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SOFT COMPUTING AS A TOOL TO OPTIMIZE AN INVESTMENT PORTFOLIO

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Annotation: The paper describes the creation and application of an investment portfolio. Main aim of the paper is to perform statistical analysis of selected financial instruments and to find a connection between the input data. Authors use application Adaptrade from the Adaptrade software company which is based on genetic algorithms basis and is able to process this difficult task in real time.

The case analysis is performed for three world currencies—U. S. dollar, Canadian dollar and Swiss franc. Statistical analysis was performed specifically on the currency couple USD: CAD and USD:CHF. The input data consists of time series, which records the progress of prices of the financial instruments with a period of 15 minutes continuously from Monday 00:00 to Friday 23:00 for the period 2.1.2009 – 14.3.2011.

JEL classification: C61, G11
Keywords: Optimization, soft computing, Adaptrade, genetic algorithms, investment portfolio.
Reikšminiai žodžiai: optimizacija, minkštasis skaičiavimas, Adaptrade, genetinis algoritmas, investicinis portfelis.

Introduction

The main aim of this paper is to describe one of the ways of investment portfolio creation. The contribution aim fulfils the statistical analysis of chosen financial instruments with the aim to find the connection in input data. The analysis is fulfilled by the use of software (Adaptrade), which works on the basis of genetic algorithm. The application of genetic algorithms in financial decisions starts to interest nowadays a significant role.

The aim is to quickly and efficiently generate outputs that support decision making of financial experts in the field of world markets. Today's "digital" time offers recording large amounts of data and finding relationships between these data using standard algorithmic techniques is becoming very difficult up to an impossible task. Here starts to play a significant game the genetic algorithms, which accelerate the period of finding the optimal solution of engaged tasks.

1. Current state of solving problematics

Problems of investment portfolio optimization isn't new issue. There are many assignments and scientific papers that are focused on this issue in different point of view. Many researchers deal with soft computing as a tool for investment portfolio optimization.

Conventional models of investment portfolio optimization suppose that the future price moves on financial markets is relatively easy to predict on the base of historical price moves. With the regard to high volatility of market environment this supposition isn't valid. Due to the author Liu, S. – T it is possible to use fuzzy models to optimize portfolio when profit of the assets represent fuzzy data. Authors with this approach eliminate high volatility of market environment (Liu, S.-T, 2011)

Research made by authors Chen j. – S. et al found out possibilities of using genetic algorithm as a tool for solving optimization issue investment strategy of portfolio. (Chen J. – S. et al,) The same as research made by Chang T. – J., Yand S. – C, Chang k. – J deal with the possibilities of using genetic algorithm during the optimization of portfolio to several risk measures.

Authors Dombrovskii, V. V. and Lyashenko, E. A. applied linear quadratic management of discrete systems with accidental parameters and xxx interference for optimization of the investment portfolio. (Dombrovskii, V. V., Lyashenko, E. A., 2003)

Authors F.D. Freitas et al presented in their research new prediction based on optimization of portfolio model that can notice short time investment opportunities. The prediction model works on bases of neural networks. (F. D. Freitas et al, 2009).

The key issue for long term successful prediction based on application of neural networks is the choice of right type of neural network and application for significant input data. The right choice of the type of neural network is solved in many publications. (Kattan, Abdullah, Geem, 2011; Anthony, Bartlett, 2009). The choice of the suitable input data is critical factor for successful prediction. Many scientific papers analyze suitable combination of input data for successful predication of stock markets. (Chang, Liao, Fanc, 2011). Developers also make experiments with alternative inputs that include for example activity of the market volatility of financial instruments to the model. (Chavarnakul, Enke, 2008) or correlation between two different markets, so called statistical arbitrage and pair trading (Huck, 2010; Alexakis, 2010). Other application can be for example prediction option trades (Yao, Tan, 2000).

2. Investment portfolio

The investment portfolio generally means a set of investment strategies related to one unit. Partial strategy set in the ideal case, diversifying risk a different approach to the investment itself. Accesses, how to create an investment portfolio, there are many. Generally it is possible to quantify it in to two basic groups—passive and active access. (Lien, 2008)

Passive access is the situation, when the investor makes his portfolio from the products offered on the market of banks and funds. Nowadays exits many products offering an annual value reaching about 2-10%. Specificity of this type the investment is that the investor insert the capital on a bank account of given financial authority and of the separate investment realization it does not already care. (Vanstone, 2010)

Active access is the situation when the investor individually on the basis of his experience gains the information (diversified business strategy) to investment decision. This access is very difficult, but on the other hand offers relatively high rate of annual investment evaluation. Investors working with an active form of their capital can also use the two main access to investment strategy formation. (Williams, 1999; Schabacker, Ed Mack, 1997)

The first access, so-called fundamental access, puts together strategies on the basis of issued fundamental reports. As an example of this access it is possible to show the reactions of world markets on proclamation of fundamental state of the employment of the United States of America the first Friday in a new month. There are issued tens of fundamental reports daily and it is up to the investor to which reports assign his relevancy.

