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OPTIMIZATION OF THE METHOD OF CHOOSING THE INVESTMENT STRATEGY OF INFORMATION SECURITY EQUIPMENT BASED ON THE COMBINATION OF GAME THEORY AND THE GENETIC ALGORITHM

Abstract. Today, there is a tendency to increase financial income from criminal organizations and increase attacks on information systems. At the same time, new methods and models are being developed to support decision-making regarding the choice of financing strategy. Investments in innovative projects, for example, in the field of information technology and cyber security, in many cases are determined by a high probability of calculation inaccuracy and risk. Data analysis systems are often used to improve the efficiency and optimization of project evaluation procedures and to support investment decision-making. It is decision support systems that make it possible to optimize procedures related to the selection of strategies for financial investment of projects based on a combination of game theory with the help of a genetic algorithm. The lack of standardization of the information field and limited access to structured information regarding the degree of cyber security of a specific informatization object is one of the main problems in the field of information protection and cyber security of many states. The only option for solving the problem of finding a rational strategy for investing in cyber security is only to involve the potential of the decision support system. The article describes a method for a decision-making support system based on a genetic algorithm and a combination of game theory, which contribute to ensuring the continuous and effective functioning of the information resource protection system of the informatization object of any scale. In the developed genetic algorithm, the so-called quality index or degree of achievement of the desired goals for a specific information protection tool is adopted as an integral indicator of information protection tools. The presented method can be applied to reduce the time in solving the problem of finding rational (optimal) strategies of investors based on game models in combination with a genetic algorithm, in particular, in the conditions of dynamic opposition to an attacker, when the evaluation of a rational investment strategy is extremely important for the defense side.

Keywords: decision support system; information protection tools; investment strategies; game theory; genetic algorithm.

INTRODUCTION

Ensuring information security (IS) is a complex and costly task. In addition to costly investments, it is necessary to resolve certain disagreements. There are discrepancies between the availability of information resources (IR) and the required degree of protection. This is especially relevant for distributed computing systems (DSC).

An increase in the scale and number of successful cyberattacks [1], the development of the pace of computer crime has become a global trend. The objective necessity of solving the multi-criteria optimization task of managing resources allocated to ensuring information security (IS) is such that decision-makers (DM) are forced to act in dynamically complex situations.

It is obvious that in the process of solving such a task, it is necessary to involve the potential of intelligent decision support systems (DSS). Similar modular [2, 3] or cluster [4] DSS can be used as a complex of interdependent systems in the IS management tasks of informatization objects (IOB). As a rule, similar DSS are based on synergistic ensembles of methods and models. One of such ensembles of methods and models is extremely important in such a subtask of IS management of informatization objects, as the task of finding a rational strategy for investing in information protection means for a distributed computing system of IB.

The lack of forecasted assessments of the dynamics and development prospects of various cyber security (CS) investment projects, rational or optimal options for the development of various projects for the implementation of hardware and software complexes of information protection means (IPN), organizational and other measures for information protection (IP), in general, can lead to an incorrect choice of priority areas of development IOB information security management system. Or create complications related to the wrong strategy of placing funds of investment projects in the cyber security system of IB. From this follows the need to strengthen the potential of the forecasting function, taking into account the application of the provisions of game theory, for example, taking into account the connection of genetic algorithms (GA).

Problem statement. The above caused the problem associated with the need to develop new models based on the joint (hybrid) use of the apparatus of bilinear differential games of quality and GA.

Analysis of recent researches and publications. The authors [5], [6] believe that the development of such a direction of applied research as mathematical decision-making support when choosing a rational investment strategy in IS should be accompanied by the synthesis of new models and methods. The software implementation of the models given in the works is not described. In [6], the authors note that for this class of tasks, the most adequate approach in the process of finding a solution will be the application of game theory.

The authors of [7] note that the category of software products such as DSS and expert systems (ES) helps to simplify the task of finding rational strategies for investors in the field of IS. In [8], various approaches from the point of view of the mathematical apparatus used in such models are considered in sufficient detail. However, the software implementation of the proposed model is not given. The authors [9] describe the application of classical economic and mathematical models. However, these models, in most situations related to the assessment of investments, do not take into account many parameters of investing in complex projects in the field of IS of the IOB. As the analysis of similar studies has shown, most of the models and algorithms given in the works analyzed above do not contain real recommendations and projected evaluations for investors in the IS field. The main drawback of similar software products described in works [10, 11] is the low informativeness of the obtained results. In particular, it is rather difficult to assess the prospects of investment projects and options for investors' actions in the field of the IS of the IOB.

