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The “ontological square” and modern type theories

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Abstract: This paper focuses on the connection between “four-category ontologies” (which are based on Aristotle’s ontological square) and modern type-theoretical semantics. Four-category ontologies draw a distinction between four types of entities: substantial universals, substantial particulars, accidental universals and accidental particulars. According to B. Smith, “fantology is a doctrine to the effect that the key to the ontological structure of reality is captured syntactically in the ‘Fa’”.

Smith argues that predicate logic cannot adequately describe these four types of entities, which are reduced to just two kinds — the universal (‘F’) and the particular (‘a’). B. Smith has criticized G. Frege’s first-order logic. He argues that Frege, being the father of modern logic, simultaneously became the father of “fantology” and its ontological commitments.

Smith transforms the ontological square to the ontological sextet (which also involves universal and particular events) and proposes a set of predicates for different ontological relations.

However, Smith’s approach faces some limitations. We argue for another formal analysis for the ontological square’s entities. This approach is based on modern type-theoretic semantics, according to which, the difference between substantial universals and accidental universals can be expressed. In first-order logic the sentences “Socrates is a man” and “Socrates is wise” share the same logical form. However, this fact is not consistent with “ontological square” metaphysics (“being a man” is a substantial universal and “being wise” is an accidental universal). Whereas, according to the type-theoretical approach, relations to accidental universals are expressed by means of a judgment (a : A), but relations to accidental universals are expressed by predication (‘Pa’).

Keywords: type theory, the “ontological square”, formal semantics


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1. Introduction

This paper deals with a particular case in the general discussion on the relation between semantics and ontology: in particular, the search for adequate semantic interpretation of a set of entities defined by so-called “ontological square” and “four-category ontologies” (see: Angelelli, 1967; Lowe, 2006; Lowe, 2013; Smith, 2005), the idea of which goes back to Aristotle (see: Aristotle, 1978).

B. Smith [Smith, 2005] has criticized G. Frege, who as well as being the father of modern logic time had become the father of a terrible ontology monster — fantology — a theory where the diversity of entities is reduced to objects (“a”) and predicates (“F”): “...Frege’s object/function distinction rides roughshod over two traditional ontological distinctions, between substance and property, and between particular and universal” [Smith, 2005, p. 163].

B. Smith suggests to go back to pre-Fregean times when things were good and logic was not spoiled by “fantology”. According to B. Smith, logic can be cured from “fantology” through predicate logic acquiring a whole set of relations corresponding to “ontological square” commitments and thereby enriching ontological commitments postulated by logical theories. In this paper we offer a different approach for formalizing entities postulated by the ontological square, an approach based on type-theoretic semantics that has a number of advantages compared to B. Smith’s approach.

2. “The Ontological Square” and “Fantology”

2.1. “Fantology”

In the paper ‘Against Fantology’ B. Smith [Smith, 2005] states that “the analytical philosophy of the last hundred years has been heavily influenced by a doctrine to the effect that the key to the correct understanding of reality is captured syntactically in the “Fa” structure (or, in more sophisticated versions, in the “Rab” structure) of standard first-order predicate logic”, i.e. the reality structure is isomorphic to the structure of predicate logic.

The term fantology (“fantology” comes from the sentence “Fa”). By using this notion, it is emphasized that in predicate logic there are just two syntactically different types and therefore, in reality there should be two corresponding types of entities — general (properties) and the particular (objects)\(^1\).

\(^1\)When talking about fantology, Smith means a simple version of predicate logic without function constants
B. Smith not only associates fantology with G. Frege but also with Plato, G. Leibniz, I. Kant and D. Hume, since they all considered language to be a source of ontological differences. It is important to note that Smith does not criticize predicate logic as such, he rather describes how some ontological sentences behind it implicitly influenced the progress of analytical philosophy.

Smith’s main criticism of fantology therefore, comes down to the fact that the general and the universal refer to the predicate, and the single – to the object. In this sense all additional categories can be derived from the main two. What is lost under this problem sentence? To prove this, B. Smith offers a simplified version of the ontological square previously described by E. Angelelli [Angelelli, 1967, p. 11], then further developed by E. Lowe [Lowe, 2006], A. Back [Back, 2000], L. Schneider [Schneider, 2009].