The second access, so-called technical access, basically differs from the above mentioned, because the investor does not follow any fundamental reports, but he follows only the price, its moves and the mathematical transformation in the form technical indicators.

There are generally two possibilities, when the investor at the investment decision prefers gained feeling for price moving and of technical indicators. The second possibility is to take an advantage of the statistical analysis supported by sophisticated calculations for example by a type of correlation or co-integration by using the programming applications. (Edwards, Magee, 2001).

The intermediate stage between an active and a passive report is in the conditions of the Czech republic not really known service business signals shopping. The investor subscribes at a company so-called "newsletter," when he gets by an e-mail commands for shopping or selling of financial decisions from the specialist (expert). By this specialist we can mean a physical (legal) entity or a computer programme. If the appropriate investment step will be realized or not, it depends only on the investor.

The specifity for this type of access to investments is, that the investor actively manage his capital on the basis of input signals of specialist for investment decision.

The above-mentioned theoretical way out, related to the production of investment portfolio, presents the following figure 1.

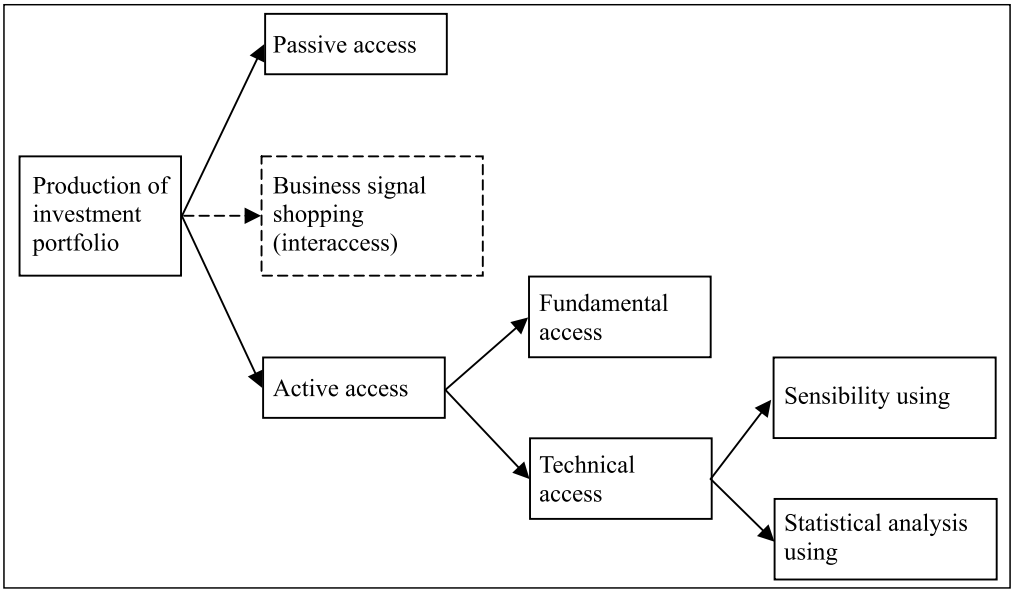


Figure 1: The basic principle at formation of investment portfolio
Source: Personal processing

3. Genetic algorithms

The main algorithm of genetic algorithms is built according the theory of Charles Darwin so, that in population live only stronger individuums – better solution of the problem. Each individuum has its own genetic information, which is interpreted as its fitness. The individuums can crossover or mutate. The selection pressure insures, that in the population will increase stronger and stronger individuums from the time, when the population come across to acceptable solution (intended in finishing condition – target functions), optimum (ideal solution) or local maximum (population does not improve in the long term), which will not be able to leave a general algorithm. The process of reproduction simply describes the following figure 2.