In [11] it is shown that a universal method of multi-criteria optimization of the distribution of financial resources allocated to the construction of IS contours of distributed computing systems for the IOB is still missing. This means that the solution of the indicated task, the computing core of the DSS, should include an ensemble of models. Works [12, 13] show that a fairly effective approach in solving a similar class of optimization problems is the use of game theory. First of all, we are talking about such a section of game theory as multi-step games of quality with several terminal surfaces [12, 13] 14]. When considering complex investment projects, the game model in its pure form makes it quite difficult or impossible to apply classical game models, as well as well-known optimization methods. This actualizes the necessity of forming new approaches to solving this class of tasks. For example, taking into account the use of genetic algorithms.

The works [14, 15] consider the possibilities of using genetic algorithms to solve problems related to the choice of an investor's strategy. In these publications, GA supports a population (a group of chromosomes) that is a contender for the optimal solution.

The lack of forecasted assessments of the dynamics and prospects of the development of various investment projects of the CS, in general, can lead to an incorrect choice of priority directions for the development of the IOB information security management system or create complications related to the wrong strategy of placing funds of investment projects in the cyber security system of the IOB. From this follows the need to strengthen the potential of the forecasting function, taking into account the application of the provisions of game theory, for example, taking into account the connection of genetic algorithms.

The aim of the article. The purpose of the article is to develop a genetic algorithm for a decision support system using a method of choosing an information security investment strategy based on a combination of game theory and a genetic algorithm.

To achieve the goal of the research, the following tasks must be solved:

- Develop clarifications for GA taking into account the total value of the risk and the cost of the CS system;
- To develop and implement DSS on the basis of GA for the method of choosing a strategy for investing information protection means;
- Conduct computational experiments to check the operability of the specified GA and the proposed DSS.

THEORETICAL BASICS OF RESEARCH

The considered task of finding a rational strategy for investing in cyber security projects for informatization objects is proposed to be solved in two stages. At the first stage, the potential of bilinear differential games [16-23] and the description of the interaction of objects in multidimensional spaces [24] were involved. At the second stage, a modified GA genetic algorithm was put into operation.

Let's formulate the model of the first stage of the method.

The complete solution for this stage, the proposed method is described in [24]. Two groups of investors (players) control a dynamic system in multidimensional spaces. Groups of players follow different strategies in their approaches to investing in IS of the IOB. For example, one group acts based on the priority of the paradigm of innovativeness of IS systems for IOB. The second group adheres to more pragmatic approaches. This approach of investors implies investing financial resources in IT systems that do not make excessive demands on system resources. In addition, some similar hardware and software solutions are already installed on the IOB.

A dynamic system (DS) is defined by a set of bilinear differential equations with dependent movements. A number of strategies have been defined for DS *(U)* and *(V)* groups of players. Terminal surfaces S_0, F_0 are also defined for DS. The goal of the first group of players (further on in the text *Inv1*) bring the DS to the terminal surface S_0 with the help of its control strategies. Moreover, this must be done regardless of the actions of the second group of players (further *Inv2*). The aim of *Inv2* bring the DS to the terminal surface F_0 with the help of its control strategies, regardless of actions of *Inv1*. Formulated statement of the problem generates two tasks. This, respectively, is the task of the first allied player and the second allied player [16-23].

Within the framework of the article [24], the solution of the problem was described from the point of view of the first allied player. The tasks are symmetrical, so there is no need to consider the solution of the task in detail from the point of view of the second allied player.

The solution is to find the set of initial states of the players. It is also necessary to determine their strategies. Strategies will allow players to bring the DS to one or another terminal surface.

Players have certain financial resources (FR) to invest in IS of the IOB projects. For example, the construction of multi-circuit protection of a distributed computing system.

Assume, that *Inv1* has a set $g(0)=(g_1(0),\dots,g_n(0))$ ФР ($g_i(0)$ – FR for development of the IS systems for IOB. Consider, that $g_i(0)$ – vector of n-dimensional space with positive elements. On the contrary, for *Inv2* – $p(0)=(p_1(0),\dots,p_n(0))$, ($p_i(0)$ – FR for development of the IS systems for IOB, $p_i(0)$ – vector of n-dimensional space with positive elements. These sets define the predicted, at the moment $t=0$, values of FR (further– *FinR*) players for each new IOB information security system.

