УДК 004.8

08.00.13 - Математические и инструментальные методы экономики (экономические науки)

ПОДДЕРЖКА ПРИНЯТИЯ РЕШЕНИЙ ДЛЯ УПРАВЛЕНИЯ ХОЛДИНГОМ С ПРИМЕНЕНИЕМ СЦЕНАРНОГО АСК-АНАЛИЗА[1]

Луценко Евгений Вениаминович
д.э.н., к.т.н., профессор
Web of Science ResearcherID S-8667-2018
Scopus Author ID: 57188763047
РИНЦ id=123162, SPIN-code: 9523-7101
prof.lutsenko@gmail.com http://lc.kubagro.ru
https://www.researchgate.net/profile/Eugene-Lutsenko
Кубанский Государственный Аграрный университет имени И.Т.Трубилина, Краснодар, Россия

Печурина Елена Каримовна
РИНЦ SPIN-код: 1952-4286
geskov@mail.ru
Кубанский Государственный Аграрный университет имени И.Т.Трубилина, Краснодар, Россия

В данной работе ставится, рассматривается и решается актуальная задача поддержки принятия решений (управления) для холдинга. Предлагается теоретическое и практическое решение этой задачи путем применения сценарного автоматизированного системно-когнитивного анализа (сценарный АСК-анализ) и его программного инструментария – интеллектуальной системы «Эйдос». Приводится подробный численный пример, основанный на реальных данных. Как показывает анализ результатов численного эксперимента предложенное и реализованное в системе «Эйдос» решение поставленных задач является вполне эффективным, что позволяет обоснованно утверждать, что цель работы достигнута, поставленная проблема решена. В результате исследования с помощью системы «Эйдос» непосредственно на основе реальных эмпирических данных созданы статистические и системно-когнитивные модели, в которых обобщенные образы классов соответствуют будущим значениям экономических показателей холдинга и сценариям их изменения. В созданных моделях отражены сила и направление влияния прошлых значений экономических показателей холдинга и сценариев их изменения на переход холдинга в состояния, соответствующие классам, т.е. решена задача прогнозирования

UDC 004.8

08.00.13 - Mathematical and instrumental methods of economics (economic sciences)

DECISION SUPPORT FOR HOLDING MANAGEMENT USING SCENARIO ASC-ANALYSIS

Lutsenko Evgeniy Veniaminovich
Doctor of Economics, Cand.Tech.Sci., Professor
Web of Science ResearcherIDS-8667-2018
Scopus Author ID: 57188763047
RSCI id=123162, SPIN-code: 9523-7101
prof.lutsenko@gmail.com http://lc.kubagro.ru
https://www.researchgate.net/profile/Eugene-Lutsenko
Kuban State Agrarian University named after I.T. Trubilin, Krasnodar, Russia

Pechurina Elena Karimovna
RSCI SPIN code: 1952-4286
geskov@mail.ru
Kuban State Agrarian University named after I.T. Trubilin, Krasnodar, Russia

In this article, we set, consider and solve the actual problem of decision support (management) for the holding. A theoretical and practical solution to this problem is proposed through the use of scenario automated system-cognitive analysis (scenario ASC-analysis) and its software tools - the intellectual system "Eidos". We have also given a detailed numerical example based on real data. As the analysis of the results of the numerical experiment shows, the solution of the tasks proposed and implemented in the Eidos system is quite effective, which allows us to reasonably assert that the goal of the work has been achieved, the problem has been solved. As a result of the study, using the Eidos system, statistical and system-cognitive models were created directly on the basis of real empirical data, in which generalized images of classes correspond to the future values of the economic indicators of the holding and scenarios for their change. The created models reflect the strength and direction of the influence of the past values of the economic indicators of the holding and scenarios for their change on the transition of the holding to the states corresponding to the classes, i.e. the problem of forecasting is solved

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Ключевые слова: АВТОМАТИЗИРОВАННЫЙ СИСТЕМНО-КОГНИТИВНЫЙ АНАЛИЗ, АСК-АНАЛИЗ, СИСТЕМА «ЭЙДОС»

Keywords: AUTOMATED SYSTEMIC COGNITIVE ANALYSIS, ASC-ANALYSIS, EIDOS SYSTEM

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CONTENT

1.Introduction

This work is a continuation of a series of publications related to solving the problem of holding management as a highly complex multi-parameter dynamic nonlinear system [1-7][2].

In the course of solving this problem earlier, the author obtained the following results.

1. The problem of strategic planning and management of holdings based on information and cognitive technologies has been posed [1].

2. The requirements for the mathematical method and the model of strategic planning and management of holdings are substantiated [1].

3. A mathematical method and principles for creating a model that meet reasonable requirements have been developed [1].

4. Conducted cognitive-target structuring of the subject area [2].

5. Principles and methodology for formalization of the subject area have been developed [2].

[2] In this paper, all references to literary sources are given according to the list of references in [1].

6. The subject area has been formalized [2].

7. The initial data are encoded using classification and descriptive measuring scales and gradations developed at the stage of formalization of the subject area, resulting in the formation of a training sample [2].

8. The synthesis and verification of the system-cognitive model of the holding was carried out (on a specific real example) [2].

9. A classification of the tasks of strategic planning and management of holdings has been developed on the basis of a system-cognitive model [3].

11. A study of the holding was carried out by studying its system-cognitive model [5].

10. The problem of predicting the values and scenarios for changing the future economic indicators of the holding for the holding has been solved [7].

This work is devoted to solving problems of decision support (management) for the holding.

2. Methods

To solve the problem, we used scenario automated system-cognitive analysis (scenario ASC analysis), proposed and implemented by the author in the intellectual system "Eidos" [8-14].

