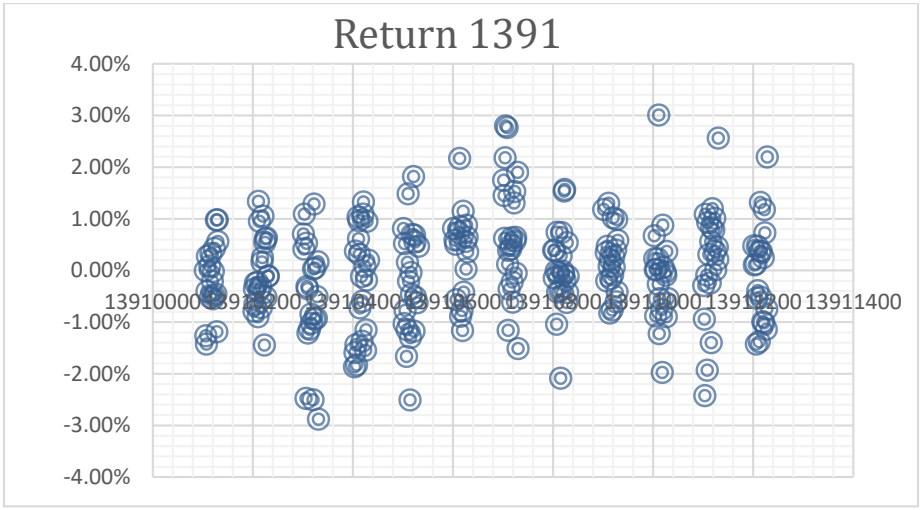

Figure 2: the average stock return 50 excellent companies in 2013

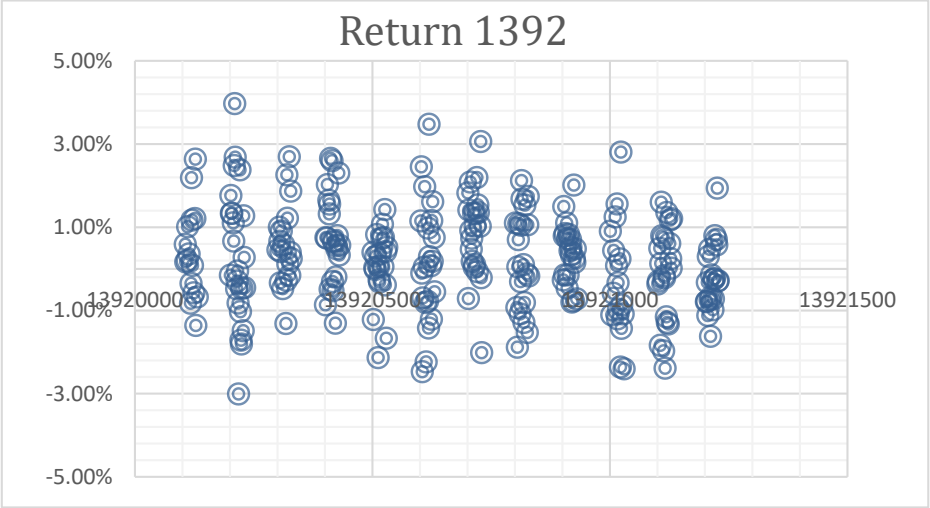

Figure 3: the average stock return 50 excellent companies in 2014

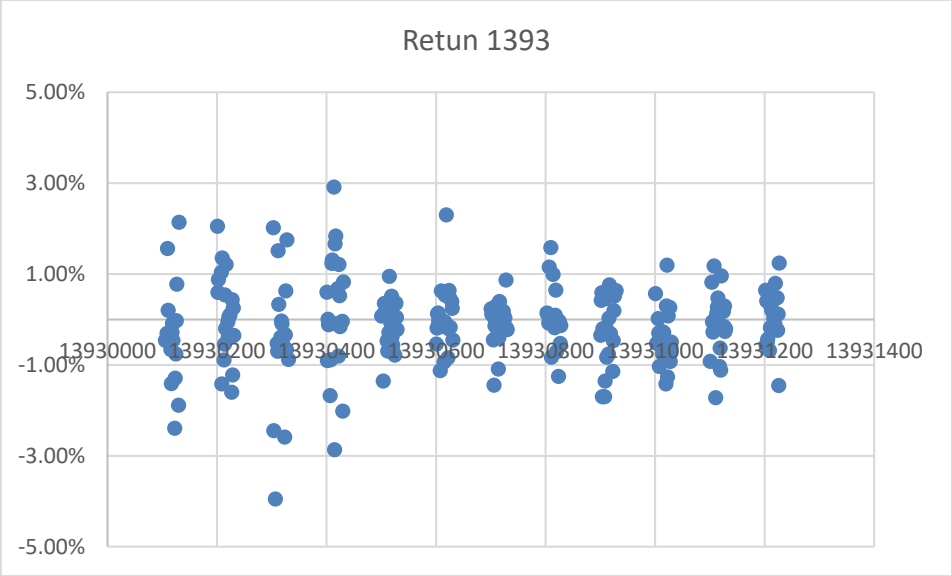

Figure 4: the average stock return 50 excellent companies in 2015

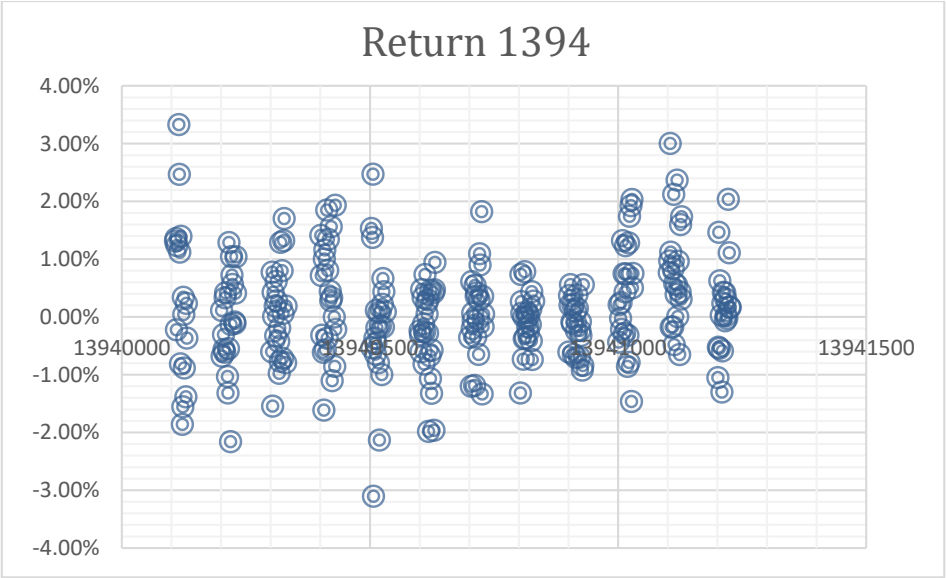

Figure 5: the average stock return 50 excellent companies in 2016

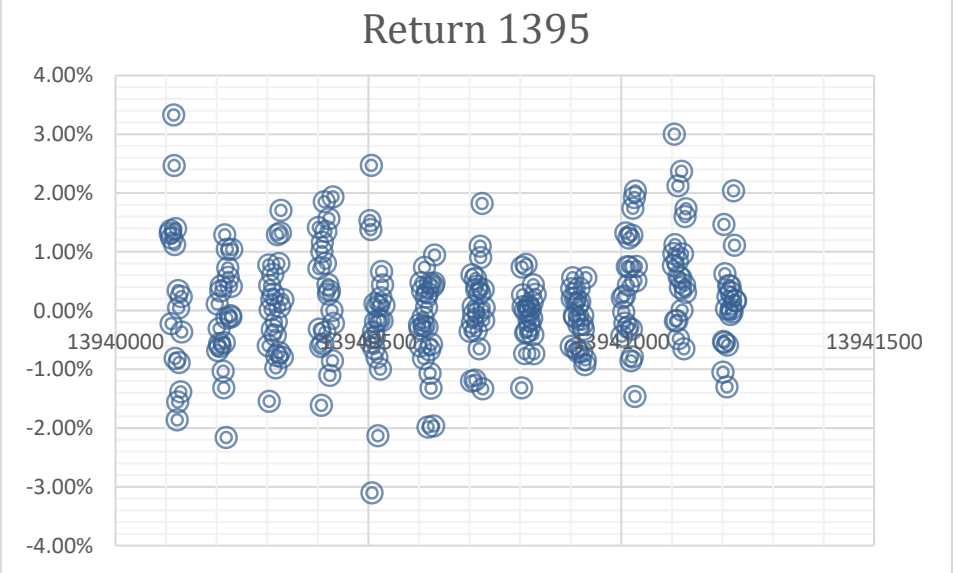

Figure 6: the average stock return 50 excellent companies in 2017

In the above diagram, it is clear that the mean return the stock exchange excellent companies always has the fluctuations during years 2012 to 2017.

In this research for numerical solving financial information, we extract 50 companies for 2012 to 2017 daily then by helping the balck hole algorithm to we pay attention its optimization that results are stated. Also the number of selected company in term of portfolio equal to 8. For using the provided method in this research, can use the annual or daily return if time series sufficiently for computation covariance matrice if needed and there is the expected return estimation.

