CSIT'2011

Proceedings of the 13th International Workshop on

Computer Science and Information Technologies

Germany, Garmisch-Partenkirchen
September 27 – October 02, 2011

Volume 1

The International Workshop on Computer Science and Information Technologies

UDC 004.7

Proceedings of the Workshop on
Computer Science and Information Technologies (CSIT'2011),
Germany, Garmisch-Partenkirchen, September 27 – October 02, 2011
Volume 1
Ufa State Aviation Technical University, 2011

ISBN 978-5-4221-0207-5

The Workshop on Computer Science and Information Technologies (CSIT) is an annual international conference providing a forum for exchange of scientific achievements between research communities of Eastern Europe and the rest of the world in the area of computer science and information technologies. *The 13th* International *Workshop on Computer Science and Information Technologies (CSIT'2011)* was aimed at bringing together researchers, practitioners, developers, and users to explore new concepts, tools and techniques for advanced information technologies.

The papers are included as they are submitted by the authors, without editing

Within a framework of
German-Russian Year of Education, Science and Innovation

Navigation and Synthesis for Stratified Terminology Environment

S. G. Maslov
Theoretical Foundations of Computer Science Department
Udmurt State University
Izhevsk, Russia
e-mail: mshsci@gmail.com

A. P. Bel'tukov
Theoretical Foundations of Computer Science Department
Udmurt State University
Izhevsk, Russia
e-mail: belt@csdc.udsu.ru

Abstract[1]

The article analyzes the context, clarifying statements of problems and examples for the processes of synthesis and navigation in a stratified terminology environment. These tools are considered as a basis for creating IT-sphere for interdisciplinary studies of a new generation. The process of creating is based on full disclosure of problematic situations, leading to the symbiosis of man and the living environment in the process of system evolution and accumulation of knowledge.

1. Introduction

Creating the information technology environment for effective communication and research activities, as a rule, includes creating terminological environment and tools for effective building and using it. It is a terminological environment often becomes the primary tool of understanding arising problems, tool of organizing communications and descriptive-constructive activities.

The presence of a computer or access to Web resources are themselves the necessary means, but they do not solve problems of extracting in time the terminology and information, accurate and adequately to the problem (creating problem solving environment and the decision itself). It is really necessary the system organization of information, taking into account the individual development of the researcher (the subject), the problem and the conditions for its solution. It is also necessary to ensure an efficient navigation in the information, not just by looking for, but also by constructing the required facilities and processes of problems decomposition and integration. This article is devoted just to these aspects of working with information, or rather, with its representation as a stratified terminology system.

What, then, the properties must have a system to work with information? First of all, in a series of basic requirements it is necessary to ensure the following:

- multisensority and multimodality;
- associativity and stratification (layering, distributing);
- timeliness and reliability;
- integrability and convertibility with a resolution of contradictions;
- flexibility and adequacy to an arising problem.

To ensure fulfilling these requirements, it is necessary to consider the following objects, sub problems and processes:

- composition and structure of a stratified system of terminology, as well as a number of practical problems of its use:
    - classification and formal presentation of emerging problems;
    - creating a terminological context of the problem to solve;
    - a rapid concentration of the subject, and emerging him into the associative relationships of terms;
    - visualization and moving by the graphic information; on the basis of this you can create a constructive interface;
- navigation problems;
- problems of constructing a new object (or process);
- identifying libernetics grounds in the development of problem solving.

2. Structure of stratified of terminology environment

The stratified terminological system is a set of interacting stratums of terminology, which reflect the view point on

Proceedings of the 13th international workshop on computer science and information technologies CSIT'2011, Garmisch-Partenkirchen Germany, 2011

the object or process, fixing it in some form. Terminological stratum is a set of terms associated within a particular class of problems or a particular situation. We begin the solution of problems with the terminology, because it is a tool of communication. It can be represented as interlinked and coordinated multisensor forms.