The mathematical method, data structures and algorithms for their processing (a manual for numerical calculations), as well as the structure of the system and the methodology for creating a model and its application for solving problems of forecasting, decision making and research of the modeled subject area are described in a number of works of the author [8-14], therefore it is inappropriate to present them in this work.

In previous works [1-7], the following tasks, which are standard for ASC analysis, were posed and solved on real data:

*Task-1:*cognitive structuring of the subject area;

*Task-2:*preparation of initial data and formalization of the subject area;

*Task-3:*synthesis and verification of models and selection of the most reliable model;

*Task-4:*solution in the most reliable model of subtask 4.1. forecasting the values and scenarios for changing the future economic indicators of the holding for the holding [7].

Below, using a real numerical example, we will consider the implementation of the standard stages of scenario ASC analysis [8-12] when solving subtask 4.2 of decision support (management) for a holding:

– decision support in the simplest version (SWOT analysis)

– advanced decision-making algorithm.

Note that when implementing these stages of ASC analysis, especially in the developed decision-making algorithm, many results of solving subproblem 4.3 are used, i.e. study of the object of simulation by studying its model:

– cognitive class diagrams;

– agglomerative cognitive clustering of classes;
– cognitive diagrams of factor values;
– agglomerative cognitive clustering of factor values;
– non-local neurons and non-local neural networks;
– 3d-integrated cognitive maps;
– cognitive functions;
- the strength and direction of the influence of the values of factors on belonging to classes;
- the degree of determinism of classes by the values of the factors that determine them.

These problems were solved earlier in [5], but for basic ASC analysis. In this paper, we will consider the solution of some of them in the scenario ACK analysis.

3. Results

3.1. Task 1: cognitive structuring of the subject area

At the stage of cognitive-target structuring of the subject area, we decide in a non-formalized way at a qualitative level what we will consider as an object of modeling, what as factors acting on the modeled object (reasons), and what as the results of these factors (consequences).

In essence, the cognitive-target structuring of the subject area is the statement of the problem to be solved.

Descriptive scales serve to formally describe the factors, and classification scales - the results of their action on the modeling object. Scales can be numerical and textual.

In this work, as classification scales, we will choose economic indicators for the holding as a whole and in the context of its constituent enterprises, characterizing the economic results of activities, i.e. performance results in value terms. As factors influencing these results, we will take the following economic indicators [2].

In accordance with the methodology of scenario ASC analysis [8-14], in addition to the basic classification and descriptive scales that directly reflect their values, the model also uses automatically created based on the basic scales [7]:

- scenario scales reflecting the dynamics of changes in the values of the basic indicators of factors and the results of their action;

– scales reflecting the values at given points of these scenarios.

3.2. Task 2: preparation of initial data and formalization of the subject area

3.2.1. Automated Programming Interface (API) for Entering Numerical and Textual Data and Tables

The Eidos System has 6 automated program interfaces (APIs) that provide input into the Eidos system of external data of text, numeric and graphic types. With the help of one of these API-2.3.2.2, the initial data on the problem being solved in the paper [7] were entered.

3.2.2. Classification and descriptive scales and gradations and training sample

As a result, classification and descriptive scales and gradations were created, and then the initial data were encoded with their help, as a result of which a training sample was obtained, which is essentially the initial data normalized using these scales and gradations [7].

3.2.3. Future and past scenarios for changing the values of gradations of the basic scales

Past and future scenarios are generated by API-2.3.2.2 fully automatically. These scenarios are gradations of the corresponding scenario classification and descriptive scales, which are also formed automatically. All scenarios are automatically encoded and taken into account in the training set [7].

In total, the models generated and used 971 future scenarios for changes in economic indicators (grades of classification scales) and 5888 past scenarios (grades of descriptive scales). Therefore, figures 10 and 11 show only a small part of them.

All of these past and future scenarios can be seen in full in animated presentations, which can be viewed at the links:

– past scenarios:
https://www.researchgate.net/publication/357478537.
– future scenarios:
https://www.researchgate.net/publication/357478446.

These presentations were created using standard PowerPoint-2010 and ACDSee v4.0-2 tools.

3.3. Task 3: synthesis and verification of models and selection of the most reliable model

3.3.1. Synthesis and verification of statistical and system-cognitive models

Synthesis and verification of statistical and system-cognitive models (SC-models) of models is carried out in mode 3.5 of the Eidos system. Mathematical models, on the basis of which statistical and SC models are calculated, are given in [8-14].

Note that in ASC-analysis and SC-models, the degree of manifestation of various properties of objects of observation (the strength and direction of the influence of factor values) is considered from a single point of view: from the point of view of how much information they contain about what the object of modeling is under their action will move to one or another future state corresponding to the classes. Therefore, it does not matter in what types of scales (nominal, ordinal or numerical) and in what units of measurement certain values of factors are measured, and also in what units the results of the influence of these factor values are measured, natural, in percentage or cost [13] . This is the solution to the problem of comparability in ASC analysis and the Eidos system, which distinguishes them from other intelligent technologies.

3.3.2. Estimating Model Reliability

The assessment of the reliability of models in the "Eidos" system is carried out by solving the problem of classifying objects of the training sample according to generalized images of classes and counting the number of true and false positive and negative solutions by Van Riesbergen's F-measure, as well as by the criteria of L1-L2-measures of prof. E.V. Lutsenko, which are proposed in order to mitigate or completely overcome some of the shortcomings of the F-measure [13, 15]. In [7] it is shown that the created models have a very high reliability.