After finishing this steps, the black-hole algorithm is used for solving the problem and this algoritm is compared with the Markowitz pattern. Pay attention that in the tables only company list that have weight in the portfolio have mentioned and the companies that their weight were zero are not mention in the table.

Table 1: the obtained results from algorithm for 2012-2017

	2012			2013			2014		
Row	Name of company	Markowitz	Black hole	Name of company	Markowitz	Black hole	Name of company	Markowitz	Black hole
1	Betrans	0.00%	16.61%	Betrans	8.06%	0.00%	Akhayer	0.00%	8.31%
2	Pardis	0.00%	11.93%	snosa	0.00%	9.87%	Khodro	26.79 %	0.00%
3	Dejaber	10.65%	0.00%	retco	0.00%	9.96%	sefars	0.00%	14.42
4	Soghrob	11.01 %	0.00%	soghreb	11.01 %	0.00%	shabandar	9.04%	0.00%
5	Sefares	17.52%	0.00%	Ghazer	0.00%	22.87%	Shabhorn	0.00%	8.77%
6	fazer	0.00 %	11.62%	fabahonar	7.94%	0.00%	Shefn	0.00%	8.63%
7	webmelat	0.00 %	11.40%	Folad	0.00%	11.02%	shiran	0.00%	40.00%
8	vabimeh	12.16%	0.00%	Kachi ni	7.49	0.00%	Fakhas	11.93%	0.00%
9	vatosa	0.00%	11.58%	Kahram	9.25%	0.00%	Famli	8.29%	0.00%
10	vasakht	10.53%	14.30%	vebshahr	7.45%	12.84%	vebshahr	13.02%	0.00%
11	vaspeh	15.94%	0.00%	vapars	0.00%	9.48%	vebmelat	0.00%	7.12%
12	vasina	11.00%	11.02%	vasina	7.45%	0.00%	vapasar	10.47%	0.00%
13	vasanat	11.18%	0.00%	vasanat	0.00%	14.15%	vatejarat	8.77%	6.39%