2.2. “The Ontological Square”

The ontological square is a theory derived from the works by Aristotle (in particular, from the second chapter of Categories) and confirming the need to distinguish between four types of entities: substantial universals, substantial particulars, accidental universals and accidental particulars. The second chapter of the treatise “Categories” already in its name (“Said about the subject and present in the subject”) suggests two major relation types based on which square and four object classes are built: “what is said about the subject”, “what is present in the subject”, “what is not present in the subject” and “what is not said about the subject” [Aristotle, 1978].

How do the two main relations in Aristotelian terminology correlate with the traditional later division into substances, accidents, universals and particulars? What is not in the subject is substances, what is in the subject are accidentals, what is said about the subject is universal, what is not said about the subject is single, or particular.

Table 1. “Aristotle’s Ontological Square” (Angelelli’s version)

<table>
<thead>
<tr>
<th></th>
<th>Not present in the subject</th>
<th>Present in the subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is said about the subject</td>
<td>Man</td>
<td>White</td>
</tr>
<tr>
<td>What is not said about the subject</td>
<td>This man</td>
<td>This is white</td>
</tr>
</tbody>
</table>

---

\[2\] We believe that it would be worth while making a distinction between fantology in the narrow sense (an isomorphism between the reality and the first-order logic) and fantology in the broad sense (isomorphism between the reality structure and language structure).
Aristotle explains this in Categories: “By being “present in a subject” I do not mean present as parts are present in a whole, but being incapable of existence apart from the said subject” —which is why what “is not in the subject” is a substance in the classical reception of Aristotle. The category of what “is not said about the subject and is not in the subject” is, for example, according to Aristotle, a separate person or a separate horse. The idea of dividing categories is developed by E. Lowe who created a four-part hierarchy of different categories:

• first level entities are divided into universals and particulars;

• universals are divided into properties and relations, particulars — into concrete and abstract;

• concrete are divided into things and events;

• things divided into substantial and non-substantial

However, even this Lowe’s hierarchy is sooner or later reduced to just two main categories: universal and particular, which makes the other categories dependent on these rather than them being equal. The ontological square presented in the paper by B. Smith, looks quite similar to the Aristotle reception: vertically, it is divided into universals and particulars, horizontally, it is divided into substantial and accidental.

<table>
<thead>
<tr>
<th></th>
<th>Substantial</th>
<th>Accidental</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Universals</strong></td>
<td>Second substance</td>
<td>Second accident</td>
</tr>
<tr>
<td></td>
<td><em>man</em></td>
<td><em>headache</em></td>
</tr>
<tr>
<td></td>
<td><em>cat</em></td>
<td><em>sun tan</em></td>
</tr>
<tr>
<td><strong>Particulars</strong></td>
<td>First substance</td>
<td>First accident</td>
</tr>
<tr>
<td></td>
<td><em>this man</em></td>
<td><em>this headache</em></td>
</tr>
<tr>
<td></td>
<td><em>this cat</em></td>
<td><em>this sun tan</em></td>
</tr>
</tbody>
</table>

From the traditional Aristotle square in first-order predicate logic there are only two major angles left — universal and single or in other words, properties and objects.
2.3. Smith’s solution

A few points seem to be fundamental to Smith in this context. Firstly, in fantology, generality traditionally belongs to the predicate. Secondly, the language of first-order predicate logic developed by G. Frege, B. Russell and A. Whitehead is first and foremost applicable to mathematical sentences, since its objects do not exist in time and space. However, when it comes to objects that exist empirically, the situation gets more complicated — the categories of action, event, process become more important.

Lowe presents three alternative ways of describing properties in time in a predicate logic, which do not seem satisfactory to Smith, just the opposite, in his opinion, they involve a “heavy price”\(^3\).

Smith suggests introducing equal-order categories, i.e. expand the base matrix transforming a square into a sextet: the vertical still contains universal and particular, while horizontally the structure will change into three new categories — independent continuant entities, dependent continuant entities and occurrent entities (events and processes).

