Situational-activity approach for designing synergetic combinations of intelligent models

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Abstract: **an original method of designing synergetic combinations of intelligent models based on the integration of system representations, the activity approach and situational analysis is presented. The presented triad of techniques under consideration leads to the construction of the conceptual structure of the act of activity, which highlights the particular representation: functions, processes, context and patterns. The proposed approach makes it possible to formalize the necessary knowledge about the subject area for the implementation of expert, cognitive, analytical, evolutionary and simulation models.**

Keywords: system representation, big system, activity approach, situational analysis, categorical scheme of the act of activity, conceptual structure of the act of activity, matrix of decisions, conceptual plan, showcase of knowledge, intellectual superstructure.

System analysis on the one hand is now recognized as the most constructive of the areas of system research, but on the other it does not exist in the form of a strict methodological concept, although it is closely related to the various areas of modern science.

Due to the avalanche-like nature of the system research, a large number of general and special definitions of the concept "system" are proposed. Some of them claim to be universal: the system is a set or a set of related elements [1]. However, the universality property of such definitions makes it possible to expand knowledge about a dynamically complex environment in any direction. Then the structure is constructed from the set of elements A filling the space of system S.

It is proposed to consider a dynamically complex environment characterized by the following features [2]:

- in order to achieve the goals, it is necessary to make a lot of decisions, each of which should be considered in the context of the rest;
- the decisions are dependent on each other, have stochastic and indirect connections;
- the environment changes both under the influence of a certain set of systems and as a result of decisions taken.

In a dynamically complex environment there are many systems (economic, social, technological, etc.) in which the central role is played by the logic of human goals and actions. Under such conditions, the environment is determined by the multidimensional composition and complexity of the organization, and knowledge about it is not structured and difficult to formalize. Then it is necessary to define dynamically complex environment with terms of system analysis which will allow to form idea of the whole representation.

It is proposed to consider a dynamically complex environment as a large system, i.e. a system that can not be considered except as a set of a priori selected subsystems [3]. Thus, the large S_b system is defined by the dimension and uniformity of the composition, which can be described in one modeling language. This makes it possible to assert that communications between subsystems are possible only if they are united by a common basis. In multilevel dismemberment of a large system it is necessary to define the term the concept of "subsystem" as part of the system, which a detailed examination is provided by the system [4]. Then the subsystem, according to this definition, may be presented as a complex object, which can be assigned as many systems as you can think of. Each such system expresses only a certain face of the object, that is, in other words: a complex system is a system built to solve a multipurpose problem; a system that reflects different, incomparable aspects of the characteristics of the object; a system that requires several languages to describe it; a system that includes an interconnected set of different models [3].

Then, with respect to the space of a large and complex system S_{bc} in subsystems S_1 and S_2, there are structures *(*S_1^1*,* S_1^2*,* S_1^3*,* S_1^4*)* and *(*S_2^1*,* S_2^2*,* S_2^3*,* S_2^4*)*, that increase the dimension of the composition and complexity of the organization.

Thus, it is possible from the same set of elements to build various hierarchical structural representations that form a polystructure. In this case, the structure determines the function, as with the same composition of elements, but with different interactions between them changes the function of the system and its capabilities. At the same time, the same function can be implemented by different structures that are in different environments. It can then be argued that a dynamically complex environment should be seen as a large and complex system that is not only multi-structural but also multifunctional.

The variability of the environment determines the high activity of its elements, components and systems, i.e. they have a large degree of freedom of their various organizations. However, the organization acts not only as a property of all things, but also as a certain order of the content, the order of the system in accordance with the system-forming factor [5].

It is obvious that the main system – forming factor in a dynamically complex environment is active human interaction with the outside world-activity. Therefore, it is necessary to consider the modeling of a dynamically complex environment from the perspective of the activity approach [6]. There can be many activities in a dynamically complex environment. The activity exists in the reproduction cycles that share her private picture: areas, types of acts and activities. Thus, the hierarchical structure of dynamically complex environment is realized, which has the property of polystructure and multifunctionality. These properties allow the activity to unfold in a variety of structures and occupy a certain space of the surrounding reality. Space reality has intrinsic characteristics – integrity and logical consistency. In other words, it is possible to separate the activity from the other realities by constructing its structure and logically move from any element of this structure to another element of the same structure. [6].

The *act* is an element of the activity and is built in accordance with certain norms (rules), without which it does not exist. These rules are of interest when they are used repeatedly in the construction of other activities, while it is possible to highlight the generalizing norms that will represent a certain pattern. To construct the scheme of the act of activity it is expedient to consider "... quite abstract, actually methodical representations of activity in the form of a set of blocks" [4]. Then the template of the act of activity has to represent the categorical scheme of the act of activity, each element of which can "be developed" in the chosen direction of activity.

For the solution of a problem situation it is offered:

- goal is to express in the form of product requirements of the act activities;
- the lack of knowledge on the elements of the categorical scheme can be filled from the results (product) of other categorical schemes of acts.