The most implementations of genetic algorithms work with the conceptions used in genetics, for example the conception chromosome. In a human genetics is the chromosome defined as a functional complex of heritable record of genetic information in a cell, able of independent function at information transfer. At genetic algorithm the chromosome is represented by zeros and ones, i.e. binary representation. In this case are chromosomes represented by binary chain, for example 01100110. For the manipulation with chromosomes were designed some genetic operators, which are mainly selections, crossover and mutation.

Genetic algorithms are used there, where the exact task solutions from practice would take endlessly long time by systematic searching. They enable to solve difficult problems very elegantly.

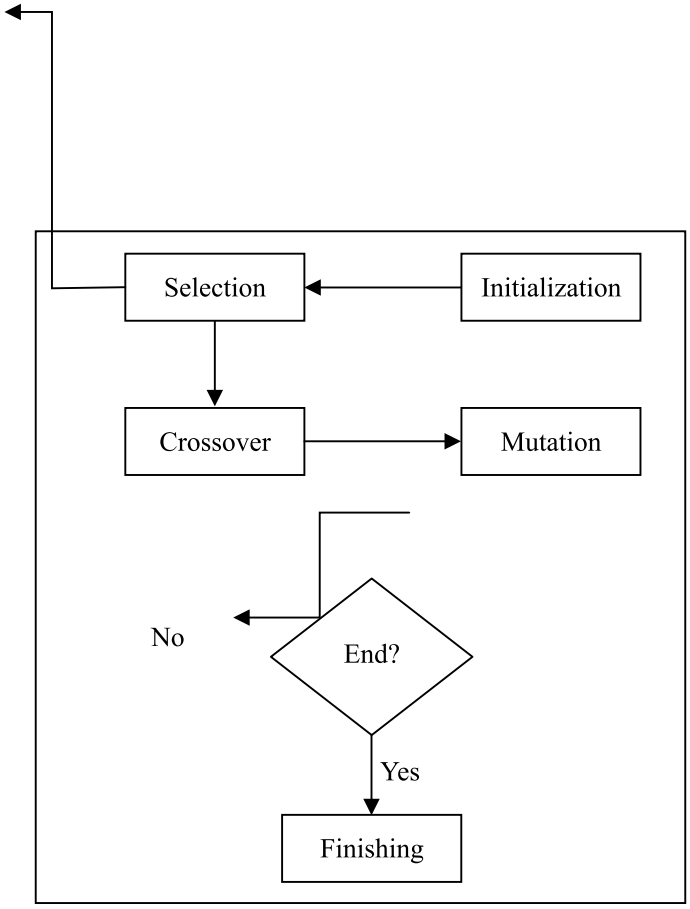


Figure 2: Process of reproduction
Source: Dostál, 2008

The considerable advantage of genetic algorithms is the ability to solve the tasks abstractedly on the character of data (linear, nonlinear, leap), cohesion of individual parts of system or existence of feedback. On the contrary of classical mathematical methods, does not come to conditions adding and the limitation to increasing of description complication of the problem and thus it is possible to solve even very difficult tasks, indescribable by classical mathematics. (Bauer, 1994).

Genetic algorithms are generally used at optimization. For economical tasks it is typical to use, for example, for the solution of decision problems to minimize the costs or maximization of turnovers (profit).

Practical using is possible to see at the solving at the task problems like cluster analysis, approximation of economic curve, prediction etc. (Dostál, Rais, Sojka, 2005).

4. Application

4.1. Application description

The contribution describes an active access formation of portfolio by using the technical access supported by statistic analysis, there is no consideration on fundamental reports.

For statistic analysis is used the application Adaptrade from the company Adaptrade Software, its computation core works on the basis of genetic algorithms and proves to work up even so difficult task in a real time.

The input in this concrete case is made by 23 technical indicators with some tens of periods.

At some various possibilities of inputs and outputs from investment position the number of combinations grows on the value which is not possible to solve by standard algorithmical methods. For example the applications of genetic algorithm can solve this difficult task.

The basis of computation system made by applications based on genetic algorithms, when we are able to reach relevant solutions in a real short time.

The input data show the indicators of technical analysis, which directly come from the price. It is a price transformation by the help of defined patterns. As an example we can show sliding averages, oscillators represent the price moments and many others. Each of these indicators, we can further quantify according to the period of calculation from historical price. Thanks to this fact it is very easy to get to the number of operations overlapping billions of combinations.

On the figure 3 is graphically shown the input of the programme Adaptrade represented the technical indicators, which are calculated from the price.