The dynamics of changing *FinR* for players is described by the following system of equations [24]:

$$\begin{aligned}
&dg_1(t)/dt = -g_1(t) + \Delta_1^1 \times g_1(t) + [(\Psi_1^1 + Z_1^1) - E]\times \\
&\times U_1(t)\times \Delta_1^1 \times g_1(t) - [(\Psi_2^1 + Z_2^1) - E]\times V_1(t)\times \Delta_2^1 \times p_1(t) \\
&\dots \\
&dg_M(t)/dt = -g_M(t) + \Delta_1^M \times g_M(t) + [(\Psi_1^M + Z_1^M) - E]\times \\
&\times U_M(t)\times \Delta_1^M \times g_M(t) - [(\Psi_2^M + Z_2^M) - E]\times V_M(t)\times \Delta_2^M \times p_M(t); \\
&dp_1(t)/dt = -p_1(t) + \Delta_2^1 \times p_1(t) + [(\Psi_2^1 + Z_2^1) - E]\times \\
&\times V_1(t)\times \Delta_2^1 \times p_1(t) - [(\Psi_1^1 + Z_1^1) - E]\times U_1(t)\times \Delta_1^1 \cdot g_1(t); \\
&\dots \\
&dp_M(t)/dt = -p_M(t) + \Delta_2^M \times p_M(t) + [(\Psi_2^M + Z_2^M) - E]\times \\
&\times V_M(t)\times \Delta_2^M \times p_M(t). - [(\Psi_1^M + Z_1^M) - E]\times U_M(t)\times \Delta_1^M \times g_M(t); \\
&\dots
\end{aligned} \tag{1}$$

where

$$\Delta_1^* = \begin{pmatrix} \Delta_1^1 0 \dots\dots 0 \\ 0\ \Delta_1^2 \dots\dots 0 \\ \dots\dots\dots\dots \\ 0\ \dots\dots\dots \Delta_1^M \end{pmatrix}; \quad \Delta_2^* = \begin{pmatrix} \Delta_2^1 0 \dots\dots 0 \\ 0\ \Delta_2^2 \dots\dots 0 \\ \dots\dots\dots\dots \\ 0\ \dots\dots\dots \Delta_2^M \end{pmatrix}; \quad U = \begin{pmatrix} U_1\ 0 \dots\dots 0 \\ 0\ U_2 \dots\dots 0 \\ \dots\dots\dots\dots \\ 0\ \dots\dots\dots U_M \end{pmatrix}; \quad V = \begin{pmatrix} V_1\ 0 \dots\dots 0 \\ 0\ V_2 \dots\dots 0 \\ \dots\dots\dots\dots \\ 0\ \dots\dots\dots V_M \end{pmatrix};$$

$$\Psi_1^* = \begin{pmatrix} \Psi_1^1 0 \dots\dots 0 \\ 0\ \Psi_1^2 \dots\dots 0 \\ \dots\dots\dots\dots \\ 0\ \dots\dots\dots \Psi_1^M \end{pmatrix}; \quad \Psi_2^* = \begin{pmatrix} \Psi_2^1 0 \dots\dots 0 \\ 0\ \Psi_2^2 \dots\dots 0 \\ \dots\dots\dots\dots \\ 0\ \dots\dots\dots \Psi_2^M \end{pmatrix}; \quad Z_1^* = \begin{pmatrix} Z_1^1 0 \dots\dots 0 \\ 0\ Z_1^2 \dots\dots 0 \\ \dots\dots\dots\dots \\ 0\ \dots\dots\dots Z_1^M \end{pmatrix}; \quad Z_2^* = \begin{pmatrix} Z_2^1 0 \dots\dots 0 \\ 0\ Z_2^2 \dots\dots 0 \\ \dots\dots\dots\dots \\ 0\ \dots\dots\dots Z_2^M \end{pmatrix};$$

$$E^* = \begin{pmatrix} E \ 0........0 \\ 0 \ E......0 \\ .... \\ 0 \ ....E \end{pmatrix}; \quad g = \begin{pmatrix} g_1 \\ g_2 \\ . \\ . \\ . \\ g_M \end{pmatrix}; p = \begin{pmatrix} p_1 \\ p_2 \\ . \\ . \\ . \\ p_M \end{pmatrix};$$