14	vaghadir	0.00%	11.53%	valsapa	13.61%	0.00%	vakharazm	11.69%	6.36%
total	100.00%	100.00%	100.00%	total	100.00%	100.00%	total	100.00%	100.00%
Row	Name of company	Markowitz	Black hole	Name of company	Markowitz	Black hole	Name of company	Markowitz	Black hole
1	Parsan	10.36%	0.00%	Hakeshti	12.81%	10.74%	betrans	0.00%	15.50%
2	Sharak	7.44%	25.74%	khabahman	0.00%	12.70%	petrol	0.00%	12.46%
3	shaspa	15.04%	0.00%	khaspa	0.00%	10.84%	Topico	12.58%	0.00%
4	fars	0.00%	23.05%	khodro	0.00%	20.50%	hakeshti	0.00%	14.66%
5	fakhor	0.00%	10.01%	shkharak	9.15%	0.00%	khapares	0.00%	8.65%
6	famli	0.00%	6.07%	fazer	10.47%	0.00%	khodro	14.46%	0.00%
7	foolad	35.57%	00.00%	fakhor	26.71%	0.00%	shabandar	0.00%	11.27%
8	Kachad	0.00%	10.31%	Famli	0.00%	0.00%	shapna	18.57%	0.00%
9	vamid	7.34%	0.00%	folad	0.00%	14.57%	father	0.00%	6.99%
10	vansar	7.71%	11.97%	kachad	11.20%	10.98%	folad	16.66%	0.00%
11	vapasar	0.00%	6.29%	vatejarat	9.20%	0.00%	kachad	0.00%	17.23%
12	vakharazm	8.95%	0.00%	vasandogh	10.45%	9.98%	hamrah	2.14%	0.00%
13	vasapa	0.00%	6.57%	valespa	0.00%	9.68%	vansar	9.86%	0.00%
14	vasandogh	7.58%	0.00%	vamaaden	10.01%	0.00%	vabank	0.00%	13.25%
15							vaghadir	19.95%	0.00%
16							vamaaden	5.78%	0.00%
total		100.00%	100.00%	total	100.00%	100.00%	total	100.00%	100.00%