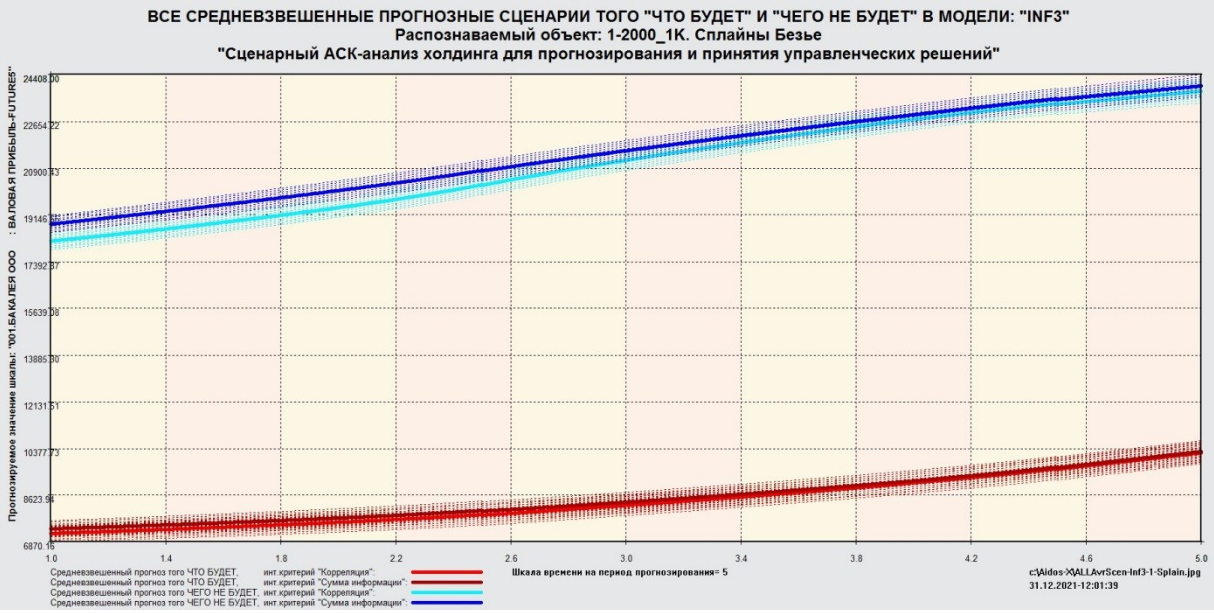
3.3.3. Setting the current model

In the Eidos system, most tasks are solved immediately for all models. However, the problem of identification (recognition, classification, diagnostics) and the problem of forecasting are solved only in the model set as the current one. This is done because these tasks are the most computationally intensive and their solution can take quite a long time. This computational complexity is due to the fact that when solving these problems, each object of the training sample is compared with each of the classes according to all the features it has.

3.4. Task 4: solve various problems in the most reliable model

3.4.1. Subtask 4.1. Forecasting (diagnostics, classification, recognition, identification)

The problem of forecasting for 5 years by systemic identification of 28 objects of observation with 1191 classes according to 7258 features was solved in [7] in the most reliable INF3 SC model on the central processing unit (CPU) (Figure 1).

