Logical Definition of Object Domain Ontology. *

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The paper is devoted to a formalization of object domain ontology. Now ontology is very useful tool for different fields of knowledge engineering. However until now there is not a unique common definition of object domain ontology. There are a number of different approaches to ontology definition. Aim of this article is to present a model theoretical definition of object domain ontology.

Let us summarize how various authors define the ontology [1, 2, 3, 4]: ontology is a tool for reality modeling; ontology describes an object domain; knowledge represented by ontology should be intersubjective (it means that different experts in the given object domain should agree with the statements presented in the object domain ontology); ontology should contain specification of senses of object domain key concepts; ontology describes general properties of object domain, not depending of its concrete realizations. We base our formalization on ontology definition presented in [5].

Definition 1. A formal ontology of an object domain O is a pair $< S, \sigma >$, where σ is a set of key concepts and S is a set of analytic sentences describing meanings of key concepts.

Actually the set σ is the signature of the object domain. It means that σ contains only symbols of concepts. The set S includes definitions of the symbols containing in σ.

Definition 2. The set T of the sentences that are true in every example of an object domain O will be called as the theory the object domain O, or the object domain theory.

Definition 3. Let a pair $< S, \sigma >$ be a formal ontology of an object domain O. The set $T_a = \{\varphi | S \vdash \varphi\}$ is said to be an analytic theory of the object domain O.

Definition 4. Let T be the theory of an object domain O, T_a be the analytic theory of O and S_e be a set of sentences, such that $T = T_a \vee S_e$, i.e. $T = \{\varphi | T_a \cup S_e \vdash \varphi\}$. Then the set S_e is called as a set of heuristics of the given object domain O.

The heuristic set S_e formalizes the special knowledge of the experts in the given object domain.

Definition 5. A deductively closed formal ontology of an object domain O is a pair

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$< T_a, \sigma >$, where σ is a set of (symbols of) key concepts and T_a is a deductively closed set of analytic sentences describing meanings of key concepts.

Definition 6. A formal ontology $< S, \sigma >$ is called canonical if:

a) For any $\varphi \in S$ there not exist ψ and ξ such that $\varphi \equiv \psi \& \xi, \sigma(\psi \& \xi) \subseteq \sigma(\varphi), \sigma(\psi) \neq \sigma(\varphi)$ and $\sigma(\xi) \neq \sigma(\varphi)$.

b) For any $\varphi \in S$ and for any ψ if $\varphi \equiv \psi$ then $\sigma(\varphi) \subseteq \sigma(\psi)$.

For ontologies $< S, \sigma >$ and $< S', \sigma >$ we denote $< S, \sigma > \equiv < S', \sigma >$, if $S \vdash S'$ and $S' \vdash S$.

Theorem. For any ontology $< S, \sigma >$ there exists a canonical ontology

$$< S', \sigma > \equiv < S, \sigma > .$$

We call a pair $< \sigma, R >$ as *a concept net* if $R \subseteq \sigma^2$ and R is reflexive and transitive. We say that a concept net $< \sigma, R >$ is a representation of an ontology $< S, \sigma >$ if for any $p, q \in \sigma$ we have $R(p, q)$ iff $p, q \in \sigma(\varphi)$ for some $\varphi \in S$. We say that a concept net $< \sigma, R >$ is *a canonical representation* of an ontology $< S, \sigma >$ if $< \sigma, R >$ is a representation of a canonical ontology $< S', \sigma > \equiv < S, \sigma >$.

Corollary. Every ontology has a canonical representation.

Hypothesis. For any ontology a canonical representation is unique.

Let $< \sigma, R >$ be a concept net, $\Delta \subseteq \sigma$ and $p \in \sigma$. A distance $\rho(p, \Delta)$ between p and Δ in $< \sigma, R >$ is the minimal number of steps in the graph R from p to some $q \in \Delta$.

Definition 7. A triple $< S', \sigma, f >$, where $f : \sigma \to [0, 1]$ is called a fuzzy ontology. A fuzzification of ontology $< S, \sigma >$ modulo a set $\Delta \subseteq \sigma$ is a fuzzy ontology $< S', \sigma, f >$, where $f(p) = \frac{1}{(\rho(p,\Delta)+1)}$ for any $p \in \sigma$.

Fuzzy ontology is a useful tool for fine search organizing and knowledge retrieval in Internet. Here $< S, \sigma >$ is an object domain ontology and Δ is a set of key words from a search engine query.

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