In the following the descriptive statistics is mentioned for years 2012-2017

Table 2: descriptive data for 2012-2017

1390															
	beterans	pardis	dejaber	segharb	sefars	fazar	vabemelat	vabimeh	vatoosa	vasakht	vasepah	vasina	vasanat	vaghadir	
Average	-0.07%	-0.14%	-0.09%	0.25%	-0.05%	-0.03%	-0.14%	0.02%	-0.06%	0.16%	-0.12%	0.01%	-0.01%	-0.14%	
Variance	2.13%	0.08%	0.04%	0.14%	0.04%	0.07%	0.05%	0.07%	0.04%	0.07%	0.07%	0.10%	0.04%	0.26%	
Standard Dev	14.61%	2.75%	2.06%	3.77%	2.03%	2.71%	2.34%	2.73%	2.07%	2.57%	2.69%	3.20%	2.06%	5.15%	
Kurt	11364.58%	3141.83%	96.84%	5088.49%	1051.81%	-54.36%	6744.14%	-68.44%	22.14%	-57.48%	3668.48%	5182.11%	-11.48%	16478.06%	
Max	149.30%	4.80%	5.85%	31.51%	5.84%	5.48%	5.30%	6.80%	5.64%	6.77%	6.14%	28.76%	5.13%	6.02%	
Min	-165.96%	-26.01%	-7.66%	-35.31%	-14.52%	-8.80%	-26.66%	-5.58%	-5.72%	-6.96%	-26.38%	-28.45%	-4.84%	-72.73%	
Skew	-163.72%	-350.77%	29.61%	-103.85%	-130.24%	-1.02%	-577.79%	16.17%	23.40%	4.02%	-379.74%	15.34%	10.13%	-1164.04%	
Semi Variance	14.65%	2.77%	1.22%	3.21%	1.69%	1.52%	2.53%	1.54%	1.22%	1.44%	2.65%	2.64%	1.24%	7.71%	
VAR	-3.74%	-3.74%	-3.20%	-3.05%	-2.98%	-4.06%	-2.51%	-4.20%	-3.31%	-3.80%	-3.70%	-3.12%	-3.28%	-3.29%	

