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The Use of Description Logic in The System-Objective Modeling of Organizational Knowledge

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Abstract. This article provides a brief description of the "Union-Function-Object" system-object approach, proposes a new way to formalize the "Union-Function-Object" three-element construction (UFO-element) using descriptive logic (DL). Considered the possibility of using DL for representing systems in an unambiguous, formalized form. Such logics combine rich expressive capabilities and relatively low computational complexity. DL uses the concepts of individual, concept and role. The basic theoretical concepts of description logic (DL) are described on the basis of the $\mathcal{ALC}$ DL and it's extension $\mathcal{ALCOQ}$. A definition of each part of the UFO element in form of $\mathcal{ALCOQ}$ DL was given. The described method of system-object knowledge modeling allows to obtain logical chains of concepts and connect them with roles.

Keywords. system-object approach; formalization; element "Union-Function-Object"; $\mathcal{ALC}$ and $\mathcal{ALCOQ}$ descriptive logic.

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1 Introduction

Nowadays, systems theory (general or abstract) is at the stage of forming its foundation. The existing theoretical constructions, no matter how they were called, do not constitute a complete scientific theory. This situation encourages researchers to propose various options for a systematic approach and use them to create a theory of systems. One of the variants of such a systematic approach, based on the fact that there is no set-theoretic system theory, is the "Union-Function-Object" system-object approach. The system-object UFO-approach is described by the following main points [1].

The system is represented as *a functional object*. The function of this object is due to the function of an object of a higher tier (super-system). The phenomenon of conditionality of a function of a system as a function of a supersystem is considered as a functional request of a supersystem for a system with a certain function - *an external determinant of the system*. It is the purpose of existence and the cause of the system, i.e. *universal system-forming factor*, as it determines the structural, functional and substantial properties of the system. The functioning of the system under the influence of the external determinant is its *internal determinant* and establishes between the system and the super-system *the relation of maintaining the functional ability of a more whole*. The process of moving of the internal determinant of the system to its external determinant is considered as an adaptation of the system to the supersystem request.

In addition, it is assumed that each system is necessarily connected to other systems. These links are flows of elements of the deep tier of related systems. The links between the subsystems of the system - supporting, the links between this system and external systems - are functional.

$$s_i = [(L_i?, L_i!); fs(L_i?)L_i!; (O_i?, O_i!, O_if)] \quad (1)$$

Expression (1) is one of the main ways of formalizing the UFO-approach using the Abadi-Kardeli calculus objects. In this calculus, an abstract object is a collection of methods and fields. $L_i?$ - field of a special object for describing the set of incoming interface flows corresponding to the incoming connections of the system s_i; $L_i!$ - field special object to describe the set of outgoing interface flows; fs - a special object method describing the function of the system s_i, i.e. process of converting incoming interface flows (system inbound) $L_i?$ in the outgoing $L_i!$. In accordance with the accepted notation in the theory of objects. $O_i?$ - a set of fields that contains the interface input characteristics of a special object (system s_i), $O_i!$ - a set of fields, which contains the interface output characteristics of a special object (system s_i), O_if - a set of fields, which contains the transfer characteristics of a special object (system si). At the same time, there are many fields for describing the object characteristics of the system $O_i = O_i? \cup O_i! \cup O_if$.

In the same time, description logic and an ontological approach can be used to describe information system architectures [1]. Descriptive logic is a family of languages for the formal description of knowledge. In this sense, the use of DL allows you to describe the elements of the system with some logical expressions. From the point of view of the authors of this article, the use of DL to create a new way of formalizing the system-object approach is a promising direction.

2 Main results

Descriptive logic combine rich expressive capabilities and relatively low computational complexity. DL uses the objects of *individual*, *concept* and *role*. One of the most well-known and basic DL is the $\mathcal{ALC}$ logic and it's extension $\mathcal{ALCOQ}$. $\mathcal{ALCOQ}$ logic concept syntax is following [2]:

$$\top|\bot|A|\neg C|C \sqcap D|C \sqcup D|\exists R.C|\forall R.C|\forall R| \leq NR| \geq NR|\exists R|\{a\} \quad (2)$$

Next, we describe correspondence between UFO-elements and expressions of $\mathcal{ALCOQ}$ descriptive logic (2). So, the system s_i formulates as following expression:

$$s_i = U_i \sqcap F_i \sqcap \exists R_p.O_i, \quad (3)$$

where $U_i = (L_i? \sqcup L_i!) \sqcap \exists R_{in}.L_i? \sqcap R_{out}.L_i!$ and $F_i = L_i! \sqcap \exists R_f.L_i?$ and $O_i = \{a_1\} \sqcap ... \sqcap \{a_n\}$. R_{in}, R_{out}, R_f - roles that shows relationship between concepts.

The formalization (3) of the UFO-element using the $\mathcal{ALCOQ}$ logic allows us to simulate the nodal, functional and substantive (object) characteristics similar to (1). Consideration of the UFO-element in the form of the intersection of composite concepts (concept-object O_i, concept-function F_i, concept-node U_i). Such formalization makes it possible to describe the system as a whole in the form of expressions of the form (1).

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