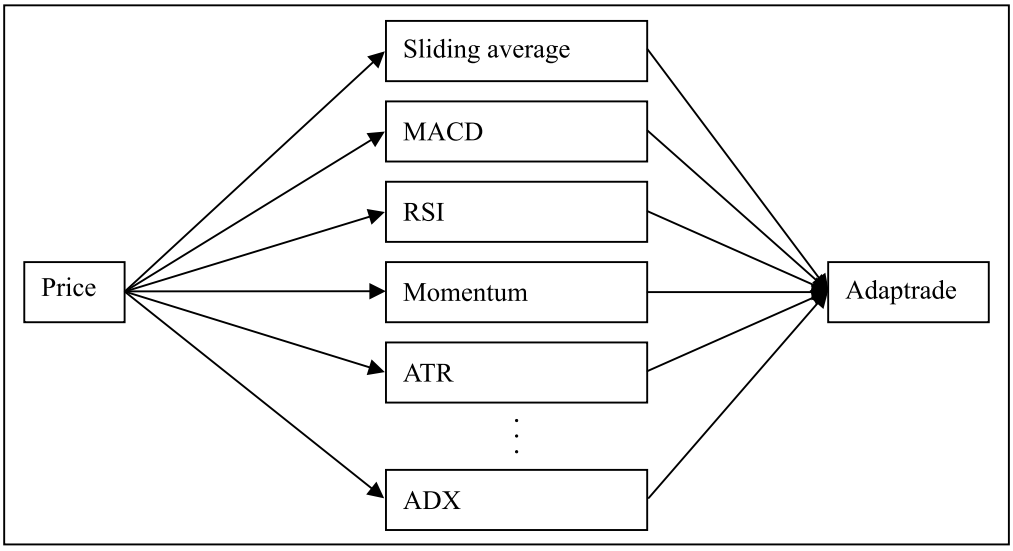


Figure 3: Inputs of the programme Adaptrade
Source: Personal processing

The input in this concrete case is made by 23 technical indicators with some tens of period. At some various possibilities of inputs and outputs from the investment position, the number of combinations increases on the value which is not solved by standard algorithmical methods. For example the application of genetic algorithms can solve this difficult task.

4.2. Case study

The statistical analysis by the help of the Adaptrade software was performed concretely on currency couple USD:CAD and USD:CHF, which is traded on financial market ForEx.

The input data consists of time series, which records the progress of prices of the financial instruments with a period of 15 minutes continuously from Monday 00:00 to Friday 23:00 for the period 2.1.2009–14.3.2011. The time series was divided into two periods. In the first period, learning period (4. 1. 2010–31. 12. 2010), were generated the rules for investment and in the second period, validation period (4. 1. 2011 – 15. 6. 2011), were application of found rules.

The programme Adaptrade after fulfillment of statistic analysis generate the text file containing the list of relevant information, which are implemented into the application TradeStation. This application generates commands for buying or for selling of chosen financial investment.

Statistics of currency couple USD:CAD

In the table 1 are stated the basic statistical results from the analysis for the currency couple USD:CAD and on the figure 4 is shown the accumulation of profit and loss distribution of particular speculative positions for currency couple USD:CAD.

Table 1: Statistics of investment strategy for currency couple USD:CAD

Number of trades[-]	224
Number of profitable trades [-]	115
Number of loss trades[-]	109
Number of profitable trades[%]	51,33
Number of loss trades[%]	48,66
Clear profit[$]	21200
Clear loss[$]	9000
Total profit[$]	12200

Source: Personal processing

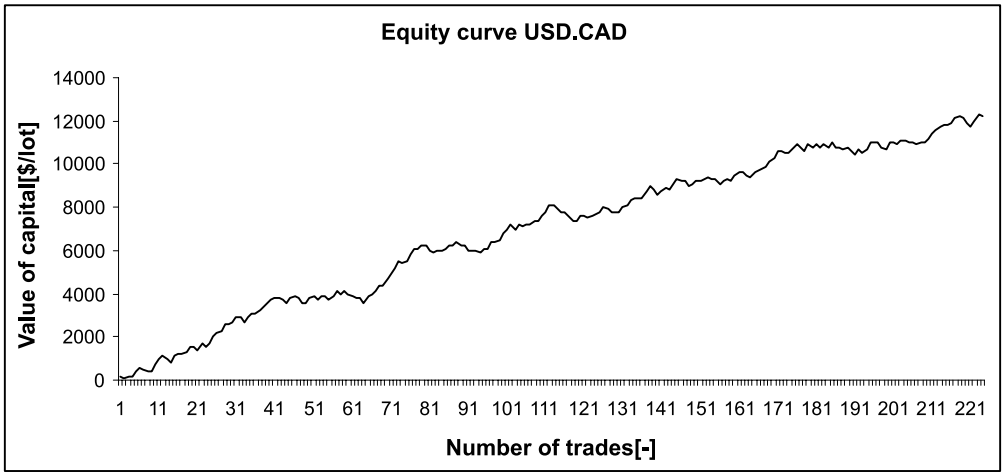


Figure 4: Accumulation of profit and loss distribution of particular speculative positions for currency couple USD:CAD
Source: Personal processing