1391															
	beterans	senoosa	retko	sefars	ghazar	fabahonar	foolad	kechini	kehram	vabeshahr	vapars	vasina	vasanat	vaghadir	valesapa
Average	-0.12%	0.03%	-0.08%	0.06%	0.12%	0.09%	0.20%	-0.05%	-0.16%	-0.12%	0.01%	-0.09%	0.04%	-0.05%	-0.44%
Variance	0.06%	0.08%	0.08%	0.06%	0.50%	0.09%	0.07%	0.12%	0.08%	0.06%	0.03%	0.29%	0.06%	0.07%	0.25%
Standard Dev	2.46%	2.81%	2.84%	2.41%	7.07%	2.93%	2.61%	3.44%	2.89%	2.53%	1.60%	5.35%	2.42%	2.59%	4.98%
Kurt	-58.97%	143.92%	-95.17%	91.26%	6723.06%	495.39%	751.58%	3250.21%	-106.21%	1750.56%	101.78%	9286.64%	902.12%	1761.31%	6212.48%
Max	5.65%	12.28%	6.13%	9.85%	72.91%	17.15%	13.39%	25.66%	5.63%	7.75%	5.47%	55.05%	14.19%	6.17%	52.71%
Min	-7.27%	-8.32%	-7.34%	-6.09%	-59.22%	-12.84%	-14.04%	-29.04%	-6.63%	-17.48%	-4.47%	-54.98%	-14.45%	-20.61%	-32.29%
Skew	9.91%	34.08%	9.07%	36.28%	225.62%	62.91%	45.87%	-64.79%	-1.62%	-235.11%	23.38%	6.29%	2.80%	-232.28%	381.53%
Semi Variance	1.29%	1.86%	1.47%	1.36%	5.27%	1.66%	1.66%	2.73%	1.52%	2.49%	1.02%	5.28%	1.67%	2.28%	3.59%
VAR	-3.90%	-4.90%	-4.07%	-3.67%	-4.65%	-3.84%	-3.28%	-3.45%	-4.26%	-3.22%	-2.38%	-3.13%	-3.42%	-3.01%	-4.01%

1392															
	akhaber	khodro	remapna	sefars	shebandar	shebehran	shefan	shiran	fakhas	fameli	vabeshahr	vabemelat	vapasar	vatejarat	vakharazm
Average	0.15%	0.47%	0.56%	0.47%	0.39%	0.45%	0.32%	-0.23%	0.05%	0.02%	0.33%	0.30%	0.32%	0.84%	0.16%
Variance	0.07%	0.14%	0.06%	0.09%	0.19%	0.06%	0.11%	0.30%	0.03%	0.32%	0.09%	0.06%	0.06%	0.45%	0.16%
Standard Dev	2.59%	3.71%	2.51%	2.94%	4.41%	2.41%	3.33%	5.50%	1.64%	5.62%	2.93%	2.43%	2.48%	6.72%	4.01%
Kurt	811.82%	1469.00%	444.62%	-80.20%	14016.19%	1278.06%	2316.06%	15201.03%	769.67%	8113.33%	277.94%	1924.74%	901.19%	16712.52%	8612.54%
Max	6.43%	26.48%	7.49%	7.63%	60.17%	17.95%	22.15%	18.41%	7.91%	50.82%	16.78%	5.74%	11.59%	96.04%	5.93%
Min	-17.47%	-7.12%	-14.59%	-9.05%	-6.70%	-4.74%	-25.55%	-76.36%	-7.31%	-60.18%	-7.00%	-20.04%	-16.44%	-11.26%	-48.07%
Skew	-122.64%	251.98%	-82.05%	-9.50%	1030.43%	219.39%	-53.88%	-1076.87%	-11.82%	-185.23%	62.81%	-228.06%	-77.79%	1174.36%	-723.39%
Semi Variance	2.00%	1.74%	1.78%	1.60%	1.34%	1.19%	2.55%	7.43%	1.54%	5.24%	1.55%	2.06%	1.84%	1.71%	4.39%
VAR	-3.63%	-4.22%	-3.51%	-4.06%	-3.19%	-2.96%	-3.78%	-3.28%	-2.11%	-3.20%	-3.76%	-3.11%	-3.57%	-3.79%	-3.70%

