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DEVELOPMENT OF A COMPLEX MODEL FOR PROCESSING VARIOUS DATA

The object of the research is intelligent decision-making support systems. The scientific problem that is solved in the research is the development of a comprehensive model for processing various types of data in intelligent decision-making support systems (DMSS). The relevance of the research lies in the fact that in intelligent DMSS circulate different in origin and units of measurement data obtained from various technical devices of obtaining information.

The essence of the integrated approach in modeling is that two partial models are proposed: a model for processing different types of data in intelligent decision-making support systems and a model for processing homogeneous data in intelligent decision-making support systems.

Analysis of the intelligent DMSS model for processing different types of data allows to draw such a conclusion. While solving the problem of processing different types of data, a model of intelligent DMSS is proposed, in contrast to traditional, even for the process of solving partial problems incorrectly started by experts with the help of self-organization, expressed in the coordination of partial tasks of the decision maker, striving for an ideal solution to the problem of processing different types of data, which increases the efficiency of finding an acceptable result for processing different types of data.

The homogeneous data processing model is based on the idea that the same processing of homogeneous data in intelligent DMSS can be solved in parallel by different functional elements. Element integration relationships arise as internal non-verbal images in the user's memory, which can compare the dynamics of modeling a task for processing different types of data in intelligent DMSS from different points of view, which allows to see what modeling does not give using one model.

The direction of further research should be considered the improvement of information processing methods in intelligent decision-making support systems.

Keywords: *decision-making support systems, efficiency of decisions, dynamics of modeling, different types of data.*

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1. Introduction

Modern trends in armed struggle, against the background of a constant increase in the number of armed confrontations in the world, determine the transition to new forms and methods of increasing the effectiveness of the combat use of heterogeneous groups of troops (forces).

Classical approaches of armed struggle have shown their inability to achieve the aim of force confrontation even with numerical superiority in typical forces and devices. This was shown by the open armed aggression of the Russian Federation in the course of a full-scale military invasion of the territory of Ukraine.

Therefore, victory over a numerically superior enemy is possible only if there is a technological advantage over it. One of these technological approaches is the use of the concept of the Internet of Things (IoT) by the armed forces of Ukraine.

The essence of this concept involves the use of a large number of sensors, unmanned aerial vehicles and other technical devices (tablets, communication devices) connected in a single network, which are united by a common purpose of functioning.

The development of IoT and its adaptation on a large scale will require both new theoretical research and significant funding. The distribution of network resources of various technical devices will require new approaches and intelligent automation. An important issue will be the perception of the amount of information that IoT will provide.

The most promising option for increasing the efficiency of information processing is the use of approaches based on artificial intelligence. One such toolkit of artificial intelligence is an expert system.

Currently, expert systems have become the main tool used to solve various types of tasks (interpretation, forecast, diagnosis, planning, design, control, debugging, instruction and management) in a wide variety of problem areas [1–4]. The functioning of expert systems is based on the knowledge model [5–8]. It contains a set of principles that describe the state and behavior of the research object. The most widely used knowledge model for expert systems is the production model due to its simplicity, ease of processing and comprehensibility of the end user [9–12].

However, now, fuzzy expert systems have become widespread. This type of expert systems is based on a set of rules that use linguistic variables and fuzzy relations to describe the state and behavior of the object under investigation [11–14]. The rules presented in this form are the closest to natural language, so there is no need to use a separate expert knowledge engineer to create and edit the rules. In most cases, they can be edited by the expert itself practically without special training [15–17].

One of the most important problems inherent in knowledge-based systems is the problem of knowledge representation [15–19]. It is explained by the fact that the form of knowledge representation significantly affects the characteristics and properties of the system. In order to operate all kinds of knowledge from the real world with the help of a computer, it is necessary to carry out their simulation. In such cases, it is necessary to distinguish knowledge intended for processing by computational devices from knowledge used by humans. In addition, with a large amount of knowledge, it is desirable to simplify the sequential management of individual elements of knowledge.