Statistics of currency couple USD:CHF

In the table 2 are shown the basic statistic analysis results for the currency couple USD:CHF.

Table 2: Statistic of investment strategy for the currency couple USD:CHF

Number of trades[-]	206
Number of profitable trades [-]	107
Number of loss trades[-]	99
Number of profitable trades[%]	51,94
Number of loss trades[%]	48,05
Clear profit[$]	22100
Clear loss[$]	9300
Total profit[$]	12800

Source: Personal processing

Figure 5 shows the accumulation of profit and loss distribution of particular speculative positions for the currency couple USD:CHF.

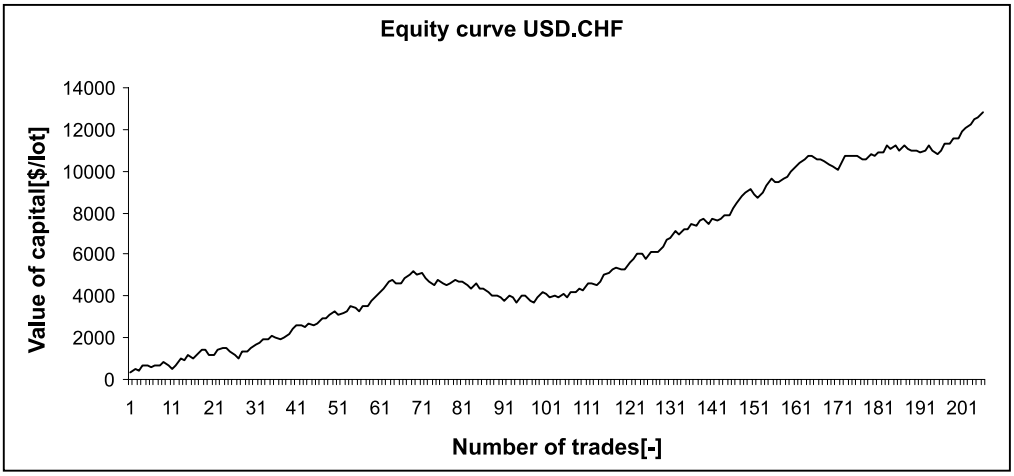


Figure 5: Accumulation of profit and loss distribution of particular speculative positions for the currency couple USD:CHF
Source: Personal processing

Statistics of currency couple USD:CAD + USD:CHF

In the table 3 are shown the basic statistic analysis results for the currency couple USD:CAD and USD:CHF together.

Table 3: Statistic of investment strategy for the currency couple USD:CAD + USD:CHF

Number of trades[-]	224
Number of profitable trades [-]	143
Number of loss trades[-]	81
Number of profitable trades[%]	63,83
Number of loss trades[%]	36,16
Clear profit[$]	34400
Clear loss[$]	9400
Total profit[$]	25000

Source: Personal processing

Figure 6 shows the accumulation of profit and loss distribution of particular speculative positions for the currency couple USD:CAD and USD:CHF together.