1393														
	parsan	sharak	shaspa	fars	fakhooz	fameli	foolad	kachad	vaomid	vaansar	vapasar	vakharazm	vasapa	vasandogh
Average	-0.49%	-0.67%	1.03%	-0.18%	-0.23%	-0.10%	-0.16%	-0.36%	-0.09%	0.04%	-0.21%	-0.14%	-0.06%	-0.07%
Variance	0.27%	0.69%	3.43%	0.03%	0.03%	0.05%	0.08%	0.04%	0.02%	0.06%	0.07%	0.04%	0.08%	0.09%
Standard Dev	5.20%	8.32%	18.51%	1.63%	1.64%	2.33%	2.86%	2.07%	1.35%	2.41%	2.64%	2.03%	2.86%	3.00%
Kurt	19084.28%	21571.85%	23658.83%	253.19%	1759.75%	1718.22%	3594.56%	2279.97%	196.72%	290.69%	8977.92%	-34.28%	1676.16%	4852.05%
Max	5.17%	7.43%	286.22%	7.32%	5.75%	12.84%	23.05%	6.79%	4.89%	11.13%	4.70%	4.47%	7.93%	27.66%
Min	-76.42%	-126.00%	-4.41%	-4.62%	-11.88%	-17.85%	-19.74%	-17.39%	-4.05%	-11.70%	-32.27%	-4.92%	-23.23%	-24.95%
Skew	-1295.12%	-1420.61%	1523.15%	56.27%	-174.26%	-102.39%	138.51%	-255.22%	50.29%	8.39%	-734.77%	19.86%	-201.46%	100.39%
Semi Variance	7.60%	12.45%	1.08%	1.01%	1.60%	1.96%	2.20%	1.96%	0.86%	1.48%	3.15%	1.14%	2.38%	2.40%
VAR	-2.76%	-2.79%	-2.46%	-2.85%	-2.09%	-2.71%	-2.36%	-2.58%	-2.26%	-3.33%	-2.81%	-3.39%	-4.00%	-3.39%

1394													
	hekeshti	khebahman	khesapa	khodro	shekhark	fazar	fakhooz	foolad	kachad	vatejarat	vasandogh	valesapa	vamaaden
Average	0.22%	0.25%	0.42%	0.24%	-0.06%	0.22%	0.05%	0.04%	0.03%	0.10%	0.29%	0.17%	0.02%
Variance	0.05%	0.09%	0.15%	0.08%	0.07%	0.07%	0.24%	0.16%	0.04%	0.06%	0.12%	0.06%	0.16%
Standard Dev	2.22%	2.96%	3.93%	2.89%	2.71%	2.58%	4.94%	3.98%	1.94%	2.37%	3.53%	2.46%	4.00%
Kurt	-26.37%	1553.22%	9369.32%	290.99%	5207.84%	-37.64%	3025.24%	8004.64%	582.50%	911.37%	5265.62%	-5.80%	3405.57%
Max	6.87%	23.56%	48.73%	10.79%	22.35%	6.79%	34.90%	27.96%	9.98%	12.87%	35.05%	7.80%	28.19%
Min	-4.96%	-11.62%	-4.96%	-14.59%	-25.90%	-5.83%	-36.17%	-45.51%	-6.08%	-14.91%	-21.18%	-6.47%	-28.39%
Skew	30.13%	190.08%	771.21%	-38.48%	-122.82%	18.02%	-18.61%	-463.77%	117.75%	-22.72%	444.24%	13.01%	-16.04%
Semi Variance	1.20%	1.55%	1.35%	1.97%	2.61%	1.51%	4.00%	3.78%	1.15%	1.75%	1.97%	1.47%	3.32%
VAR	-3.20%	-3.33%	-3.26%	-3.95%	-2.70%	-4.24%	-4.10%	-2.88%	-2.65%	-3.48%	-2.77%	-3.79%	-3.23%

1395																
	beterans	petrol	tapico	hekeshti	khepars	khodro	shebandar	shapna	fazar	foolad	kachad	hamrah	vaansar	vabank	vaghadir	vamaaden
Average	-0.03%	0.01%	-0.06%	-0.16%	-0.22%	-0.22%	-0.02%	-0.05%	-0.20%	0.00%	-0.04%	0.06%	-0.04%	0.01%	-0.10%	0.01%
Variance	0.04%	0.10%	0.01%	0.01%	0.06%	0.06%	0.03%	0.03%	0.04%	0.02%	0.03%	0.00%	0.01%	0.01%	0.01%	0.04%
Standard Dev	1.89%	3.16%	1.13%	1.08%	2.37%	2.35%	1.85%	1.76%	1.90%	1.51%	1.66%	0.69%	1.08%	1.14%	1.05%	2.05%
Kurt	108.80%	15790.70%	1376.69%	1594.84%	-45.58%	-18.42%	69.20%	124.83%	31.30%	141.60%	271.13%	826.75%	678.50%	538.36%	299.35%	416.66%
Max	4.75%	44.28%	5.59%	4.50%	4.80%	5.01%	4.73%	4.61%	4.82%	4.79%	5.40%	4.26%	4.51%	4.30%	4.66%	11.66%
Min	-5.11%	-4.19%	-7.90%	-8.27%	-5.06%	-5.13%	-4.72%	-4.96%	-4.95%	-4.22%	-4.98%	-2.75%	-4.57%	-4.40%	-3.62%	-4.55%
Skew	30.79%	1129.57%	-34.75%	-128.28%	13.63%	13.73%	4.45%	33.94%	48.15%	41.48%	56.91%	125.69%	125.97%	107.78%	72.46%	119.49%
Semi Variance	1.28%	0.85%	0.94%	0.93%	1.36%	1.43%	1.30%	1.11%	1.04%	0.94%	1.05%	0.39%	0.67%	0.68%	0.63%	1.08%
VAR	-3.39%	-2.02%	-1.35%	-1.23%	-4.21%	-4.55%	-3.40%	-2.64%	-2.95%	-2.43%	-2.44%	-0.76%	-1.56%	-1.43%	-1.67%	-3.04%