It is assumed that the terminological system (or system of knowledge) is ordered so that a considerable part of it is given in response to a particular system of questions. Set of questions denoted by Q ("who", "what", "how much", "where", "when", "what type of", "how", "by what", "what is the reason of", "what for"?). In addition, each question is provided with a number of modifiers. Currently known classes of modifiers are denoted by M, S, K, V. Here, M denotes modifiers of the formalization kind (metaphorical, conceptual, mathematical, ...). Letter S denotes modifiers of the form of system representations (morphological, functional, libernetic, ...). Letter K denotes modifiers of the stratum of knowledge (descriptive, constructive, ...). Letter V denotes modifiers of the forms of representation (monosensor, multisensor, ...) [1, 2].

So, the detailed describing structure of knowledge is a function g of the form

$$g: M\times S\times K\times V\times Q \to W,$$

that is, $g(m, s, k, v, q) = w$, where w is an element of W, the set of possible answers to the questions. The set of $M\times S\times K\times V\times Q$ will be called the *space of constructing solutions*, and the set of $M\times S\times K\times V\times Q \to W$ is the *knowledge space* or more precisely it is the space *of descriptive-constructive knowledge*. The amount of data to represent the function g in a table may be too large. To avoid this, you may use an "excision" or a projection (a subset of $M\times S\times K\times V\times Q$ to narrow the definition of g). The main role of the "excision" is the clarifying of the real contradictions and obstacles, which arise in the way of solving the problem. A mechanism for creating such "excision" may be introducing constraints and the generating freedom degrees or analyzing and controlling freedom degrees.

The main constructive hypothesis suggests that constructing solutions for the problem formulated in this space is based primarily on libernetic description, within which the contradictions and the problems are interpreted [3, 4].

In addition to the libernetic mechanism of creating projections of space for constructing solutions, there is one more mechanism as the evaluating resources required to get answers to questions. If necessary, the formulation of the problem may be revised. Revising the statement of the problem can be taken during the solution also. Simultaneous use of both mechanisms allows controlling the solution process at qualitative and quantitative levels.

3. Navigation and synthesis

The formulation of the problem for synthesis in the simplest form (see, e.g. [7]) can be initially represented as:

$$f: (a: A \Rightarrow B(a)),$$

where A is the type of input object, a is an instance name of the input object, $B(a)$ is the type of output object (it is, in general, depends on a) f is a converter of the input object into the output one (usually the process, transformation, etc.). It should be noted that this record does not take into account all the details of the problem. Firstly, we are interested in the structure of this converter. It is assumed that for the executing this converter requires a *performer* (e.g. a universal machine). It will be denoted by u. The performer at this work uses *a program*, which is denoted below by p. This program can refer to some tools, resources, its *own data* (internal data see, e.g. [5, 6]), which are denoted below respectively by i, r, d.

In the most general form, the described task will be as follows (using the notation of [7]):

$$u(p,i,r,d): (a: A,\ R(a) \Rightarrow b: B(a),\ C(a,b),\ R''(a,b) \mid E(a),\ R'(a)), \qquad (1)$$

where $R(a)$ is a description of resources available, and actually consumed in solving the problem, $C(a, b)$ is a property of exit (constraints on b), $R''(a, b)$ is a description of return resources, $E(a)$ is a description of a possible failure while solving problem, $R'(a)$ is a description of resources returned in case of the failure. In addition, the problem can be solved by running some measures μ, designed to optimize the solution and the solution process.

Creating terminology space (or environment) we can go to the effective implementation of the search operations, navigation, and synthesis. It is done not merely to meet the cognitive needs, but first of all to meet the creative, constructive and design needs. Therefore we can go to constructing new objects with specified properties. In fact, any arising problem within the framework of the terminology environment either actualizes and associates a certain group of terms, or reveals the contradictions and challenges. Resolution of these situations is done through a transition in another terminology stratum and by reformulating the problem, or through an extension (the introduction of new entities) or changing relations of terms in the existing stratum.

