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Object Traces in the Conceptual Modeling

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Abstract—**The paper considers the problem of conceptual modeling (CM) of the domains, in which a large number of changes takes place, possesses a number of specific features connected to the nature of the ongoing changes or large quantity of independently acting agents possibly produce changes in various parts of the model.**

The dynamic nature models required supporting means. The paper states that the possibilities of future changes in model objects might largely be determined not only by their current state, but also by the past state - history of the objects in the model. The support to such history inside the current state of the object can be difficult and stimulates the search for new approaches to ensure the map of the changes of objects in the domain model.

It is offered to receive the decision by single out the individual information identities that can be called state trajectories from the conceptual point of view and object traces from the implementation point of view. It is noted that the traces can fix not all changes of the corresponding objects, but only those which have an influence on the further behavior of the model.

The paper presents an approach to the determination and the support to the traces, based on using a combination of methods of the intensional logic and applicative computational systems. In p.2 the concept of the state trajectories or object traces is discussed and also some of their properties. The p. 4 contains the setting of the task to support the traces in the conceptual modeling systems. The p. 3 describes some of the earlier proposed approaches to the description and tracing of the states of objects. The p. 5 describes the theoretical methods of the state trajectories or object traces description. The p. 6 discusses the possibility of toolkits oriented to support the object traces. In conclusion, some results are given, which have been obtained in the process of application of the developed methods, and the work prospects are briefly reviewed.

Keywords—conceptual modeling; interrelated data; object traces

I. INTRODUCTION

Conceptual modeling of the domains, in which a large number of changes takes place, possesses a number of specific features. Some of the features are connected to the nature of the ongoing changes. Another part of the specific features is associated with the need to preserve the integrity of the model when mapping the changes in the domain. The problem becomes severe when the domain contains a large quantity of independently acting agents that can produce changes in various parts of the model

When supporting the dynamic nature models the possibilities of future changes in model objects might largely be determined not only by their current state, but also by the past state - history of the objects in the model. The support to such history inside the current state of the object can be difficult, which also stimulates the search for new approaches to ensure the map of the changes of objects in the domain model.

As appeared a prospective approach to solving the problem is to single out the individual information entities that represent a sequence of changes in the state of model objects essential for its support. We call such entities state trajectories when consider it from the conceptual point of view and object traces when consider it from the implementation point of view.

The support to the trajectories can be performed for different objects in various ways. The selection of the support method for each object is carried out taking into account the requirements of the model as a whole. The paper presents an approach to the determination and the support to the object traces, based on using a combination of methods of the intensional logic and applicative computational systems.

II. OBJECT TRACES

The refinement of the task for the support to the object traces is based on the correct determination of state within the model. In particular, such determination depends essentially on the type of the information processing recognised in the model. As a rule, it is assumed that the model objects have attributes, the values of which determine the state of the object.

In the case of the applicative computational models [1], the state is determined in a different way. The values of the characteristics of the objects are determined as a result of application of a function to an argument. When calculating the function, the argument values are kept in the computing environment, which possesses the nested nature. The computation can be interrupted and then resumed. The computing environment may, thus, contain information representing partial computations and the one that is required for their restarting.

In the case of considering the abstract machine [1, 2] the state is represented by a set of machine registers. The values of the registers determine the course of the computation. Typically, the abstract machine may also switch between computing. In this case, one of the kinds of values that can be contained in the register is the data saved during the computation, which can be resumed later on.

The present paper introduces the notion of the state trajectories or object traces for representation of the sequences of the states of the objects in the model. The corresponding data structure is the specific entity of the applicative system. We call such entities state trajectories when consider it from the conceptual point of view and object traces when consider it from the implementation point of view. The preceding consideration shows that the state of the model can be correlated with the computing environment. The structure of the environment of computation determines the state of model, and hence the object trace.

III. Task of the object traces support

Filing the comments regarding the relations between the object traces and computing environments allows for getting the computational nature to the concept of the trace, which provides the possibility of building supportive tools to the object traces. The necessity of the support of the object traces requires the corresponding toolkit. The toolkits of the object traces support should provide:

- possibility of supporting the object traces, defined by both the values at certain points, and description of change of state;
- carrying out computations “along” the object traces, in particular, the computation of requests for traces;
- possibility of interpreting the trace as a specialized element of the computation environment.

As the practice of the work with the states shows (both in the field of intensional logic, and in the field of software systems design), theoretically not properly thought through approach to the definition of the state results in vague and difficult-to-use systems. On the contrary, a strict definition of the state, a set of admissible states, etc., enhances the expressive power of the relevant means and increases the reliability and safety of the resulting software systems.