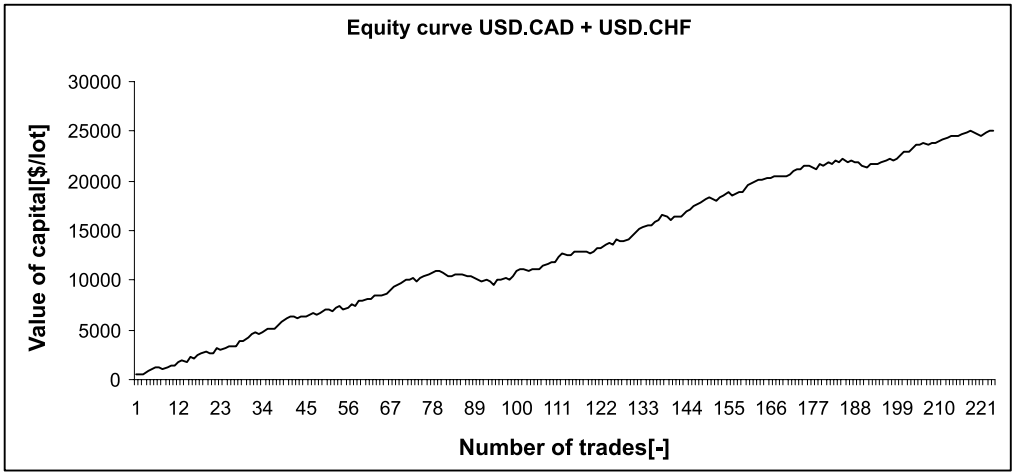


Figure 6: Accumulation of profit and loss distribution of particular speculative positions for the currency couple USD:CAD + USD:CHF
Source: Personal processing

5. Discussion

The statistic analysis specialized on a technical access to the solitary speculation were by the support of the programme Adaptrade found some conjunctions in the input data. At suitable application of found conjunctions is possible to generate the profit of financial market.

The statistic analysis was made for the three significant currencies. Concretely for two financial instruments working with the currency couple crossing Canadian dollar and the American dollar (USD:CAD) and the Swiss franc and the American dollar (USD:CHF).

For the currency couple USD:CAD is designed the strategy, which entered into 224 speculative positions last time by the advantageousness prediction 51,33%, generated a total profit 21200$/lot, clear loss 9000$/lot and a total accumulated profit 12200$/lot.

For the currency couple USD.CHF is designed the strategy, which entered into 206 speculative positions last time by the advantageousness prediction 51,94%, generateda total profit 22100$/lot, clear loss 9300$/lot and a total accumulated profit 12800$/lot.

By the reason of the risk diversification are designed two investment strategies (for the currency couple USD:CAD and USD.CHF) generating an investment portfolio.

These strategies generated a total profit 25000$/lot with a 63,83% of successfully prediction. The profit distribution of these strategy profits and loss did not embody the colerated dependence, that it is possible to apply together by the diversification aim of investment portfolio.

Conclusion

By the help of the programme Adaptrade, which works on the base of genetic algorithms, was made the statistic analysis based on the principle of technical access to speculations.

By the above mentioned algorithmic principle are found some connections in input data, which at the suitable application on financial markets, concretely monetary market, can generate profit.

The application of genetic algorithms presents one of the possible solutions of difficult optimization tasks elaborating a huge amount of inputs. The principle founded on the base of evolution ensures the found optimal solution by the help of cross-over of two "weaker" solutions or mutations of partial solution.

The analysis is made for the three world currencies (U.S. dollar, Canadian dollar and Swiss franc). The sample of data is represented by the record during the price of above- mentioned currency couples in the time interval 15 minutes always from Monday 00:00 to Friday 23:00 from 4. 1. 2010 to 15. 6. 2011.

The time interval from 4. 1. 2010 to 31.12.2010 shows the "designating" area of data, in which are searched the rules for outputs and inputs at speculative positions. The time interval from 4. 1. 2011 to 15.6.2011 shows the area of validation and application of found rules.

The statistic analysis were detected by the connection between input and output data, which for the currency couple USD:CAD generated a total profit 12200$/lot and for the currency couple USD:CHF 12800$/lot. Investment portfolio is built-up for the work with the financial lever 1:40.

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MINKŠTASIS SKAIČIAVIMAS KAIP PRIEMONĖ OPTIMIZUOTI INVESTICINĮ PORTFELĮ

Jan BUDÍK, Radek DOSKOČIL

Santrauka. Straipsnyje nagrinėjami investicinio akcijų paketo kūrimo ir taikymo klausimai. Pagrindinis tyrimo tikslas atlikti statistinę pasirenkamų finansinių priemonių analizę. Taikytas Adaptrade programinės įrangos paketas, grindžiamas genetiniu algoritmu, kuris leido atlikti investicinio akcijų paketo tyrimus realiame laike. Nagrinėti skirtingų valiutų, t. y. JAV dolerių, Kanados dolerių ir Švedijos frankų, akcijų paketų pavyzdžiai. Statistinė analizė buvo atlikta porinio sulyginimo metodu. Įvedami duomenys atspindėjo finansinių instrumentų kainų pokyčius, išreiškiamus laiko eilutėmis su 15 min. periodu nepertraukiamai stebint duomenis nuo pirmadienio iki penktadienio nuo 2009 01 02 iki 2011 03 14.

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