Consider the problems of navigation and synthesis in the terminology environment. As a first approximation we can take the simplified environment of terms (objects) for solving the navigation problem:

$$O = X \cup F,$$

where the O are the objects of the terminology environment, X are the processed entities, F are the functional entities, that make transitions between the processed entities and their transformations. Some functional entity can also be processed. Note that the objects O of the terminology environment may have agreed multisensory representations:

$$\rho : V \to O,$$

where ρ is the representing map, V is the representations of the terms. It is definitely important for the rapid concentration of the subject and for the adequacy of his immersion into the problem to be solved. Different states of an object can be presented in different ways.

4. An example of synthesis in a terminology environment

As an example, [8, 9] we consider a small terminology environment that includes objects of x_i types of $X_i\ (p)$ and the functional entities of f_k. Here p is some implicit parameter. The formula

$$f_k\!: (x_i\!: X_i\,(p) \Rightarrow x_j\!: X_j\,(p))$$

for brevity will be write in the form

$$x_i \to f_k \to x_j.$$

From the logic viewpoint this example is practically of a propositional nature. A concrete set of functional entities can have the following form:

$$x_1 \to f_1 \to x_2;\ \ x_1 \to f_2 \to x_4;\ \ x_1 \to f_3 \to x_3;$$
$$x_2 \to f_4 \to x_5;\ \ x_4 \to f_5 \to x_5;\ \ x_4 \to f_6 \to x_6;$$
$$x_3 \to f_7 \to x_6;\ \ x_5 \to f_8 \to x_7;\ \ x_6 \to f_9 \to x_7;$$
$$x_4 \to f_{10} \to x_7;\ \ x_7 \to f_{11} \to x_8.$$

Then a dual formulas with forward and backward wave of computing can be naturally constructed in the following form (□ is the initial state, ■ is the final state, the goal):

$$f_k \to x_j \to f_n.$$

For the direct wave, we have the following:

$$\square \to x_1 \to f_1/f_2/f_3;\ \ f_1 \to x_2 \to f_4;\ \ f_3 \to x_3 \to f_7;$$
$$f_2 \to x_4 \to f_5/f_6/f_{10};\ \ f_5/f_4 \to x_5 \to f_8;\ \ f_7 \to x_6 \to f_9;$$
$$f_8/f_9 \to x_7 \to f_{11};\ \ f_{11} \to x_8 \to \blacksquare.$$

For the backward wave we have the following:

$$\blacksquare \to x_8 \to f_{11};\ \ f_{11} \to x_7 \to f_8/f_9;\ \ f_9 \to x_6 \to f_7;$$
$$f_8 \to x_5 \to f_5/f_4;\ \ f_5/f_6/f_{10} \to x_4 \to f_2;\ \ f_7 \to x_3 \to f_3;$$
$$f_4 \to x_2 \to f_1;\ \ f_1/f_2/f_3 \to x_1 \to \square.$$

This record is used to accelerate the construction of solutions using the oncoming of motion on the direct and the dual formula.

A traditional problem of synthesis in the environment can be written as the problem of finding $\boldsymbol{P}$ as follows:

$$\forall\, w \in O\,(A(w) \Rightarrow B(w\,, \boldsymbol{P}(w))),$$

where, $\boldsymbol{P}\ (w) = \boldsymbol{H}(f_1,\dots\ f_K\,)$, $\boldsymbol{H}$ is some operator for composition of functions.

In the simplest case of arising problems can be written as:

$$x_i \to ? \to x_j,\ \ x_i \to ? \to ?,\ \ f_k \to ? \to f_n$$

etc, and for the given example:

$$x_1 \to ? \to x_8$$

The solution in this case can be written as follows:

$$\{\, x_1 \to f_1 \to x_2 \{\, x_2 \to f_4 \to x_5 \{\, x_5 \to f_8 \to x_7$$
$$\{\, x_7 \to f_{11} \to x_8 \}\}\}$$
$$/x_1 \to f_2 \to x_4 \{\, x_4 \to f_5 \to x_5\}$$
$$/\, x_1 \to f_3 \to x_3 \{\, x_3 \to f_7 \to x_6 \{\, x_6 \to f_9 \to x_7\}\}$$
$$\}$$

The subject easily controls a localized actions and descriptions, but their subsequent integration by the mental way often creates difficulties because of numerous parts and details. Naturally, in these conditions, methods of synthesis and computing help to overcome the difficulties that arise in solving problems.