Therefore, this sextet, not only distinguishes individual and universal substances, but also individual and universal qualities, as well as individual and universal processes. An example of the first category (Smith calls them second substance and first substance) can be man for universals and this man for particulars. An example of the second category (second quality and first quality) can be headache, sun tan for universals and this headache, this sun tan for particulars. An example of the third category (secondary and primary process): walking for universals, this walking, this thinking for particulars.

Entities in these categories are mutually connected through some formal relations: exemplification, participation, differentiation, inherence, instantiation\(^4\). Therefore, B. Smith suggests this solution: he suggests expanding the predicate logic language with the following relations:

- \(= (x, y)\): x is identical to y
- \(Part(x, y)\): individual x is part of individual y
- \(Inst(x, y)\): individual x instantiates universal y
- \(Inhere(x, y)\): individual x inheres in individual y

\(^3\)The separation of “process” category is very important for B. Smith; however in our paper we focus on other “angles” of the square, and although the event can be described as a separate type, it is beyond the scope of this paper.

\(^4\)It was hard to translate formal relations between categories in Smith’s paper, so the authors decided to copy most of the terms in order to preserve the exact meaning.
• **Exemp**(*x*, *y*): individual *x* exemplifies property *y*

• **Dep**(*x*, *y*): individual *x* depends for its existence on universal *y*

• **Is**_**a**(*x*, *y*): universal *x* is a subkind of universal *y*

• **Precedes**(*x*, *y*): individual process *x* precedes individual process *y*

• **Has**_**Participant**(*x*, *y*): individual thing *y* participates in individual occurrent *x*

• **Has**_**Agent**(*x*, *y*): individual thing *y* is agent of individual occurrent *x*

• **Realizes**(*x*, *y*): individual process *x* realizes individual function *y*

Relations between the various entities in Smith’s ontological sextet can be clarified by several examples: the substantial particular instantiates the substantial universal and exemplifies the accidental universal (or, in other words, the universal property). For example, “John is wise” in this approach (see [Smith, 2005, p. 167]) will be analyzed as

\[ \text{Exemp}(j, \text{Wise}) \]

Wisdom in this context will be a universal, “John is human” will become

\[ \text{Inst}(j, \text{Human}) \]

Accidental and substantial in this approach differ due to different types of relations — instantiation and exemplification.

### 2.4. Problems of Smith’s solution

We would like to draw our readers’ attention to a number of problems related to the solution proposed by Smith; there are other solutions (see [Lowe, 2006; Schneider, 2009]), but they seem to encounter similar difficulties.

First, in attempting to overcome the limitations of predicate logic Smith formulated a theory where only universal predicates of different types would be considered as universals. That is, the rich system of relations proposed in the current approach is not devoid of fantological features: all relations considered by Smith at the level of meta language, correspond to a cortege set (nominalist ontology where there exist only objects and sets is far from Smith’s understanding of ontological diversity of entities).
Secondly, in Smith’s approach the importance for the “ontological square” of the difference between substantial and accidental is reduced to the difference between two predicates $\text{Inst}(x, y)$ and $\text{Exemp}(x, y)$, and the difference is defined by particular interpretation and not the internal structure of logic theory.

Thirdly, Smith’s approach does not allow us to analyze in a compositional way arbitrary fragments of natural language constructs. Smith offers a set of tools for specifying a sufficiently rich ontological theory, but does not show how semantics might look for specific language expressions. A fair objection to the non-compositionality criticism would be consideration of Montague grammar (see: [Montague, 1973, Montague, 1974]) as a compositional extension of the logic of predicates and an attempt to combine the approach of Smith and Montague grammar. However, we shall try and demonstrate that Montague grammar is not as suitable for formalizing an ontological square as first-order logic.

In our view, the best alternative to overcoming fantology is not the theory proposed by Smith but different semantic analysis. As a tool for formalizing entities postulated by the ontological square, type-theoretic semantics\(^5\) can be used.