For comparison algoritm test that spaces (standard deviation square error) the current RMSE between metaheuristic model efficient boundry is there significant difference or not with the markowitz model? RMSE amount are obtained from the following formula:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(Model - Markowitz)^2}{N}}$$

Table 3: comparison algorithm distance with the Markowitz model

year	Distance Markowitz model
2012	0.023817
2013	0.024191
2014	0.021102
2015	0.022056
2016	0.0237261
2017	0.023847

As it is clear from the results in all years the balck hole method the near response to exact response that is markoitz are obtained. For the eact comparion there is significant difference between the obtain value for markowitz model and black hole algorithm is necessary until used from statistics tests. Following, firstly, the power two model are compared and then fittings distance Walds test markowitz model and blackhole algorithm are compared statistically.

The comparison of explained power

The determination coefficient in each equation show that the conucted fittness is close to reality for afew percent and the model variable until dependent variable in model have explain. Each model is provided that has the higher expalnation power for operational response are close to reality in the real world. For examination comparison explained power are examine to comparing the adjusted determination coefficient in regression equations.

Table 4: comparison of adjusted determination coefficient models

The desired model	Determination coefficient	Adjusted Determination coefficient	Rank
Markowitz	0.39	0.34	2
Black hole	0.46	0.41	1

The determination adjusted coefficient effect of the number of fitting variable in determination coefficient and more exact criteria for comparing models. In the above table is considered that black hole model even explanation power than Markowitz.

For determining whether models efficiency are stable or different in fitness, we should coefficient tests, first option, that is Wald test. For comparison quality fitted model and informs from their exact and the comparison each models with Markowitz initial model are used from the equal test or Wald test. The statistic Wald test for the new models for independent are compared to each other.

The null and contrast hypothesis is written for Wald test as follow:

H0: there is no different between curve efficient boundry optimized portfolio markowitz model and metaheuristic model black hole.

H1: there is different between curve efficient boundry optimized portfolio markowitz model and metaheuristic model black hole

Table 5: Wald test for the examined model

Model no	Wald statistic	Significant level	Result
Markowitz	4.42	0.000	Meaningful confirmation with coefficient
Black hole	4.64	0.000	Meaningful confirmation with coefficient

This test is conducted by using two statistics F-FISHER and X2 that both of them have the same examination, in this research F fisher test is used, it is clear that if the possible of this statistic is lower than 5 %, the null hypothesis is accepted, otherwise is rejected. In the above table this possible is lower

than 0.05 and therefore the null hypothesis should be accepted and this efficiency model is different in fitness.
Fisher test is usable in general state for each number of sample. For doing this test the frequent amounts are observed in table cells and the expected frequent amounts calculated for condition establishment null hypothesis. The expected frequents cell ij table (Eij) from multiplying add i_{th} line in adding column j th and its dividing on the sample total volume (n) are obtained, that is,

$$E_{ij} = \frac{n_{i.} n_{.j}}{n}$$

Therefore, the test statistics value is obtained by the following relation:

$$x^2 = \sum_{i=1}^{2} \sum_{j=1}^{2} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where O_{ij} is the observed frequency in cell ij. If the null hypothesis is created, statistic follows χ^2 from distribution with 1 freedom. Therefore if statistics χ^2 in significant level α larger than the obtained value table distribution X^2, the null hypothesis is based on dependence two nods.
As it is clear from the results, the null hypothesis is confirmed and can state that the optimization the optimized portfolio for the Markowitz and black hole metaheuristic have similarity and there is no difference between them.