Considering the above, *the aim of research* is to develop a complex model for processing various types of data in intelligent decision-making support systems. *The object of research* is an intelligent decision-making support system. *The subject of research* is knowledge representation model in intelligent decision-making support systems.

2. Materials and Method

The research problem is to increase the efficiency of processing various types of data by developing a complex model of processing various types of data in intelligent decision-making support systems. The simulation of the specified model was carried out in the analysis of the radio-electronic situation of a military formation with an atypical organizational and personnel structure of the armed forces of the Russian Federation. The sources of intelligence were radio intelligence.

Modeling was carried out using MathCad 14 (USA). Aser Aspire based on the AMD Ryzen 5 processor was used as hardware. Artificial intelligence methods used to represent knowledge in intelligent decision-making support systems were chosen as the basic mathematical apparatus in the proposed research.

3. Results and Discussion

3.1. The development of a complex model for processing various types of data in intelligent decision-making support systems

3.1.1. The development of a model of an intelligent decision-making support system for processing heterogeneous data. Based on the model of the decision-making support system [6] and a model of a complex task, which is the processing of various types of data in intelligent server and network architecture management systems, let's build a model of intelligent DMSS:

$$DMSS = < PRT, prt^{dm}, R^{dm}, M^{dm} >, \qquad (1)$$

where $PRT = \{prt_q \mid q = 1,...,N_{prt}\}$ is a set of expert models; prt^{dm} is a model of a decision-maker; $R^{dm} = \{r^{dmq} \mid q = 1,...,N_{prt}\}$ is the relationship between the decision-maker and experts, for example, the relationship of information exchange, M^{dm} are the methods of processing information received from experts. Each expert works strictly in its field of expertise $S_{prtq} \in S$, where S is the set of all fields of knowledge necessary to solve the task of processing various types of information and does not deal with any subtasks other than its own, $S_q \cap S_w = \varnothing$, with $q, w = 1,...,N_{prt}$; $q \neq w$. Based on considerations from the research [5] and taking into account that in real tasks subtasks are solved by experts step by step, the expert model can be presented:

$$prt_q = < B_{prof}, B_{theor}, B_{prec}, B_{facts}, MET_{prtq}, S_{prtq}, In_{prtq}, \Delta t >, \qquad (2)$$

where B_{prof} is a production base of professional knowledge; B_{theor} is a production base of theoretical knowledge; B_{prec} is a basis of precedents (experience); B_{facts} is a basis of facts; MET_{prtq} is a set of reasoning methods; S_{prtq} is a description of the expert's field of knowledge; In_{prtq} is an interpreter that ensures the execution of a sequence of rules for solving a task based on facts and rules stored in databases and knowledge; Δt is the period of issuing intermediate decisions by experts.

The model of the decision-maker can be built by analogy with (2):

$$prt^{dm} = \left\langle \begin{matrix} B_{prof}, B_{theor}, B_{prec}, B_{facts}, B_{ext}, \\ MET_{prldm}, S_{prldm}, In_{prldm}, E, T \end{matrix} \right\rangle, \qquad (3)$$

where B_{ext} is a production knowledge base on how to perform reduction, aggregation, comparison and coordination; E is a set of coordinating processes; T is the processing time of various data types.

The expression (3) in comparison with (2) has significant differences. Production knowledge base B_{ext} about how the decision-maker manages the processing of various types of data. This knowledge is obtained from other experts. The set E describes how the decision-maker can coordinate the work of experts; B_{prof} is a base of professional knowledge; B_{theor} is the basis of theoretical knowledge; B_{prec} is the basis of precedents (experience).

Let's consider how the intelligent DMSS functions according (1). Let the decision-maker be given a task prb^u, which is reduced to subtasks $prb_1^h,...,prb_{N_h}^h$. Analyzing (1) and (3), and relying on the practice of processing various types of data, it is possible to draw the following conclusions: GL^h contained in B_{pred} and B_{facts} is the experience combined with facts allows the expert to determine what result should be obtained; MET^h contained in $B_{prof}, B_{theor}, B_{pred}, MET_{prti}, S_{prti}, In_{prti}$; DAT^h contained in B_{facts}.