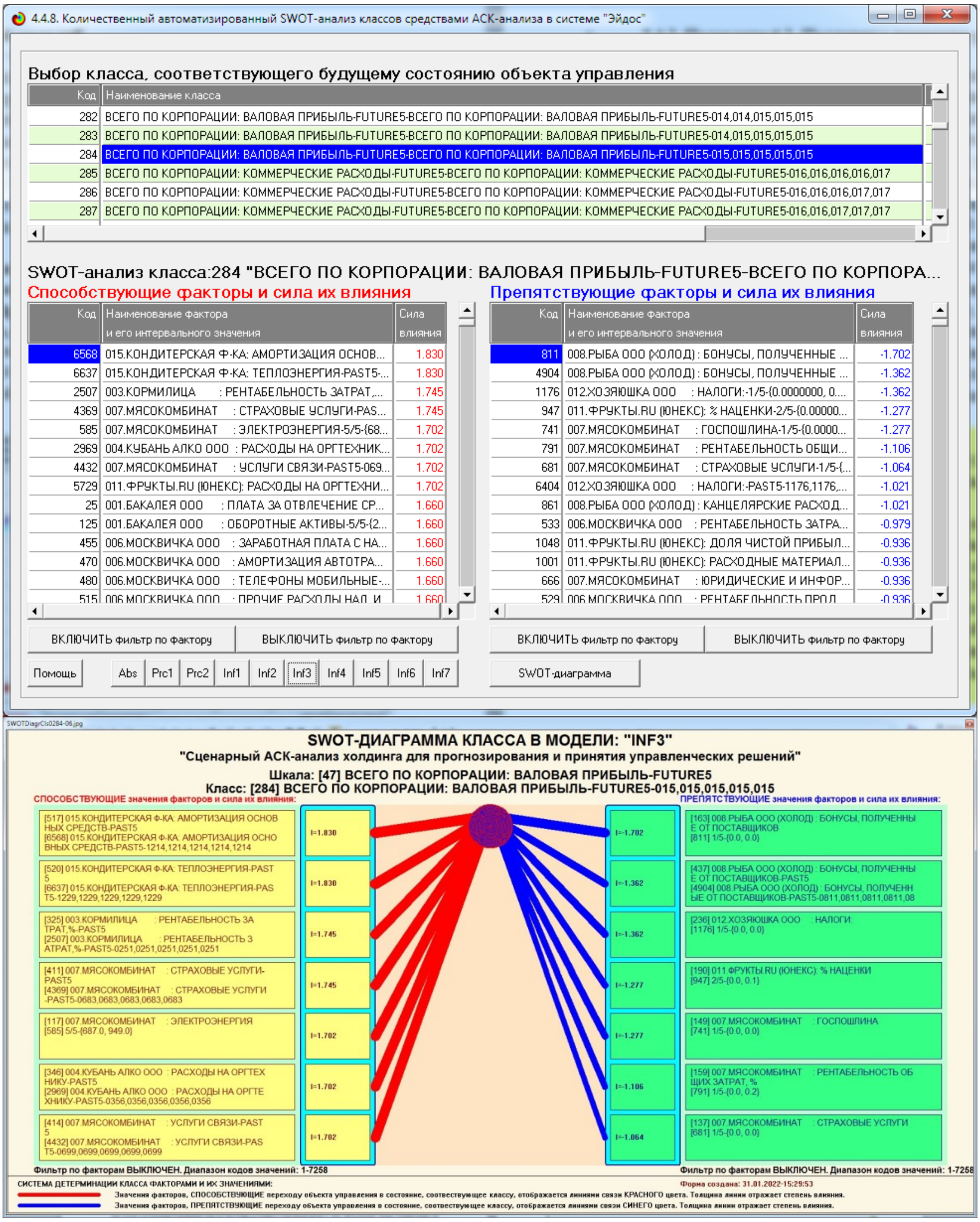


Picture1. Average weighted results of forecasting for 5 years

The thickness of the lines of the predicted scenarios corresponds to the degree of similarity of the situation at the moment of forecasting with the generalized image of the class of the corresponding scenario. The weighted average scenario is obtained by summing the predicted scenarios with their weights, as described in [8-14].

3.4.2. Subtask 4.2. Decision support in the simplest version (SWOT analysis)

When making decisions, the strength and direction of the influence of the values of the factors on the belonging of the states of the modeling object to one or another class corresponding to various future states is determined. In the simplest version, decision making is, in fact, the solution of the SWOT analysis problem [16]. With regard to the problem solved in this work, SWOT analysis shows the degree of influence of various values of past economic indicators and their dynamics on future values of economic indicators and their dynamics. In the "Eidos" system in mode 4.4.8, the solution of this problem is supported. In this case, the system of determination of a given class is revealed, i.e. a system of values of factors that cause the transition of the modeling and control object to a state corresponding to a given class, as well as preventing this transition. The degree of influence of the values of the factors on the result is also given. Figure 2 shows examples of some SWOT charts that clearly reflect the strength and direction of the influence of various values of past economic indicators and their dynamics on future values of economic indicators and their dynamics:



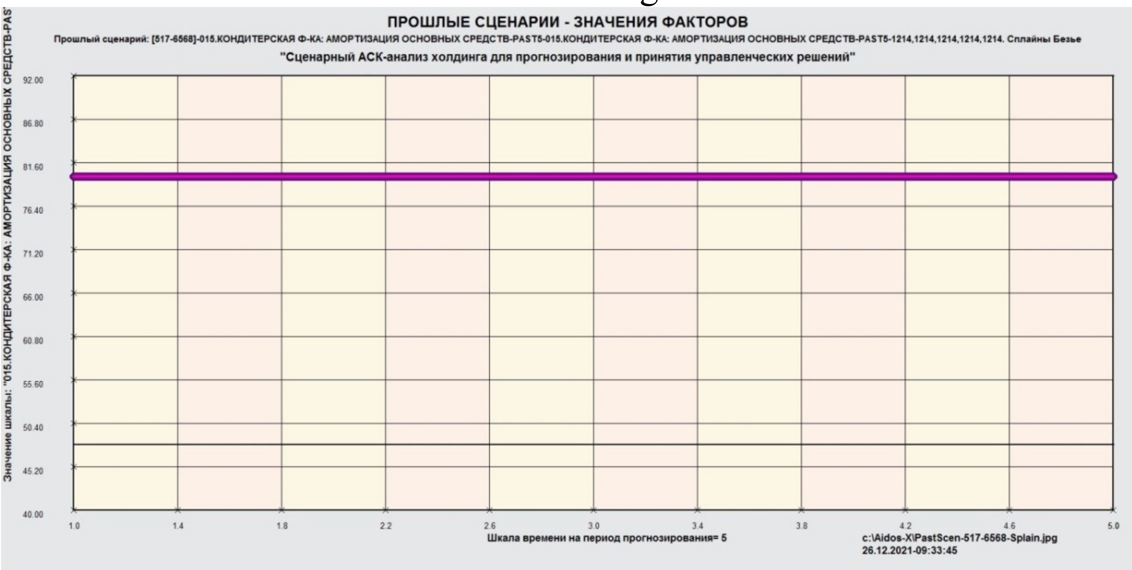
Picture2. SWOT diagrams for determining future scenarios for changes in economic indicators by past scenarios[3]

The screen forms shown in Figure 2 contain all the necessary explanations and are intuitive.