Thus, a field of knowledge about the problem situation is created. This suggests that solutions in dynamically complex environments can be found by identifying intersections by activity acts. However, it is determined that the field of knowledge does not take into account the role of situational awareness in solving the problem, so that an adequate and complete knowledge base of acceptable management decisions can not be formed. The authors studied the dynamically complex environment [7] from the perspective of the method of situational analysis and design of the model of the subject domain of arbitrary nature (further situational analysis), where the following contradiction is revealed: on the one hand, the activity approach does not take into account the situational aspect, on the other, the situational analysis does not provide a clear understanding of the result of activity. To address these shortcomings, it is proposed to synthesize these aspects into a single representation – the conceptual structure of the act of activity.

It is obvious that the construction of conceptual models is a nontrivial task that requires an understanding of the methodology of the activity approach, situational analysis and features of the subject area. In this case, there are problems that can be solved only at the software level:

The first task is visualization of conceptual structures;

The second task is to check the conceptual model for completeness and adequacy;

The third task is to generate a knowledge base of production type for expert modeling.

The fourth task is to generate a knowledge base for cognitive, simulation and other simulations supported by this approach.

For the solution of the *first task* the software "Designer" which is defined by the following tools is realized:

- node tool - allows you to create different nodes that implement the functional target part (formula 2) and the supporting part (formula 3);
- relationship tool-allows you to create different relationships, relationships, and relationships between the vertices of conceptual structures;
- text tool-allows you to modify the text content of conceptual structure elements;
- zoom tool-allows you to zoom the node in question to full-screen for a detailed study of its contents.

Conceptual structures processed in the *Designer* software are represented as an XML document, which is represented as a tree of nodes-this allows you to access any element of the conceptual structure. Therefore, it is possible to change and handle their content on the software level.

The *second and third tasks* are solved by the *Solver* software, which is developed within the framework of situational analysis and supports the following set of functions [9]:

- creation, storage, modification, integrity testing, merging of user knowledge bases of production type;
- organization performance and optimization of direct inference;
- generation of reports with textual descriptions of knowledge bases and results of problem situations analysis.

Thus, software complex *Solver* to read the XML file saved by the program *Designer*, the selection of fragments and construction of the primary logical structure that describes the conceptual schema as a marked directed graphs. If there are any syntax errors in the conceptual structures, the user receives the appropriate messages.

The knowledge base is also being tested for completeness and adequacy. All the many facts are divided into the following groups [8, p. 37]:

- facts describing the initial (or problematic) situation;
- facts describing the target situation;
- facts not included in the initial or target situation are not considered.

The analysis of the set of conceptual structures of individual solutions for adequacy begins with the establishment of the facts of the problem and the target situation. If by logical conclusions the target situation is reached, then on the basis of the content of the generated text report the fact of adequacy and completeness of the developed recommendations for the relevant knowledge base is established. For the conceptual model of a dynamically complex environment, the study of completeness and adequacy is carried out by checking the logical conclusions on the acts of activity and situations. Completeness is checked by classes of situations. However, if logical inference is interrupted because rules cannot be applied to the initial situation, the knowledge base is incomplete or the rules management strategy is incorrectly configured. Checking for adequacy due to logical conclusions on the classes of acts of activity. The resulting report on the results of the output should correspond to the logic of the simulated process of the act of activity. If there is incompleteness or inadequacy, you should Refine your knowledge base, or try to apply other rule management strategies.

The knowledge base of production rules is implemented in a text file that specifies:

- main elements of the conceptual model;
- the name of the rule <Subject Action Object>;
- content rules in the form of the following construct: IF <Conditions before the action>, THEN EXECUTE <Conditions after the action>.

The production rules describe the preconditions that must be met by the states of the participating objects and the rules for changing the state of the objects at the end of the corresponding action.

The *fourth task* is solved by the software *Interprete*r, which is divided into two blocks: dynamic and static knowledge.

The dynamic knowledge base of a functional plan report defines the following elements:

- function [Action_N Object_N];
- the input property of the function is [Object Property_N before action_N];
- the output property of the function is [Object property after the action of_N];
- the mechanisms of the function - [Means of action_N];
- instructions for managing the function - [Requirements for activity certificate_N].

A set of interacting software creates a software package "Designer + Solver + Interpreter", which is positioned as an intelligent add-in for the design of intelligent models.

Thus there is an intellectual superstructure design synergistic combinations of intellectual models presented a showcase of knowledge. The use of the software complex is due to the following algorithm:

- the expert (Advisor) sets the direction of transformation of a dynamically complex
- transformation, thereby determining the boundaries of the subject area. In each activity are determined by its
- acts. These conclusions are implemented in the software "Designer" as a hierarchical structure with all possible attachments of activity levels;
- after defining the activity acts, the Designer program implements their conceptual structures and splits them into a set of conceptual structures of single decisions, which is defined as an integral conceptual model of decision-making;
- in the Solver software package, the holistic conceptual model of decision-making is tested for completeness and adequacy. If necessary, a knowledge base report is generated in the form of production rules;
- after confirming the completeness and adequacy of the model in the software "Interpreter" generates reports on the knowledge bases of the conceptual plans. Synthesis of knowledge bases corresponds to certain models and systems of artificial intelligence.

environment, according to its view of the problem situation. Highlights the activities that contribute to and impede the movement of

Conclusion

The article deals with the design of synergetic combinations of intelligent models and systems from the perspective of system research, activity approach and situational analysis. Substantiates the possibility of the selection of the conceptual structure of the act the activities of the conceptual plans for the design of appropriate models, based on knowledge. Accordingly, at the program level creates the intellectual superstructure for the design of synergistic combinations.

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