IV. Approaches to the support to the object traces

One of the most common interpretation of state transitions is proposed in the framework of modal and intensional logic. The temporal logic [3] causes the greatest interest among the various known systems of modal logic to support the object traces. The temporal logic considers the dependence of the truth of language sentences on the time, and has the means to account such dependence in the formal toolkits. Thus, when constructing the models of temporal logic the language sentence is associated with a function that assigns a certain value of truth to each moment of time. Such a function may be considered as one of the options of the trace.

Even more general interpretation is adopted in the intensional logic [3, 4]. It generalizes the notion of time moment to the notion of the correlation point, which can be related to the set of time, spatial and other coordinates. Changing the state of the object in this case is modeled as a dependence of the characteristics values object on the correlation point. Such dependences are singled out as part of the formal toolkits of theory and are essentially used in the construction of interpretation. However, the proposed approach has a significant community, making it difficult to directly interface with systems of conceptual modeling and requires specification of the applied structures for their use in the framework of practical models. One of the methods of this specification will be discussed later (p. 5).

One of the most common approaches is adopted within the DBMS. The approach is associated with the definition of a system of states satisfying the applied restriction, usually connected with a particular transaction. This approach has proven its practical utility, but a set of integrity constraints must be defined by the database designer in advance, as a rule, without regard to the trace. In this case there is a risk of “losing” any constraint, especially when it is needed to support closely interrelated data objects. Therefore, this approach based on the transaction appears to be unsuitable as the main support for the traces, although it can be accepted as one of the elements of the supporting system.

In general, it appears that the presence of well-developed concepts and techniques that implement individual elements of support to the object traces, there is no common approach, ensuring the inclusion of the concept of the trace into the conceptual modeling systems. For this reason the development of support tools to the object traces in the conceptual modeling of systems seems to be an actual task that has undoubted applied significance.

The approach adopted in the present paper consideres the object traces as “objects of the first order” of the model. In particular, they in turn may be considered as objects, be analyzed, be involved in the computation and etc. To ensure the correct manipulation of objects of such type the use of developed formal methods is required [5, 6].

V. Methods of support

The most natural method of theoretical description of the object traces seems to be the intensional logic. To provide the computational character of the model the integration of the intensional logic possibilities with the capabilities of the applicative computational systems is desirable. Further on a version of the system, based on intensional logic and providing the basic abilities for description of the object traces is given. We use designations proposed by A.N. Prior.

The alphabet systems comprise (1) the set of basic types e, t, s; (2) the set of variables $v_{i,\sigma}$ and constants and $a_{i,\sigma}$ for each type σ, where i - a positive integer; variables will be marked as p, q, r, x, y, z, and the constants a, b, c; (3) propositional operations N, K, A, C, E; (4) quantified operation Π and Σ, λ - abstraction operation and intensional operations Δ and Θ; (5) intensional operators and Li and Mi, where i - a positive integer; (6) brackets and comma.

The types will be ascribed to the expressions of the intensional logic language. Many types Type will be defined inductively by the following way: (i) e, t ε Type; (ii-1) if σ and τ ε Type, then (σ, τ) ε Type; (ii-2) if σ ε Type, then (s, σ) ε Type.

Meaningfully we'll use the expressions like e to represent formalizations of domain objects, and t - for the presentation of statements about the domain. The expressions of type (σ, τ) are functions from the type σ objects into objects of type τ. Expressions of type (s, σ) are expressions of intensions type σ. The ratio ε is used for designation of the belonging to the metalanguage.

Let us define the set of terms Tmσ for every type σ.

vi,σ ϵ Tmσ; ai,σ ϵ Tmσ.

If a ϵ Tm(σ, τ) ans b ϵ Tmσ, then (ab) ϵ Tmτ.

If a ϵ Tmτ and vi,σ ϵ Tmσ, then (λva) ϵ Tmτ.

If a, b ϵ Tmσ, then Eab ϵ Tmt.

If a, b ϵ Tmt, then Na, Kab, Aab, Cab, Miab, Liab ϵ Tmt.

If a ϵ Tmt и vi,σ ϵ Tmσ, then Πva, Σva ϵ Tmt.

If a ϵ Tmσ, then Δa ϵ Tm(s, σ).

If a ϵ Tm(s, σ), then Θa ϵ Tmt.

Now we define the semantics for the defined system. We define the set D, which will be considered as a set of individuals, and the set Asg, which will be regarded as the set of points of assignment [Ismailova, Kosikov]. Next we define the set of values for each type as follows.