Discussion and Conclusions

The aim of this research is to show that we can use for optimization portfolio from metaheuristic algorithm black hole, gravity search and hybrid algorithm than Markowitz with the higher speed and accuracy. Therefore, in the subsample of conducted similar research with other metaheuristic algorithm in the field optimization portfolio. Kazemi and their colleague (2016) by using data covering analysis, the issue of optimized portfolio by considering value at the exposure are used on the sectional efficient. The result show that sharp criteria the better performance for the suggested method in comparison with other method are shown. In 2011, Raei and their colleague use from harmony search algorithm for optimized portfolio in Iran Stock market (Raei and Ali Beigi, 2011). In this study, the semi-variance average approach is used and by finding 50 points by algorithm, the efficient portfolio Frontier are obtained. In another research that Raei and their colleague did in 2011, the efficient portfolio Frontier with particle cumulative optimized algorithm are obtained (Raei, Mohammadi and Ali Beigi, 2011). Algorithm is performed on the Iran stock data and search efficient Frontier. The results of the research also show that algorithm for searching efficient Frontier at the proper time have the excellent accuracy. The many researches are done for using metaheuristic algorithm. The last researches have shown that metaheuristic algorithm can with exact accuracy toward the exact solution math problem, solve it (Cheng et al, 2000)
According to the findings of this research, it is suggested that investors and portfolio management companies use the black hole algorithm to solve the stock portfolio selection issues due to the acceptable speed of the model's solution. Also we suggest to other researcher use from this algorithm in different years and different portfolio and the algorithm accuracy. Researchers can compare this algorithm with other algorithm in terms of speed, optimization accuracy.

References

1. Abadian, Marzieh and Shajari, Hooshang. (2017). Multi-index method for choosing optimal portfolio by using fundamental analysis variables in stock member's petrochemical companies. Journal of Financial Engineering and Management of Securities, No. 26, pp. 1-25.

2. Asgharpour, H., Fallahi, F., Senobar, N., & Reza zadeh, A. (2015, autumn) Optimization of portfolio in the value-at-risk framework, Comparison of MS-GARCH and Bootstrapping methods. Quarterly Journal of Economic Modeling Research, 17, 87-122.
3. Kazemi, Mian Goskari, Mina, Bakide, Keykhosro and Gholizadeh, Mohammad Hassan (2016) "Optimization of stock portfolios (Application of the value-at-risk value model on cross-efficiency)". Financial Management Strategy, 2 (5) pp. 183-159
4. Khanjarphanah, Hossein, Pishvaee, Mirasan; Jabarzadeh, Armin and Sadeghi Kia, Mohammad. (2016). Increasing stock market power forecast using flexible planning. International Conference on Management, Economics and Industrial Engineering, Tehran, Institute of Managers of Idea maker, Vieira Capital.
5. Najafi, Amir Abbas and Moushkiyan, Siamak. (2015). Modeling and providing an optimal solution for optimizing multi-period investment portfolio with genetic algorithm. Journal of Financial Engineering and Management of Securities, No. 21, pp. 13-35.
6. Raei, R., & Ali Beigi, h. (2011) Stocks portfolio optimization using cumulative particle movement method. Financial Research Quarterly, 12 (29), 21-40.
7. Shiri Ghahi, Amir, Dideh khani, Hossein, Khalili Damghani, Kaveh, Saeedi Parviz (2016), A comparative study of multistage portfolio multiplier portfolio optimization model in fuzzy credit environment with different risk measures, Fifth annual financial management strategy, Fifth year, No. 18th, autumn 2016, PP 1 -26
8. Tehrani, Reza. 2015. Financial Management, Knowledge View, Thirteenth - Third Edition
9. Zanjirdar, Majid; Mousavi, Reza; Saberi, Maryam (2015). The Explanation of Human Behavioral Factors in Selecting the Optimal Portfolio Compared to the Standard Financial, Quarterly Scientific & Research Journal of Investment Knowledge, the third year, 9 no, spring 2015.