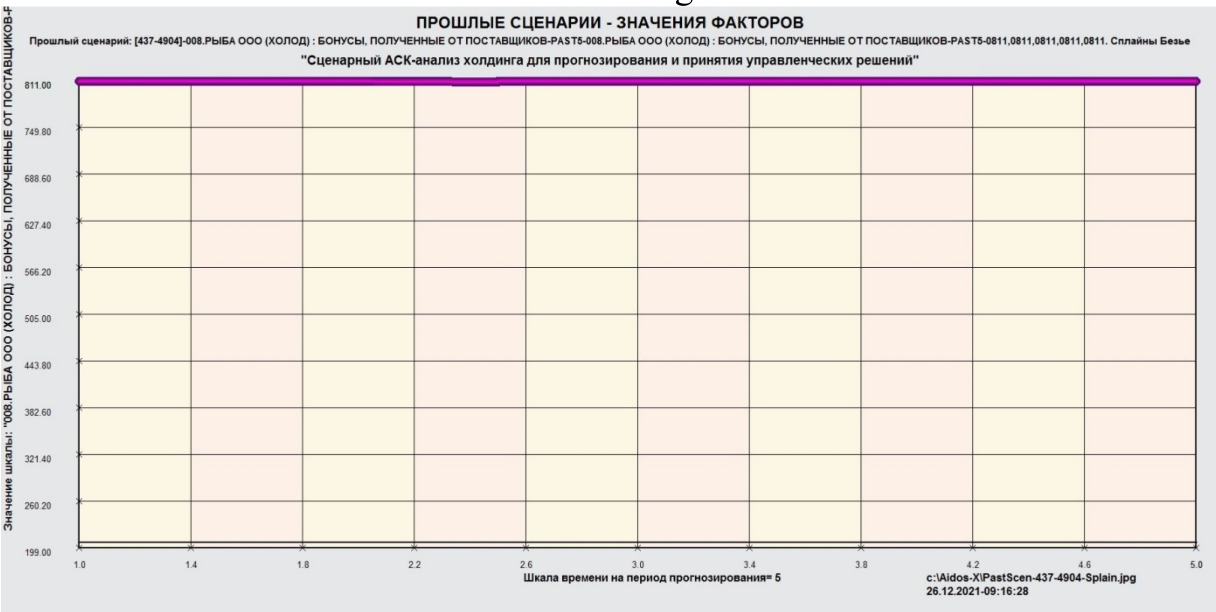
Below in Figure 3 we present images of the future scenario with the code [284] and past scenarios that contribute (codes: [6568], [6637], [2507]) and prevent (code: [4904]) the occurrence of this future scenario:

[3]Despite the small size of the figures in the work, they are quite readable when viewing the text of the work on an enlarged scale, for example, at a scale of 200% or 500%.

Contributing:



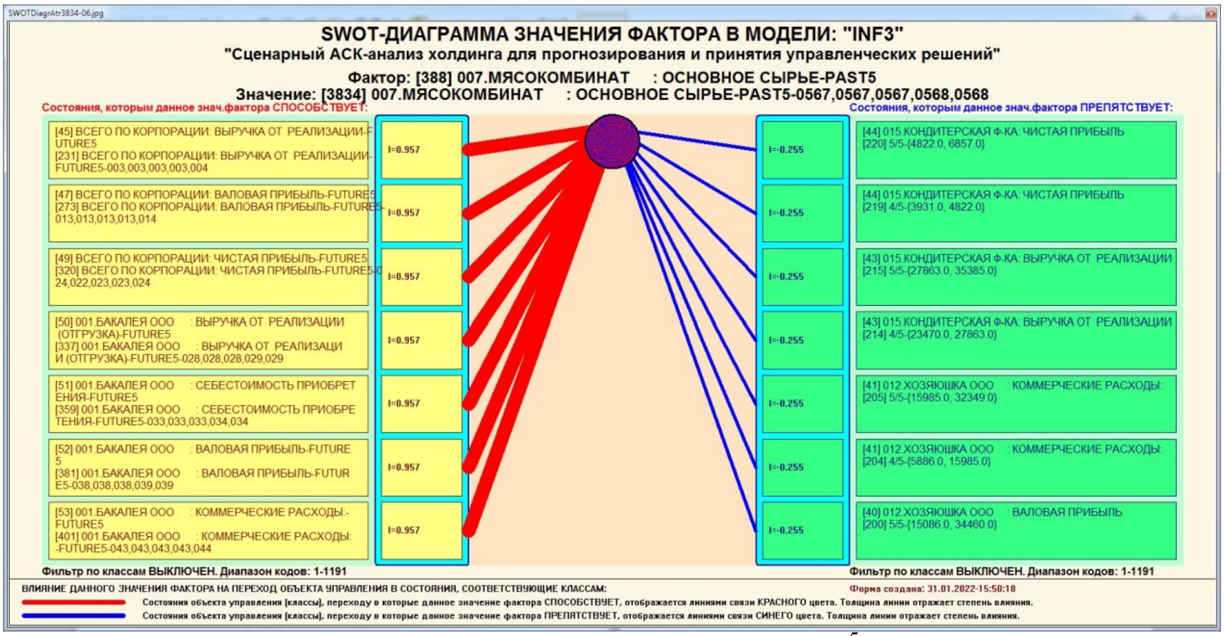
Obstructing:



Picture3. An example of determining the future scenario for changing economic indicators by past scenarios[4]

Figure 4 shows an example of an inverted SWOT chart (proposed by the author [16]), reflecting the strength and direction of the influence of various past values of economic indicators and their dynamics on future values and dynamics of economic indicators.

[4]Despite the small size of the figures in the work, they are quite readable when viewing the text of the work on an enlarged scale, for example, at a scale of 200% or 500%.



Picture4. SWOT Chart Example[5]

Note that similar inverted SWOT-diagrams can be obtained for all values and scenarios of the holding's economic indicators, and they are not presented here only due to limitations on the amount of work.

In conclusion, we note that SWOT analysis is a widely known and generally recognized method of strategic planning. However, this does not prevent him from being criticized, often quite fair, justified and well reasoned. As a result of a critical review of the SWOT analysis in full accordance with the methodology of the SWOT analysis, quite a few of its strengths and weaknesses have been identified.

In particular, according to the author, the main disadvantage of SWOT analysis is the need to involve experts both to select the system of factors itself and to assess the strength and direction of the influence of these factors on the result.

It is clear that experts do this in an informal way based on their experience, intuition and professional competence, i.e. roughly speaking "from the lantern." To be honest, most often these experts are the authors of the papers themselves, usually students, undergraduates and graduate students, who can hardly be suspected of being real experts in any subject area (except one).

The possibilities of attracting experts have their natural limitations, financial, time, organizational and others. In addition, often for various reasons, experts cannot or do not want to communicate their ways of making decisions.