In traditional DMSS, described, for example, in the work [5], each expert $prt_q, q = 1,...,N_{prt}$, having received its subtask of processing various types of data $prb_j^h, j = 1,...,N_h$, finds the solution using its professional skills B_{prof} and theoretical knowledge B_{theor}. After finishing the process of processing various types of data, it issues a result $sol^{hj} \in SOL_j^h$, where SOL_j^h is a set of results of solving the task prb_j^h, which can be written as a correspondence ψ_4:

$$\psi_4 : DAT^h \otimes B^U \to SOL^h, B^U = B_{prof} \cup B_{theor}. \qquad (4)$$

Compliance elements ψ_4 are the tuples $\left(\left\{dat_\sigma^h\right\}, \{b_\beta^u\}\right), sol_\gamma^h)$, with $\sigma = 1,...,N_{dath}$; $\beta = 1,...,N_b$; $\gamma = 1,...,N_{sh}$, where the first component is a two-component vector consisting of a list of initial data $\left\{dat_\sigma^h\right\}$, $dat_\sigma^h \in DAT^h$ and list of knowledge $\{b_\beta^u\}$, $b_\beta^u \in B^U$ (professional knowledge are production rules; theoretical knowledge are analytical dependencies), and the second is the result $sol_\gamma^h \in SOL^h$ processing of various types of data prb^h.

Conformity ψ_4 is not a function (cannot be written analytically or calculated by numerical methods) because the knowledge of an expert and the results of processing an element of heterogeneous data can be represented in natural language. It is ambiguous, because with an incomplete set of initial data (a priori uncertainty), the expert can offer several options for results, subjectively, because each decision on the processing of different types of data prb^h corresponds to at least one element of $DAT^h \otimes B^U$ and not injunctive, because not every element of $DAT^h \otimes B^U$ corresponds to the solution of the task prb^h.

It is possible to indicate the number of stages into which experts divide the process of solving partial tasks N_{sol}, but sol_l^h is the result of solving a partial task at the l-th stage, $l=1,...,N_{sol}$. A time interval is allocated to the stage of processing various types of data Δt. Because in practical tasks, the total time T for solving the task of processing various types of data prb^u, strictly limited and time Δt between refinements of the task of processing various types of data is constant, the number of stages is determined by the formula:

$$N_{sol}=T/\Delta t. \tag{5}$$

It should be noted that in the process of solving a partial task of processing various types of data prb^h, through the coordinating influences of the decision-maker, the original data DAT^h in the work (4) can be modified – additional information is entered or outdated information is replaced with new information. Let DAT_l^h output data for the l-th stage, $l=1,...,N_{sol}$. Then DAT_1^h is the initial data received from the decision-maker, moreover $DAT_1^h = DAT^h$, a DAT_l^h, $l=2,...,N_{sol}$ is the output data of the following stages. The index l means the number of the stage in which the raw data is used. Let's define DAT_{l+1}^h as output data of the $l+1$-th stage, obtained after the coordinating influences of the decision-maker regarding the change of the data of the l-th stage.

Scheme of the sequence of stages of the work of an expert in finding a solution to a partial task π^h can be expressed in the following way:

$$DAT_l^h \otimes B^U \otimes \{sol_1^h\}\otimes,...,\otimes\{sol_{l-1}^h\} \Rightarrow \{sol_1^h\},$$
$$l=1,...,N_{sol}. \tag{6}$$

The output data $DAT_l^h, l=1,...,N_{sol}$ at each stage are supplemented by coordinating influences $e^\alpha \in E$, issued by the decision-maker to the expert, which are determined on the basis of the integrated result of solving the task of processing various types of data prb^u on $l-1$-stage. Let's assume that the expert is given one coordinating influence of one type. Let's determine the correspondence ψ_5:

$$\psi_5:\{sol_l^u\}\otimes B_{ext} \to E,\ l=1,...,N_{sol}-1. \tag{7}$$

The maximum value of l is equal to $N_{sol}-1$, because after N_{sol} stage, it is no longer possible to use coordination, since the final result has been obtained; sol_l^u is the integrated result of solving the task of processing various types of data prb^u at the l-th stage; $E=\{\varepsilon_1,...,\varepsilon_{N_\varepsilon}\}$ is a set of type vectors $(e_1^1,...,e_{N_{prt}}^6)$, each component of which is a coordinating action for the expert, $e_q^\alpha \in E, q=1,...,N_{prt}$.