### 3. Principle ideas of type-theoretic semantics

Type-theoretic semantics was proposed in the pioneering work by A. Ranta [Ranta, 1994], which is based on the Martin-Löf intuitionistic type theory [Martin-Löf, 1984]. This approach was further developed in the works of D. Luo, S. Chatzikiakid is [Luo, 2012, Luo, 1999, Chatzikiakidis, Luo, 2014, Chatzikiakid is, Luo, 2017a], R. Cooper [Cooper, 2005], G. Sundholm [Sundholm, 1986, Sundholm, 1989], Becky [Bekki, 2014] and others.

Type-theoretic semantics offers solutions to a number of classical semantic problems: anaphoric binding and donkey-sentence, accommodation of presuppositions etc. (see: Chatzikiakid is, Luo, 2017b, Boldini, 2000, Francez, Dyckhoff, 2010, Ranta, 2004.)

We would like to demonstrate the advantages of applying type-theoretic semantics in the formalization of the ontological square and the overcoming of “fantology”.

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\(^5\)The transformation of ontological relations considered by Smith into the language of type-theoretic semantics seems possible, but it will not be covered in this paper.
3.1. What is “type”?

On the one hand, the concept of “type” like the concept of “set” is elementary and not defined through any other concept. On the other hand, all properties of types are fully specified by the rules of a particular formal system (in this paper we will rely on the Martin-Löf intuitionistic type theory, see [Martin-Löf, 1984]).

Types can be considered as a constructive counterpart of a set without the property of extensionality. Set properties are fully defined by objects that comprise the elements of that set, which is not the case for types.

The basic construction of type theory — the judgment of \( a : A \), means that \( a \) is an object of type \( A \) (or the object \( a \) is an ‘inhabitant’ of a type \( A \)). In this case, it is impossible to form a negative judgment of \( a : A \), and apply any Boolean operations, but such a restriction allows us to treat types as constructive objects, since judgment \( a : A \) can be decided unlike \( a \in A \).

3.2. Dependent types

A distinctive feature of type-theoretic semantics is the use of a richer set of type constructing. In Montague grammar, only one type constructor is used, allowing the formation of function type \( A \rightarrow B \) from two types \( A \) and \( B \).

This technique makes it possible to generate types corresponding to functions of any complexity, for example:

- \( e \rightarrow t \) (type of one-place predicates)
- \( e \rightarrow (e \rightarrow t) \) (type of two-place predicates)
- \( (e \rightarrow t) \rightarrow (e \rightarrow t) \) (type of second-order properties)
- \( (e \rightarrow t) \rightarrow ((e \rightarrow t) \rightarrow t) \) (type for quantors)
- \( t \rightarrow (t \rightarrow t) \) (type for two-place connectors)

In modern type theory, the product of types \( A \times B \) and two constructors of dependent types are also used: type of dependent sum \( \Sigma x : A.B(x) \) and type of dependent product \( \Pi x : A.B(x) \). Let us consider these constructors in more detail:

- The product of types \( A \times B \) is a type-theoretic analogue of the Cartesian product; this type is inhabited by ordered pairs \( (a, b) : A \times B \).

\footnote{An alternative method of formalization: “\((A, B)\)” or “\((A, B)\)”}
3.3. Type-theoretic analysis of universals and substantial particulars

Let us consider some basic ideas of the type-theoretic semantics (we will follow Chatzikyriakidis, Luo, 2014):

- TP are interpreted as propositions (type \( Prop \));
- common nouns \( CN \) are interpreted as types, unlike one-place predicates (type \( e \to t \)) in Montague grammar;
- intransitive verbs \( IV \) are interpreted as functions whose domain is the type (for each particular verb it is determined separately), and range is the type of propositions \( Prop \);
- adjectives \( Adj \) are interpreted in a similar way, i.e. as functions: \( Type(CN) \to Prop \);
- modified common names \( MCN \) are interpreted as the dependent sums of \( \Sigma(Type(CN), X) \), where \( X \) is a function of type \( Type(CN) \to Prop \).

Let us consider several examples illustrating the differences between Montague grammar (MG) and type-theoretic semantics (TTS).