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[5]Despite the small size of the figures in the work, they are quite readable when viewing the text of the work on an enlarged scale, for example, at a scale of 200% or 500%.

Sometimes there are even situations when an expert's communication to a cognitive scientist of his approach to decision-making can be considered a sincere confession, mitigating punishment under certain articles.

Thus, there is a problem of conducting a SWOT analysis without the involvement of experts. This problem is solved by automation by automating the functions of experts in SWOT analysis, i.e. by creating models directly based on empirical data that obscure measurements of the strength and direction of the influence of factors on the results. This technology has been developed for a long time, it is already more than 30 years old, but, unfortunately, the only system in which this is implemented is relatively little known (this is the Eidos intellectual system).

3.4.3. Subtask 4.2. Advanced decision making algorithm

The previous section briefly described the option of making decisions by applying cognitive automated SWOT analysis. However, for three main reasons, SWOT analysis can only be considered as a decision-making method in a very simplified form:

1) In a SWOT analysis, only one target future state is considered, and there can be a lot of them. For example, the efficiency of a company can be measured in physical and cost terms, and for each of these options there can be a lot of indicators (quantity and quality of various types of products, profit and profitability, etc.);

2) It is not known whether the management objectives are set correctly, i.e. whether the target states are simultaneously achievable, i.e. whether they are compatible in terms of the system of determining factor values (the system of determination), or whether they are unattainable at the same time, alternative.

3) All factor values recommended in the WSOT analysis must be used to achieve the target condition. However, some of them may not be physically or financially feasible to use. What to do in this case is not entirely clear.

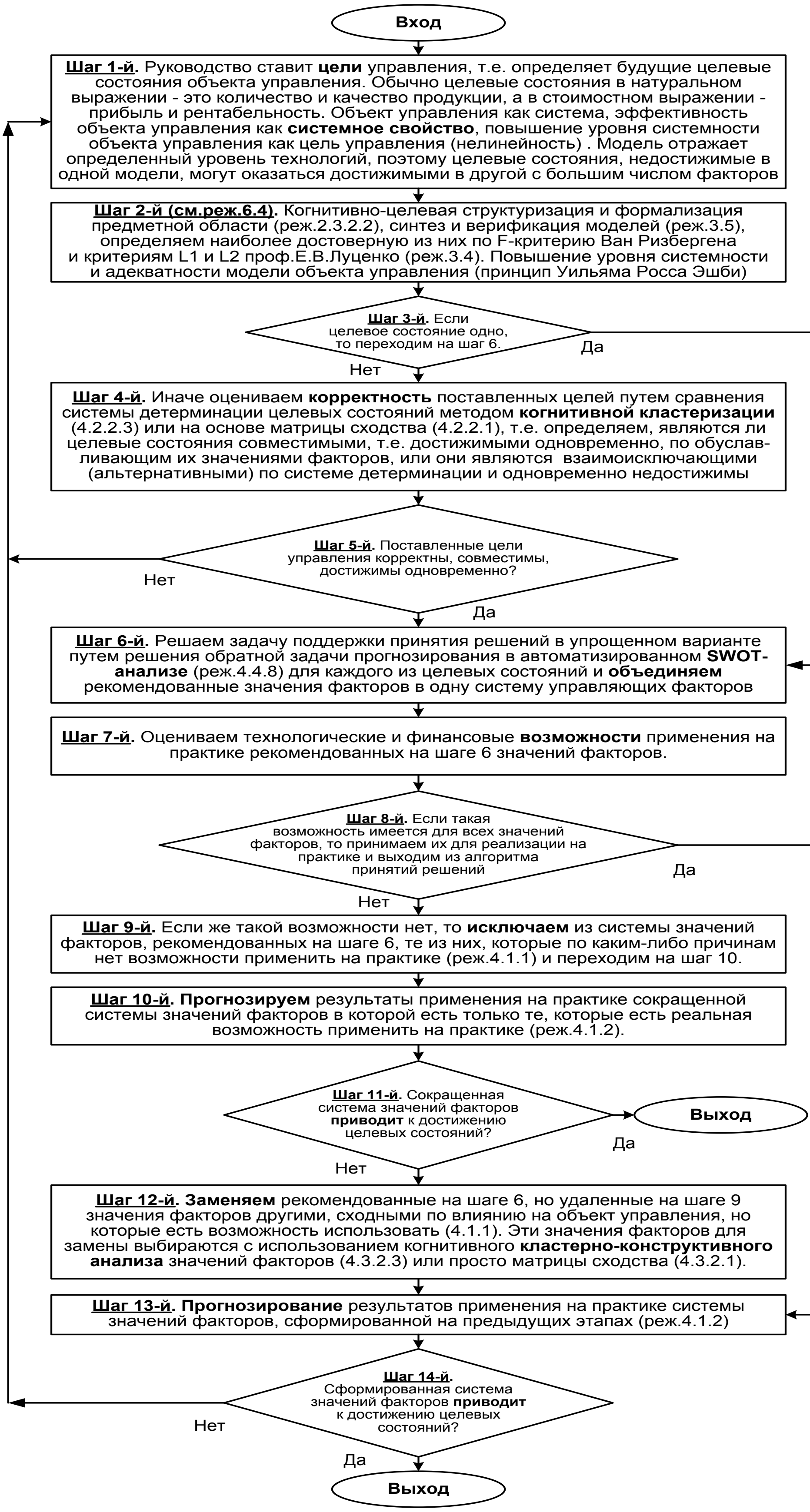
In the developed decision-making algorithm in intelligent control systems based on ASC analysis and the Eidos system, all these problems are solved. This algorithm is fully implemented by means of the "Eidos" system and ensures correct and reasonable management decisions in real situations.