Since the knowledge of integration is included in B_{ext} decision maker (4), so the integrated result sol_l^u solving the complex task of processing various types of data prb^u can be written like this:

$$\{sol_l^{h1}\}\otimes...\otimes\{sol_l^{hN_h}\}\otimes B_{ext} \to \{sol_l^u\}, \tag{8}$$

where $sol_l^{h1},...,sol_l^{hN_h}$ are solving partial tasks for processing various types of data $prb_1^h,...,prb_{N_h}^h$ respectively.

Compliance elements ψ_5 are the tuples $((sol_l^u,\{b_{ext}^\mu\}),\varepsilon_p)$, with $l=1,...,N_{sol}$, $\mu=1,..,\mu_{N_\mu}$, $p=1,..,N_\varepsilon$, where the first component is a two-component vector consisting of the integrated result sol_l^u solving the task of processing various types of data prb^u at the l-th stage and the list of knowledge used by the decision-maker on how to perform the comparison $\{b_{ext}^\mu\}, b_{ext}^\mu \in B_{ext}$ and the second component is a vector whose elements are coordinating actions $e \in E$ for an expert.

On N_{sol}-th stage ($l=N_{sol}$) vector of coordinating influences $\varepsilon=(e_1^\alpha,...,e_{N_{prt}}^\alpha)$, $\alpha=6$, thus the decision-maker does not issue coordinating influences to experts, but only aggregates (integrates solutions of partial tasks prt^h into a single, integrated solution sol_l^u a difficult task prb^u) the results of their work. If the obtained integrated result sol_l^u does not suit the decision-maker, it must revise the original task prb^u, so change DAT_l^h to all prb^h or change the list of your knowledge B_{ext} and expert knowledge B_{prof} and after that, initiate the re-operation of the intelligent DMSS.

Accordingly ψ_5 is not a function (cannot be written analytically and calculated), since the knowledge of the decision-maker and the integrated result of solving the task prb^u can be represented in natural language. It is unambiguous, as each expert is assigned a specific coordinating action e_q^α and therefore compliance ψ_5 uniquely defines only one vector $\varepsilon \in E$. It is a subjective, because for each vector $\varepsilon \in E$ at least one element matches $\{sol_l^u\}\otimes B_{ext}$ and not inductively, because not to every element $\{sol_l^u\}\otimes B_{ext}$ corresponds to vector $\varepsilon \in E$.

The choice of whether the intermediate result of the solution of a partial task of processing various types of data prb_w^h, $w=1$, ..., N_h is ready and expert $prt_q \in PRT$, $q=1,...,N_{prt}$ accepts based on experience B_{prec} (3).

3.1.2. A model for solving homogeneous tasks in intelligent decision-making support systems. The functional multi-agent system model presented in the wok [4] is adopted as the basic model for processing homogeneous data in intelligent DMSS. The choice of this model is explained by the fact that the complexity of the homogeneous tasks to be solved is not great – there are relatively few input and output parameters and expert rules, so there is no need to investigate the micro-level of subtasks. It can also be noted that the decomposition of the task of processing heterogeneous data into a set of tasks of processing homogeneous data is transparent and it is not difficult to establish a connection between subtasks and elements of the intelligent DMSS.