Then the system of differential equations in the model will look like this [24]:

$$\begin{aligned} & dg(t)/dt = -g(t) + \Delta_1^* \times g(t) + [(\Psi_1^* + Z_1^*) - E^*] \times \\ & \times U(t) \times \Delta_1^* \times g(t) - [(\Psi_2^* + \Delta_2^*) - E^*] \times V(t) \times \Delta_2^* \times p(t); \\ & dp(t)/dt = -p(t) + \Delta_2^* \times p(t) - [(\Psi_2^* + Z_2^*) - E^*] \times \\ & \times V(t) \times \Delta_2^* \times p(t) - [(\Psi_1^* + Z_1^*) - E^*] \times U(t) \times \Delta_1^* \cdot g(t), \end{aligned}$$

where $g(t), p(t)$ – vectors Mn dimensional space, $U(t), V(t)$ – unit matrices of order Mn with positive elements $u_i(t), v_i(t)$ from the segment [0,1] on the diagonals of the matrices $U(t), V(t)$ in accordance [16-24];

Δ_1^*, Δ_2^* – FR transformation matrices of the *Inv1* and of the *Inv2*. On the condition that the FR are successfully implemented in the relevant development projects of the IS of the IOB. Matrices Δ_1^*, Δ_2^* – are square matrices of order Mn with positive elements $\delta_1^{*ij}, \delta_2^{*ij}$;

Ψ_1^*, Z_1^* – diagonal matrices with positive elements. The matrix data characterizing the interest payment *Inv2* for financial investments and investment return shares *Inv2* regarding investments *Inv1* in the projects of the IS of the IOB;

Ψ_2^*, Z_2^* – diagonal matrices with positive elements. The matrix data characterizing the interest payment *Inv1* for financial investments and investment return shares *Inv2* regarding investments *Inv2* in the projects of the IS of the IOB;

E^* – unit order matrix Mn.

The interaction of players (investors in IS of the IOB projects) ends when the following conditions are met [16-24]:

$$(g(t), p(t)) \in S_0, \tag{2}$$

$$(g(t), p(t)) \in F_0. \tag{3}$$

Consider, that

$$S_0 = \bigcup_{i=1}^{Mn} \{(g, p) : (g, p) \in R^{2M \cdot n}, g \succ 0, p_i = 0\},$$

$$F_0 = \bigcup_{i=1}^{Mn} \{(g, p) : (g, p) \in R^{2M \cdot n}, p \succ 0, g_i = 0\}.$$

If condition (2) is fulfilled, then we consider that the financing procedure of the analyzed IS of the IOB project is over. In this case y *Inv2* there were not enough FR to continue the continuous investment procedure. This, at least, is true for one of the IS projects.

If condition (3) is fulfilled, then we believe that the continuous procedure of investing in IS projects is also over. In this case, *Inv1* there were not enough FR to continue the continuous investment procedure. This, at least, is true for one of the projects of IS IOB.

If both conditions (2) and (3) are not fulfilled, then we believe that the continuous investment procedure for IS projects of the informatization object continues.

METHODS

When implementing the program code of the models described in the second section of the work, the C# programming language was used, maintenance and debugging of the executable code was performed using MS Visual Studio 2022 tools. The construction of the graphical user interface was carried out using ADO.NET (ActiveX Data Object for NET) technology. The interaction of experts in the SPPR is implemented through the WEB interface, which gives the opportunity for several experts to work on finding a solution to the problem at once. SPPR, accordingly, is deployed on a special server. The site for the work of CSDP experts is developed on ASP.NET Core MVC. ASP.NET Core is a cross-platform, high-performance, open source environment for building modern web-connected cloud applications. One of the distinguishing features of the ASP.NET Core platform is its use of the MVC pattern. The ASP.NET Core MVC framework runs on top of the ASP.NET Core framework and is designed to simplify application development. The development was done in the Visual Studio 2022 IDE with the components installed.

The need to involve the GA in the method of choosing a rational investment strategy in projects to provide the CS of the IOB is due to the fact that the terminal surface is formed by many points corresponding to the investor's preference. And in order to find a rational strategy, it is necessary to additionally research information related to a fairly large number of possible directions of investment in the CS of the IOB funds. Each of these directions can also be divided into sub-directions, for example, when choosing specific hardware and software means of information protection. All this dictates the need to connect a faster algorithm for sorting through points on the terminal surface in order to find a rational trajectory that corresponds to the strategy of investing in the CS of the IOB. Iterative process of applying GA for different number of generations of GA chromosomes, making up sets of information protection tools.