A detailed explanation of this algorithm (which, in principle, is already quite understandable) is not included in the tasks of this work and is given in other works of the author, for example [9], as well as in video lessons:

– at Perm National University:
https://bigbluebutton.pstu.ru/b/w3y-2ir-ukd-bqn

– at the Kuban State University and the Kuban State Agrarian University:
https://disk.yandex.ru/d/knISAD5qzV83Ng?w=1.

Developed decision-making algorithm in intelligent control systems based on ASC-analysis and the Eidos systemshown in Figure 4. This algorithm includes the following steps:



Picture5. Developed decision-making algorithm in intelligent control systems based on ASC-analysis and the Eidos system

Step 1. Management sets management goals, i.e. determines the future target states of the control object. Typically, the target states in physical terms are the quantity and quality of products, and in value terms - profit and profitability. The control object as a system, the effectiveness of the control object as a system property, increasing the level of systemicity of the control object as a control goal (nonlinearity) . The model reflects a certain level of technology, so the target states that are unattainable in one model may be achievable in another with a large number of factors.

Step 2 (see dir.6.4). Cognitive-targeted structuring and formalization of the subject area (dir. 2.3.2.2), synthesis and verification of models (dir. 3.5), we determine the most reliable of them according to the Van Riesbergen F-criterion and the L1 and L2 criteria of Prof. E.V. Lutsenko (dir.3.4). Increasing the level of consistency and adequacy of the control object model (principle of William Ross Ashby).

Step 3. If the target state is one, then go to step 6, otherwise go to step 4.

Step 4. Otherwise, we evaluate the correctness of the goals set by comparing the target state determination system using the cognitive clustering method (4.2.2.3) or based on the similarity matrix (4.2.2.1), i.e. determine whether the target states are compatible, i.e. achievable simultaneously, according to the factors that determine them, or they are mutually exclusive (alternative) according to the system of determination and at the same time unattainable.

Step 5. Are the goals of management correct, compatible, achievable at the same time? If yes, go to step 6, otherwise go to step 1.

Step 6. We solve the decision support problem in a simplified version by solving the inverse forecasting problem in an automated SWOT analysis (dir.4.4.8) for each of the target states and combine the recommended factor values into one system of control factors.

Step 7. We evaluate the technological and financial possibilities of applying in practice the values of the factors recommended in step 6.

Step 8. If such a possibility exists for all factor values, then we accept them for implementation in practice and go to step 13 to check the effectiveness of the decisions made, otherwise go to step 9.

Step 9. If this is not possible, then we exclude from the system of factor values recommended in step 6 those of them that for some reason cannot be put into practice (dir. 4.1.1) and go to step 10.

Step 10. We predict the results of the application in practice of a reduced system of factor values in which there are only those that have a real opportunity to be applied in practice (dir. 4.1.2).

Step 11. Does the abbreviated system of factor values lead to the achievement of target states? If yes, then exit the decision algorithm, otherwise go to step 12.

Step 12. We replace the values of the factors recommended in step 6, but removed in step 9, with others similar in their effect on the control object, but which can be used (4.1.1). These replacement factor values are selected using cognitive cluster-constructive analysis of factor values (4.3.2.3) or simply a similarity matrix (4.3.2.1).

Step 13. Forecasting the results of applying in practice the system of factor values formed at the previous stages (dir.4.1.2)

Step 14. Does the formed system of factor values lead to the achievement of target states? If yes, then exit the decision-making algorithm, otherwise go to step 1.

As we can see, in the developed decision-making algorithm, the results of solving various problems are widely used: both the forecasting problem and some problems of studying the modeling object by studying its model. Therefore, below we briefly consider the solution of these problems.

3.4.4. Subtask 4.3. Investigation of the modeled subject area by examining its model

If the domain model is reliable, then the study of the model can be considered the study of the modeled object itself, i.e. the results of the study of the model should be correctly attributed to the modeling object itself, “transferred to it”.

The Eidos system has quite a lot of possibilities for such a study, but in this paper, due to limitations on its volume, we will consider only some of them: cognitive diagrams of classes and factor values, agglomerative cognitive clustering of factor classes and values, nonlocal neurons and neuronal networks, 3d-integral cognitive maps, cognitive functions), the study of the strength and direction of the influence of factors and the degree of determinism of classes, which determine their values of factors. The work [2] is devoted to the issues of studying the object of modeling by studying its model.

4. Discussion (Discussion)

Thus, there is every reason to evaluate the methodology developed and proposed in this paper for predicting the values and scenarios for changing the future economic indicators of the holding as providing high reliability forecasts. This technique was developed by using scenario automated systemic cognitive analysis [11].

An analysis of the results obtained allows us to make a reasonable conclusion about the justification and expediency of using scenario ASC analysis to solve the problems of predicting the development of diversified corporations. It should also be noted that this method was developed using software tools (the Eidos system), which is freely available on the author's website [11]. This provides both the ability to take into account the dynamics of the subject area in the forecasting methodology by adapting models to new data, and taking into account the specific features of various control objects and by localizing models. Therefore, in practice, it is recommended to apply not the forecasting methodology developed in this article, but an adapted and localized methodology, created on the basis of the methodology described in this article based on real, up-to-date data. This approach provides a much higher reliability of forecasting.