The conceptual model of an element of a multi-agent intelligent DMSS for processing homogeneous data can be presented:

$$res^e = R_1^{resmet}(res^e,met^e)\circ R_1^{respr}(res^e,pr^{ei})\circ$$
$$\circ R_1^{respr}(res^e,pr^{eo})\circ R_1^{resst}(res^e,st^e)\circ$$
$$\circ R_1^{stst}(st^e(t),st^e(t+1))\circ R_1^{prst}(pr^{ei}(t),st^e(t+1))\circ$$
$$\circ R_1^{stpr}(st^e(t),pr^{eo}(t)), \tag{9}$$

where R_1^{stst}, R_1^{prst}, R_1^{stpr} are the relationship «state – state», «input – state», «state – output», respectively. Among the crowd $MET^e=\{met_y^e \mid y=1,...,N_{met}\}$ autonomous methods will be highlighted met_1^e is an analytical calculations, met_2^e is neurocomputing, met_3^e are the fuzzy calculations, met_4^e is the reasoning based on experience, met_5^e are the evolutionary calculations, met_6^e are statistical calculations, met_7^e is the logical reasoning. If between element res^e and autonomous method met_y^e relationship is established $R_1^{resmet}\left(res^e, met_y^e\right)$, let's denote the element res^{ey}. The appropriate calculation method is selected according to expression (1).

Relation R_1^{prpr}, R_2^{prpr} (9) is given on sets of variables DAT^u, GL^u and sets of variables DAT^h, GL^h from the processing of homogeneous data included in the task of processing heterogeneous data.

The following cases are possible:

1) set of variables for prb^u coincides with the set of variables for prb^h, so $DAT^u = DAT^h$, $GL^u = GL^h$;

2) set of variables for prb^h is a subset of the corresponding set u_{prb}, so $DAT^h \subset DAT^u$, $GL^h \subset GL^u$;

3) set of variables of a subset of the corresponding set prb^h, so $DAT^u \subset DAT^h$, $GL^u \subset GL^h$. The second variant is typical for the analyzed task of processing heterogeneous data, because during the solution of the task of processing heterogeneous data, the initial data is divided between various partial tasks of processing homogeneous data.

The extension of model (9) is performed based on the following considerations. In the process of coordination, the intermediate states of the solution of partial tasks for the processing of homogeneous data are controlled. In the accepted notation (9), these states mean (decision results) of functional elements res^e, simulating the solutions of partial tasks for processing homogeneous data prb^h. From the analysis of these states, the «input» properties change during coordination pr^{ei} one or more elements res^e. To take this fact into account, let's introduce a triple $R_1^{stpr}\left(st^u(t), pr^{ui}(t+1)\right)$ into the conceptual model (9). In other words, based on the state of intellectual DMSS $st^u(t)$ at time t, the output data changes $pr^{ui}(t+1)$ for intelligent DMSS, but already at the moment of time t+1, so for the next iteration. Plural R_1^{stpr} establishes relationships between state $st^u(t)$ hybrid res_A^u (9) at the moment of the model time t and the state of the inputs of one or more elements res^e in the next step. To make the necessary change of inputs pr^{ei} one or more functional elements res^e (9) let's enter a triple $R_1^{stact}\left(st^u, act^{ek}\right)$, where $ACT^{ek} = \{act_1^{ek\alpha}, ..., act_{N_{prt}}^{ek\alpha}\}$ is the set of concepts denoting coordinating actions, which is identical to the set of coordinating actions E, where α is the type of coordinating action, $\alpha = 1, ..., 6$. In the coordination algorithm, the coordinating actions are described by the knowledge base B_{ext}. Plural R_1^{stact} is a set of relations between states st^u intellectual support system res_A^u at the moment of the model time t and the necessary coordinating actions ACT^{ek}.

The modified conceptual model of the intelligent DMSS for processing homogeneous data with coordination has the following form:

$$res_A^u = res_A^u \circ R_1^{stpr}\left(st^u(t), pr^{ui}(t+1)\right), \tag{10}$$

and a modified model of an element of an intelligent DMSS for processing homogeneous data:

$$res^e = res^e \circ R_1^{stact}\left(st^u, act^{ek}\right). \tag{11}$$

Relation R_1^{stpr} and R_1^{stact} are not set in advance, like R_1^{stst}, R_1^{prst}, R_1^{stpr} are fixed during the operation of the intelligent DMSS for processing homogeneous data and are the result of solving the k-task prb^k.