RESULTS

In order to check the adequacy of the proposed algorithm and DSS, which contribute to ensuring the continuous and effective functioning of the information resource protection system of the informatization object of any scale, appropriate computational experiments were conducted, see Fig. 1-3.

Computational experiments were conducted for randomly generated sets of information.

As a result of solving the system of equations (1), such a set of points in the multidimensional solution space is obtained, as shown in Fig. 1-3.

Calculations were made taking into account the multiplicity of factors that characterize the multidimensionality of the process of investing in CS of the IOB. This will mean that the toolkit for graphical representation in spaces of dimensions even more than three will be put into operation in the DSS under development. For example, for 4, 5 and 6-dimensional graphs, using the Plotly library for the Python language, you can emulate the depth of visualization by varying the colors, size, or shape of the markers.

In the fig. 2 and 3 show a collection of points in three-dimensional space. Axes correspond to the following model parameters: axis *H1(0)* – the first player's FR value (*Inv1*); *H2(0)* – the

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second player's FR value (*Inv2*). Parameter *Delta0(P0)* characterizes the amount of the first investor's FR spent on bringing the dynamic system to its terminal surface.

The points make it possible to determine the advantage of the sets of the first investor in the CS of the IOB. It happens in this way. As you know, each point is a set of components characterizing investors' FR. A set of components that is the first investor's FR corresponds to a set of components that is the second investor's FR. There can be several such sets of components. Part of these sets, together with the sets of components of the FR of the first investor, belongs to the majority, which guarantees the continuation of the investment procedure in IS projects. The part belongs to the majority in which the second investor is unable to continue investing. Then, choosing from these values the minimum ones (for each component), we will get for each FR the set of the first investor, which will belong to the preference of the set of the first investor.

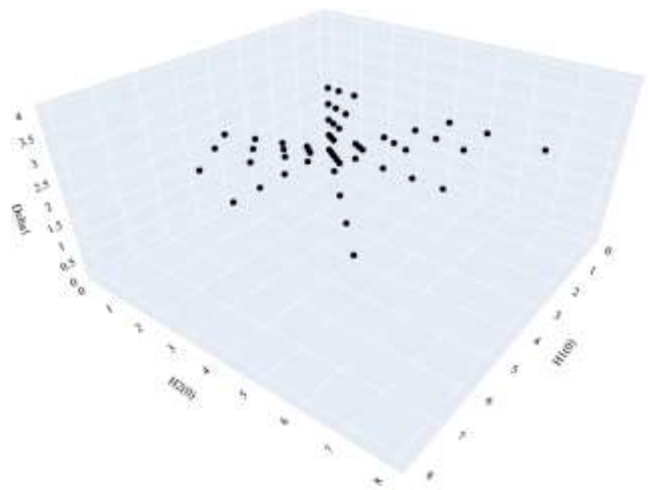

Fig. 1. Dependence of the preference of sets W_1 for the first investor in the CS of the OBI for 3 variables

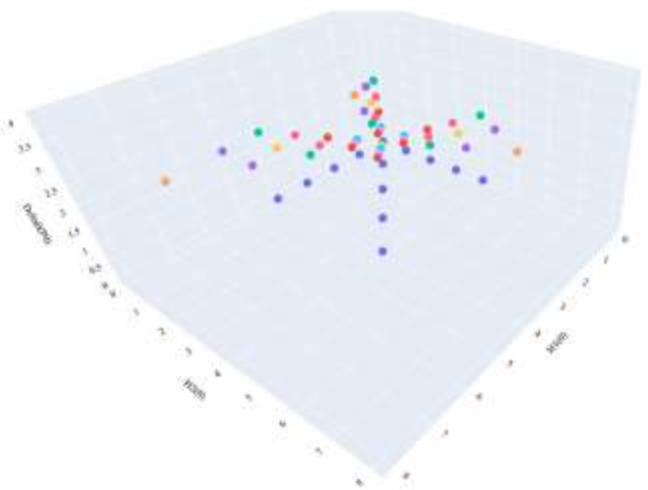

Fig. 2. Dependence of the preference of sets W_1 for the first investor in the CS of the OBI for 4 variables