In the general case any component of expression (1) can be *known*, *unknown*, *uncertain*, or *unconscious*. Various problems on construction or navigation arise depending on this. In fact, there is a transition from satisfaction the cognitive needs to satisfaction of creative, and design needs in the terminology space. It is a transition from "infinite" search to constructing new objects with the specified properties. This construction can be realized in different "styles activities" such as a deductive (e. g. the system considered above “a question – the answer”), an inductive (generalizations of the input, output and computing protocols), the genetic (when computation graphs on the specified functions of a survival or fitness functions are synthesized), constraint programming (the constraints can be the equations) and in other styles. In addition to the object and the functional entities other entities may be considered such as event based, states based, libernetic (control), resource, etc.

The main *technological* result is a clear allocation of new mechanisms and forms of the continuity for technological processes in the chain of transforming: “idea – a sequence of results – the product”, that are partially modeled and implemented.

4. Conclusion

While developing a terminology system as a basis for constructing the IT-sphere, it is necessary to strive for the symbiosis of man and living environment in the process of system evolution accumulation and using of knowledge. Distribution between the subject and the computer, controlled dosing information received by the subject based on the analysis of cognitive, creative and constructive process will create more effective processes to solve problems, to accumulate information and knowledge. Any moment of describing the stratums of IT-sphere is important. The IT-sphere is a space-structure, with its vital flows of information within and outside the subject. The key moments of constructing the terminological system are the organization of answers to system of questions, constructing of stratums of descriptions, strategies of computing, processes of formalization and deformalization, the integrity of presentations.

The proposed method was applied for solving intellectual navigation in graphics, as well as for solving problems of "site building".

Acknowledgments

This investigation is supported by the Grant 11-07-00640 "Creating of computing models to support the descriptive–constructive activities" (2011–2013) of Russian Foundation For Basic Research.

References

1. Bel'tiukov A. P., Maslov S.G. "On the terminological system for interdisciplinary research". In: Burkov, V.N. and Novikov, D.A. (ed) *Proc. of Theory of Active Systems (TAS'2009)*, Vol. II. ISC RAS, Moscow, Russia, 2009. P. 232–235.
2. Maslov S. G. "The system approach to creating the programming environment". In: Vassilyev, S. N. (ed) *Intellectual control systems*, Mechanical engineering, Moscow, Russia, 2010. P. 41–47.
3. Bel'tukov A. P., Maslov S. G., Morozov O. A. "Libernetic paradigm in the IT-sphere". In: *Proc. of the II-nd All-Russian sci. conf. "Technologies of Informatisation in Professional Activity (in Science, Education and Industry)" (ITPA-2008)*, Path 2. LLC Information and Publishing Centre "Bon Anza", Izhevsk, Russia, 2008. P. 37–52.
4. Maslov S. G. Beltukov A. P., Morozov O. A. "IT-sphere Constructive Directions". In: *Proc. of the 11-th international workshop on Computer Science and Information Technologies (CSIT'2009)*, Crete, Greece 2009, UGATU, UFA, p. 131–135.
5. Bel'tukov A. P. "Intuitionistic formal theories with realizability in subrecursive classes". In: *Annals of Pure and Applied Logic*, 1997; 89: 3–15.
6. Bel'tukov A. P. "A strong induction scheme that leads to polynomially computable realizations". In: *Theoretical Computer Science*, 2004; 322: 17–39.
7. Bel'tukov A. P. "Small complexity classes and automatic deductive synthesis of algorithms", Issue 2, Institute of Math and Informatics, UdSU, Izhevsk, Russia, 1995.
8. Maslov S. G. "Some aspects of conceptual synthesis of programs". In: *Vestnik Udmurt State University*, 1999; 8: 52–57.
9. Maslov S. G. "Structural aspects of modeling complex systems". In: *STI, ser.2., Inform. processes and systems*. 1993; 3: 7–9.