The following is a conceptual model of the operation of an intelligent DMSS for processing homogeneous data, built according to (10), (11):

$$st^{ek}(t'_0) \Rightarrow \begin{Bmatrix} st^{e1}(t_0) \\ st^{e2}(t_0) \end{Bmatrix} \to \begin{Bmatrix} st^{e1}(t_1) \\ st^{e2}(t_1) \end{Bmatrix} \Rightarrow st^{ek}(t'_0) \to st^{ek}(t'_1) \Rightarrow$$
$$\Rightarrow \begin{Bmatrix} st^{e1}(t_1) \\ st^{e2}(t_1) \end{Bmatrix} \to \begin{Bmatrix} st^{e1}(t_2) \\ st^{e2}(t_2) \end{Bmatrix} \Rightarrow st^{ek}(t'_1) \to st^{ek}(t'_2) \Rightarrow \ldots \Rightarrow$$
$$\Rightarrow \begin{Bmatrix} st^{e1}(t_{p-1}) \\ st^{e2}(t_{p-1}) \end{Bmatrix} \to \begin{Bmatrix} st^{e1}(t_p) \\ st^{e2}(t_p) \end{Bmatrix} \Rightarrow st^{ek}(t'_{p-1}) \to st^{ek}(t'_p), \tag{12}$$

where «⇒» indicate a relationship R^{stst}, which connect the states from different subspaces and specify the transition from one homogeneous space to others during the functioning of the intelligent DMSS for processing homogeneous data; «→» is a transition between states within the corresponding subspace. Transitions «⇒» from the element subspace res_k^{e7} model the issue of coordinating influences from the decision-maker to experts while processing homogeneous data. And the set of transitions «⇒» and «→» allows to simulate and trace the process of self-organization in the process of the work of an intelligent computer aided communication system for processing homogeneous data.

In the work (12), curly brackets indicate the beginning and end of parallel work of the functional elements of the intelligent DMSS for processing homogeneous data. It can be seen from the model that after each fixation «}⇒» states, functional elements res_q^{ey} control of the element is transferred res_k^{e7}, and after it changes its state, control is transferred to a group of functional elements.

This model is related to the conceptual model:

$$\begin{Bmatrix} st^{e1}(t) \to st^{e1}(t+1) \to \ldots \to st^{e1}(t+n) \\ st^{e2}(t) \to st^{e2}(t+1) \to \ldots \to st^{e2}(t+n) \end{Bmatrix}. \tag{13}$$

3.2. The results of the analysis and discussion of the results. The simulation of the proposed model was carried out in the MathCad 2014 software environment.

The initial setting of the membership functions of the set of terms of the neuron-fuzzy expert system is performed, since all sources of radio radiation have different characteristics. The experts indicated which values of primary and calculated parameters are considered high for radio emission devices, which are average and which are low. The membership functions for the analysis of the radio-electronic situation are presented in the specified form according to the formula:

1) (PJ = «H») and (KOV = «H») and (UN = «H») and (PW = «L») → (BER = «H»),

...

81) (PJ = «L») and (KOV = «L») and (UN = «L») and (PW = «H») → (BER = «L»),

82) (FJ = «L») and (FW = «L») and (UN = «H») and (PW = «H») → (BER = «N»),

...

108) (SC = «L») and (KOV = «L») and (UN = «H») and (PJ = «L») → (BER = «N»).

In this example, the part of the rule base of the neuron-fuzzy expert system is given. In the main base of rules there are rules not only with connections of conditions with the help of T-norms, but also with the help of T-conorms and with negations of conditions.

In the worst case, to find a solution, the system should check all the rules contained in the rule base. Thus, it is necessary to check 405 conditions and calculate 297 T-norm operations. This is an unacceptably long process, given the limitations of the hardware.

The input data for the neuro-fuzzy expert system are indicators of the power of transmitters of radio-emitting devices, the type of signal-code structures, the uncertainty of the radio-electronic situation, the frequency of radiation of radio-emitting devices. After passing through the phase of fuzzification, the system received fuzzy estimates for each controlled parameter.