The results obtained on the basis of the methodology and tools of scenario ASC analysis are very convincing. The main argument in their favor is the very high reliability of forecasts made using the forecasting technique developed on the basis of this methodology: Van Riesbergen F-measure = 0.855, L1 criterion of Prof. E.V. Lutsenko = 0.968 with a maximum of 1 [13]. Note that this result was obtained through the use of the methodology and tools of scenario ASC analysis [11]. This method is conceptually closely related to the spline method and wavelet analysis, as well as expansions in functions into series [26]. But there are also a number of significant and fundamental differences between scenario ASC analysis and these methods, which, in the author's opinion, in certain aspects provide him with certain advantages over these traditional methods. First of all, in the scenario ASC analysis, not splines and wavelets pre-specified in the form of analytical functions are used, but scenarios of changes in the values of various indicators that are actually available in the base of time or other ordered series. Of course, such scenarios are generally mutually non-orthogonal. The expansion of the state functions of the modeling objects into series in the scenario ASC analysis is carried out not according to the system of orthogonal functions predetermined in the analytical form, but according to the functions of generalized class images, which also do not form an orthonormal system of functions and are not initially analytically specified, although they can be in the ASC -analysis be presented in an analytical form in the form of cognitive functions [4, 10] using regression analysis. but actually available in the database of temporary or other ordered series of scenarios for changing the values of various indicators. Of course, such scenarios are generally mutually non-orthogonal. The expansion of the state functions of the modeling objects into series in the scenario ASC analysis is carried out not according to the system of orthogonal functions predetermined in the analytical form, but according to the functions of generalized class images, which also do not form an orthonormal system of functions and are not initially analytically specified, although they can be in the ASC -analysis be presented in an analytical form in the form of cognitive functions [4, 10] using regression analysis. but actually available in the database of temporary or other ordered series of scenarios for changing the values of various indicators. Of course, such scenarios are generally mutually non-orthogonal. The expansion of the state functions of the modeling objects into series in the scenario ASC analysis is carried out not according to the system of orthogonal functions predetermined in the analytical form, but according to the functions of generalized class images, which also do not form an orthonormal system of functions and are not initially analytically specified, although they can be in the ASC -analysis be presented in an analytical form in the form of cognitive functions [4, 10] using regression analysis.

However, the solution of the problem proposed in this paper is predicted for the development of the holding, of course, there are not only strengths, but also weaknesses, which must be overcome. As a weakness of the proposed forecasting technique, we note the insufficiently large amount of initial data used to develop it. Moreover, if in terms of the number of predicted and past indicators, this amount of initial data is quite satisfactory (88 and 548, respectively), then in terms of the time period that they cover (longitude 7 years), they are clearly insufficient to make it possible to reasonably say that that this technique has real practical value. Thus, this work can be considered as an experiment in developing a methodology for predicting the values and scenarios for changing the values of the holding's economic indicators using scenario ASC analysis. It is clear that in order to develop a methodology that has real practical value, representative, relevant real data are needed. At the same time, the very methodology of scenario ASC analysis and the tools for developing such a methodology, i.e. intellectual system "Eidos" are quite effective to achieve this goal.

*Practical value*of the methodology and tools proposed in this paper is that with their help, as described in detail and completely (exhaustively) in this paper, it is possible not only to develop a methodology for predicting the values and scenarios for changing the values of the holding's economic indicators, but also to localize this methodology and apply it in an adaptive mode in the environment of the same Eidos system in which it was developed.

*Practical value*of the very methodology for forecasting the values and scenarios for changing the values of the economic indicators of the holding lies in the fact that, based on the forecasts developed in this methodology, it is possible to make informed decisions on the management of the holding. The higher the reliability of the forecasts, the higher the adequacy of the decisions taken taking into account them, the higher the profit and other benefits from this activity.

Scientific (theoretical) significanceproposed in this paper, the methodology and tools for developing a methodology for predicting the values and scenarios for changing the values of the holding's economic indicators is that the development of such a methodology is a rather difficult task, for which a high-quality general solution has not yet been found. And this is despite the huge well-funded efforts in this direction, carried out by a large number of very highly qualified specialists around the world. The complexity of solving this problem lies in the need to develop adequate methodology for this purpose, a mathematical model, methods of numerical calculations (i.e., algorithms and data structures) and software tools that implement them. All these works were carried out by the author and published in a large number of scientific papers [1-25], which is possible

5. Conclusions (Conclusions)

In this paper, we consider the solution of the problem of making decisions on holding management using scenario ASC analysis. Both the simplest decision-making option (SWOT-analysis) and the developed decision-making algorithm are considered. It should be noted that the developed decision-making algorithm uses many results of the study of the simulated subject area by studying its model, in particular:

1. Cognitive class diagrams
2. Agglomerative cognitive clustering of classes
3. Cognitive diagrams of factor values
4. Agglomerative cognitive clustering of factor values
5. Non-local neurons and non-local neural networks
6. 3d-integrated cognitive maps
7. Cognitive functions
8. The value of factors and their values for management.
9. The degree of determinism of classes by the values of factors

The work [2] is devoted to the issues of studying the object of modeling by studying its model.

The result of this work is that it proposes and successfully tested a methodology and tools that provide both the development of a reliable method for predicting the values and scenarios for changing the values of the holding's economic indicators, and its localization and operation in an adaptive mode.

The knowledge gained in this work on the theory and application of scenario ASC analysis can be applied in the scientific world to develop the theory and practice of spline and wavelet analysis and series theory.

It is recommended for scientists working in the field of forecasting the development of highly complex nonlinear systems.

So, as the analysis of the results of the numerical experiment shows, the solution of the tasks proposed and implemented in the Eidos system is quite effective, which allows us to reasonably assert that the goal of the work has been achieved, the problem has been solved.

As a result of the work done, using the Eidos system, 3 statistical and 7 system-cognitive models were created, in which, directly on the basis of empirical data, generalized images of classes were formed according to the future states of the holding and their dynamics, the influence of the characteristics of various factors on these classes was studied, and, on the basis of this, the problem of predicting the values of future indicators and scenarios for their change was solved.

Additional information on the issues under consideration can be obtained from [16–22].

References (Literature)

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