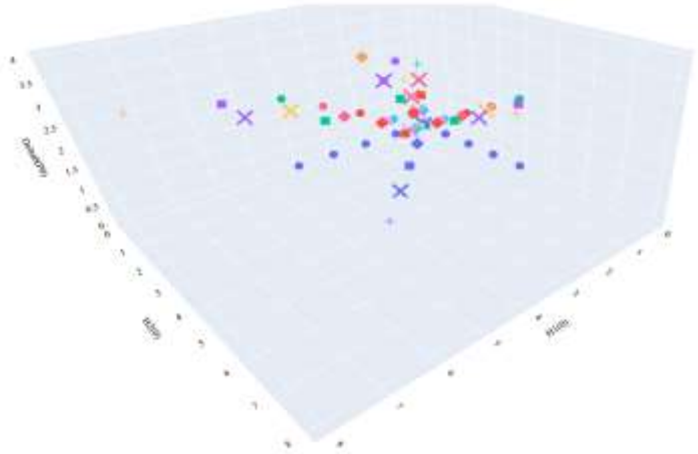

Fig. 3. Dependence of the preference of sets W_1 for the first investor in the CS of the OBI

It should be noted that the graphic interpretation with the image of a set of points for the online charts of the DSS will correspond to the investment model, in which it is assumed that the first investor can use the FR determined by the given sets of these resources. These sets of FR can be determined by the choice of specific investment programs. For example, these can be programs for the development of new technologies in the tasks of controlling the risk indicators of the realization of information threats and ensuring the necessary level of the IS of the OBI, etc.

As mentioned above, for 4-, 5-, and 6-dimensional graphs, using the Plotly Python library, you can emulate the depth of visualization by varying the colors, size, or shape of the markers. In fig. 2, the lighter shade of the markers will correspond to the lower value of the interest charge *Inv2* for financial investments and investment return shares *Inv2* regarding investments *Inv1* in the projects of the IS of the OBI.

Fig. 3 serves as an additional confirmation of the possibility of graphic interpretation in spaces of greater dimensions than three and even four. The essence of the interpretation is the same as for fig. 2.

The size of the marker for fig. 3 allows you to use the visualization of the fifth measurement. The markersize parameter of the Scatter3D function for the Plotly library was used here. The forms of markers are perfect for visualizing project categories as part of the search for a rational IS of the IOB strategy. For example, round markers correspond to the category of projects on the development of application software security. Then markers in the form of diamonds are an investment in the security of data processing technologies. Markers in the form of a plus (+) symbol - investing in the control of risk indicators of the realization of information threats and ensuring the necessary level of the IS of the OBI, etc. The Plotly library provides a choice of 10 different shapes for 3D graphs. Thus, it is possible to show up to 10 different values as a form of markers for the online DSS platform.

The identified shortcoming of the models based on this approach is the fact that the obtained data of the forecasted assessment when choosing investment strategies in CS of the IOB is not always easy to interpret without being an expert in the field of game theory or without having information about the functionality of the Plotly library.

The need to involve a genetic algorithm at the second stage of the method of choosing a rational investment strategy in projects to ensure cyber security of the informatization object is due to the following considerations. The terminal surface, as shown in fig. 1-3 or in work [25] forms a set of points corresponding to the advantage of the set of investors. This set is formed by points on the terminal surface. And in order to find a rational strategy, it is necessary to additionally research information related to a fairly large number of possible investment directions. Each of these directions can also be divided into sub-directions, for example, when choosing specific hardware and software means of information protection. All this dictates the need to involve a faster algorithm for sorting through points on the terminal surface to find a rational trajectory that corresponds to the strategy of investing in the CS of the IOB.

The main stages of solving the problem of choosing a rational investment strategy in the CS projects for the IOB are considered below. As shown above, the search for a solution is performed in two stages. At the first stage, the potential of the apparatus of bilinear differential games is involved. This makes it possible to obtain a terminal surface where there are points characterizing sets of certain investment directions. And at the second stage, a genetic algorithm is used, which, due to a fairly high speed, provides an operational review of various options for measures to ensure the CS of the IOB. This is especially important in the conditions of a dynamic confrontation with the attacking side, when it is difficult for the defense side to predict all scenarios of attacks on its information systems.

The method includes the following steps for the GA application part.

1. Initialization.

An initial population consisting of N chromosomes is generated. Хромосоми представлені у бінарному коді. Вихідними даними для кодування є дані, які отримані в процесі вирішення багатокрокової гри якості з кількома термінальними поверхнями [9].