The results of the assessment of the state of the radio-electronic environment for various presentation models are shown in Fig. 1.

The features of radio-electronic situation analysis systems are: a large number of analyzed parameters; dynamic change of the electronic environment; functioning in conditions of uncertainty about the state of the radio-electronic situation; constant updating of the signal database; functioning under the influence of natural and intentional disturbances.

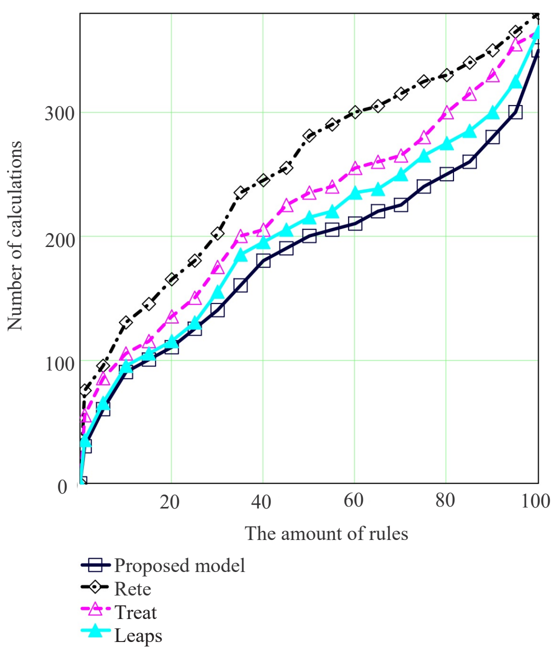

Fig. 1. Comparison of the efficiency of the obtained estimate for different models

As a result of the conducted research, the following was established:

– a complex task of processing heterogeneous data under certain restrictions and assumptions can be divided (performed decomposition) into a number of individual partial tasks of processing homogeneous data;

– taking into account the specifics of the data that must be processed in intelligent DMSS, the availability of computing power, it is necessary to carefully approach the use of mathematical apparatus for modeling and processing of data circulating in the specified systems;

– with homogeneous data, it is advisable to use the model proposed in subsection 3.1.2 of the research and after adding new types of data, it is advisable to build up lower-level models with subsequent additions to the model proposed in subsection 3.1.1 of the research.

The direction of further research should be the improvement of information processing methods in intelligent decision-making support systems.

4. Conclusions

The research proposed a complex model of processing various types of data in intelligent decision-making support systems.

The essence of the complex approach in modeling is that two partial models are proposed: a model for processing heterogeneous data in intelligent decision-making support systems and a model for processing homogeneous data in intelligent decision-making support systems.

The analysis of the model of the intelligent DNSS for the processing of various types of data allows to draw the following conclusion. While solving the task of processing various types of data, a model of intelligent DMSS is proposed, in contrast to the traditional ones, even in the process of solving partial tasks incorrectly started by experts prb^h with the help of self-organization, expressed in the coordination of partial tasks, the decision-maker strives for an ideal solution to the task of processing various types of data. This increases the efficiency of finding an acceptable result from the processing of various types of data prb^u. At the same time, errors in the processing of various types of data will be detected and corrected before the result is obtained prb^u. At the same time, in the classic DMSS, a repeated solution is required to detect an error in the processing of various types of data.

The model of homogeneous data processing is based on the idea that the same processing of homogeneous data in intelligent DMSS can be solved in parallel by different functional elements. The relations of integration of elements appear as internal non-verbal images in the memory of the user, who can compare the dynamics of the simulation of the task of processing various types of data in the intelligent DMSS from different points of view, which allows to see what the simulation using a single model does not provide. Another assumption is developed in the model: the inclusion of a model of a person making a decision in the model of the intelligent DMSS leads to the emergence of the effect of self-organization. This makes it possible to interrelate the results of the work of individual functional elements of the intelligent DMSS in the process of synthesizing the solution to the task of processing various types of data and not after, as in known models, which ensures the relevance of the intelligent DMSS to the real process of collective problem solving.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

The manuscript has no associated data.

The use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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