De = D,

Dt = {0, 1},

D(σ, τ) = Dσ → Dτ,

D(s, τ) = Asg → Dτ,

where A → B – common designation for the functional space (set of functions from A into B).

The trace of the state in the proposed system is formalized as a relation on the set Asg. The intensional operator is the formal means to work with the object trace. The adopted method of specifying the semantics for intensional operators ensures, in particular, the description of the changes of states of objects along the trace and definition of queries to objects taking into account their traces.

Let us consider a very simple example. Suppose that it is necessary to describe the object b, and its state does not change. For this the following formula can be used

MSbxΣyExΔy

It can be verified by direct computation of the formula values.

VI. MEANS OF SUPPORT

The support toolkits for supporting the conceptual modeling of domains, that contain the object traces, must combine general and specialized means of processing. The general means are understood as the conceptual modeling tools that provide the mapping of domain objects, their properties and relations, as well as the changes in the composition of objects and their interrelationships depending on the selected methods for the model parameterization. The specialized means are oriented to the work with the states and the traces, including the carrying out of computations along the trace.

For the purpose to exercise the definition techniques and the processing of the object traces the prototype editor of concept descriptions of domains was developed, it was implemented in Java language. For tracking the object traces in models with different structure the editor ensures the possibility to extend the composition of the object classes and to change the sets of attributes, assigned to a certain class of objects.

The composition of the classes of objects, the set of attributes assigned to objects of a given class, the links between elements of different classes and other conceptual frameworks are fixed by means of describing in a specialized language, represented as XML dialect. The extension is implemented by changing the description of the model structures with the following reinterpretation of the description. This way ensures both the modification of the description of the conceptual structures of the tools of editor, and the opportunity to use the external means for editing XML with the following import of the edited descriptions into the editor.

The visualization of the processed conceptual structures presents some problems, because the composition of these structures (the set of attributes, links, types of attribute values, etc.) changes during the development of the conceptual model. For solving the problems a special visualization language has been developed, which is also an XML dialect. The language defines a set of specific components used to visualize the objects of the model, and the way of their compositing in the dialog box, oriented to the user.

VII. CONCLUSION

The present paper has proposed approaches to the identification and support of the object traces, based on the use of a combination of methods of the intensional logic and the applicative computational systems. Seemingly, the proposed approaches provide for the following opportunities:

- setting the object traces for objects of conceptual model of domain;
- determining the properties of the object traces and verification of their implementation;
- performing computations along the object traces;
- interpreting the traces as "objects of the first order" of the conceptual model;
- visualizing and modifying the individual elements of the traces;
- debugging the conceptual model taking into account the traces.

The proposed methods and techniques were applied as methods of data processing when solving a number of problems from the field of law (modeling of the antimonopoly legislation, a number of issues of criminal law application, etc.). Building the models showed the practical applicability of the proposed techniques. The development of formalization methods for the object traces processing is expected to be promising to increase the power of conceptual modeling systems, integrity and security of supported models.

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REFERENCES

[1] Wolfengagen V.E. Methods and means of computation with objects. M., JurInfoR, 2004.

[2] Wolfengagen V.E. Categorical Abstract Machine M., JurInfoR, 2002.

[3] Wolfengagen V.E., Ismailova L.Yu. , Kosikov S.V. Computational Model of the Tangled Web. Procedia Computer Science, Elsevier, Volume 88, 2016, pp. 306-311–7th Annual International Conference on Biologically Inspired Cognitive Architectures, BICA 2016, 16-19 July New York, USA.

[4] Wolfengagen, V. 2010. Semantic Modeling: Computational Models of the Concepts. In Proceedings of the 2010 International Conference on Computational Intelligence and Security (CIS '10). IEEE Computer Society, Washington, DC, USA, pp. 42-46.

[5] Ismailova L.Yu., Kosikov S.V., Wolfengagen V.E. Applicative Methods of Interpretation of Graphically Oriented Conceptual Information – Procedia Computer Science, Elsevier, Volume 88, 2016, pp. 341-346 – 7th Annual International Conference on Biologically Inspired Cognitive Architectures, BICA 2016, 16-19 July New York, USA

[6] Ismailova L.Yu., Kosikov S.V., Wolfengagen V.E. A harmony and disharmony in mining of the migrating individuals – 2016 Third International Conference on Digital Information Processing, Data Mining, and Wireless Communications (DIPDMWC), Moscow, 2016, pp. 52-57.