2. The suitability of chromosomes in the population is assessed.

The suitability function (objective function in the general case) is calculated. As the target function, the predicted value of the return on investment in certain directions of the development of the CS system for the OBI is accepted. The target function is determined for each of the chromosomes.

3. Reproduction.

Below are steps 3.1 to 3.4. This is implemented until a new population consisting of N chromosomes is created.

3.1. Selection and selection. We select two parental chromosomes from the population with probability P_i^{sel} .

3.2. Crossing. Let's determine whether there is a need to perform a crossing operation or not. If there is such a need, we will exchange bits in random positions. For any option (crossing is carried out or it is absent), the chromosomes will be transferred to the category of offspring.

3.3. Mutation. For offspring chromosomes, we randomly replace the selected bit.

3.4. Generation of a new population. A new population is generated. At the same time, we will apply the principle of "elite" selection.

4. Reiteration.

We repeat the process according to point 2 until the condition for the termination of the algorithm is reached.

5. Selection of the "best" chromosome.

The selection of the best chromosome characterizes the priority areas of investment of projects in the CS of the IOB, from the point of view of the investor. And for which the return on investment in CS will be maximum.

CONCLUSIONS

Thus, the article presents the following results:

1. A modified GA is proposed to solve the task related to obtaining a forecasted assessment of returns from various directions of investment in the projects of CS of IOB. This allows potential investors at the stage of assessing the attractiveness of individual projects related to the development of the CS of the IOB to receive projected assessments of the prospects of the selected investment strategies by determining significant factors for the growth of returns from investing in the CS of IOB, as well as tracking growth points and structural changes.

2. The method presented in this section can be applied to reduce the time in solving the problem of finding rational (optimal) strategies of investors based on game models in combination with GA, in particular, in conditions of dynamic opposition to an attacker, when the evaluation of a rational investment strategy is extremely important for the defense side.

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ОПТИМІЗАЦІЯ МЕТОДУ ВИБОРУ СТРАТЕГІЇ ІНВЕСТУВАННЯ ЗАСОБІВ ЗАХИСТУ ІНФОРМАЦІЇ НА ОСНОВІ КОМБІНАЦІЇ ТЕОРІЇ ІГОР ТА ГЕНЕТИЧНОГО АЛГОРИТМУ

Анотація. Сьогодні існує тенденція збільшення фінансових надходжень від злочинних організацій збільшення атак на інформаційні системи. Водночас розробляються нові методи та моделі для підтримки прийняття рішень щодо вибору стратегії фінансування. Інвестиції в інноваційні проєкти, наприклад, у галузі інформаційних технологій та кібербезпеки, у багатьох випадках визначаються великою ймовірністю неточності обчислень та ризику. Для підвищення ефективності та оптимізації процедур оцінки проєктів та підтримки прийняття рішень, пов'язаних з інвестуванням, часто використовують системи аналізу даних. Саме системи підтримки прийняття рішень дають можливість оптимізувати процедури, пов'язані з вибором стратегій для фінансового інвестування проєктів на основі комбінації теорії ігор за допомогою генетичного алгоритму. Відсутність стандартизації інформаційного поля та обмежений доступ до структурованої інформації щодо ступеня кібербезпеки конкретного об’єкту інформатизації, є однією з головних проблем сфери захисту інформації та кібербезпеки багатьох держав. Єдиним варіантом для розв’язання задачі пошуку раціональної стратегії інвестування у кібербезпеку є лише залучення потенціалу системи підтримки прийняття рішень. У статті описано метод для системи підтримки прийняття рішень на основі генетичного алгоритму та комбінації теорії ігор, які сприяють забезпеченню безперервного та ефективного функціонування системи захисту інформаційних ресурсів об’єкту інформатизації будь-якого масштабу. У розробленому генетичному алгоритмі в якості інтегрального показнику засобів захисту інформації прийнятий так званий індекс якості або ступінь досяжності бажаних цілей для конкретного засобу захисту інформації. Представлений метод може бути застосований для скорочення часу в ході розв’язання задачі пошуку раціональних (оптимальних) стратегій інвесторів на основі ігрових моделей у поєднанні з генетичним алгоритмом, зокрема в умовах динамічного протистояння нападнику, коли оцінка раціональної стратегії інвестування виключно важлива для сторони захисту.

Ключові слова: система підтримки прийняття рішень; засоби захисту інформації; стратегії інвестування; теорія ігор; генетичний алгоритм.

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