The most significant differences have to do with the semantic interpretation of common nouns:

- CN (examples: man, human)

---

7 Alternative notation options: \( \Sigma(A, B) \), \( \sum_{x:A} B(x) \).

8 Alternative notation options: \( \Pi(A, B) \), \( \prod_{x:A} B(x) \).

9 This is one of the most essential differences of type-theoretic semantics from Montague grammar (and from Frege’s ideas, which were generally developed by R. Montegue); within its framework all true sentences are referred to an abstract object “truth”, and all false sentences are referred to to an abstract object “false”.

10 Such an approach is not shared by all representatives of the type-theoretic approach in semantics, in particular, in Bekki, 2014, common nouns are considered as predicates.
The “ontological square” and modern type theories

In Montague grammar, common nouns (“man”, “human”, “cat”, etc.) are analyzed as one-place predicates, that is, as expressions of the type “e \to T”. In type-theory semantics, common nouns are analyzed not as one-place predicates, but as basic types: Man, Human, Cat, etc. These base types could be considered as subtypes of the entity type “e”.

Consider the sentence:

(1) John is human

In Montague grammar (1) will be processed by application of a predicate to an individual constant:

\[ \text{man}'(j) \]

In type-theoretic semantics (1) will be analyzed as a judgment:

\[ j : \text{Man} \]

In the approach [Chatzikyriakidis, Luo, 2014], any common nouns are considered as types, including CN such as “doctor”, “student”, etc. But this approach raises substantial objections: the common noun “doctor” can be better viewed as a predicate of the type \( \text{Human} \to \text{Prop} \) than as the basic type. To distinguish between substantial and accidental universals, it is not enough to have a syntactic criterion, but we do not insist that the difference between substantial and accidental predicates is clear cut and free of context.

Let us consider some more examples:

- **IV** (example: \( \text{walk, talk} \))

  MG \( \text{walk}' : e \to t \)
  
  TTS \( \text{walk}' : \text{Human} \to \text{Prop} \)

- **Adj** (example: \( \text{man, handsome} \))

  MG \( \text{handsome}' : (e \to t) \to (e \to t) \)
  
  TTS \( \text{handsome}' : \text{Man} \to \text{Prop} \)

---

\(^{11}\text{Due to the mechanism of } \eta\text{-reduction in Montague grammar, the following analysis options are equivalent to } \lambda x : e. [\text{man}'(x) : t] \text{ and } \text{man}' : e \to t. \text{ Other versions of notation are also common: } \lambda x_e. [\text{man}'(x_e) : t] \text{ and } \lambda x. [\text{man}'(x)].\)
What are the advantages of type-theoretic semantics over Montague grammar? Consider the sentence:

(2) Table talks

In Montague grammar (2) will be evaluated as false, since the predicate talk is defined for any object of type e, and in type-theoretic semantics (2) will be incorrectly constructed because of the type conflict: predicate talk is applied to objects of the type Human to which the table does not belong.

Let us compare the Montague approach to the type-theoretic semantics approach applied to modified common nouns (MCN) and sentences (TP).

- MCN (example: handsome man)
  
  MG  handsome′(man′): e → t
  
  TTS  Σx: Man.handsome′(x) : Type

- TP (example: A man walks)
  
  MG  ∃x: e [man′(x) ∧ walk′(x)] : t
  
  TTS  Σx: Man.walk′(x) : Type

In Montague grammar, modification of a common noun is understood as the application of a second-order property (of the type (e → t) → (e → t)) to the first-order property (e → t), resulting in a modified first-order property. In type-theoretic semantics, the modification depends on the type of property. For example, the function handsome can only be applied to objects of the type Man, and not to any objects. This again allows us to consider sentences of the type

(3) The table is beautiful

as meaningless (due to the conflict of types).

It should be noted that the type Σx: Man.handsome′(x) populate object pairs (a, p) such that a: Man, and p is proof of the handsome′(a) proposition. By virtue of the principle “propositions as types” in type-theoretic semantics, the truth of the proposition is understood as the population of the corresponding type; that is, the expression “p : handsome′(a)” can be abbreviated as “handsome′(a) true”.
Therefore, the type-theoretic semantic structure implies differences between two types of universals — substantial (type) and accidental (predicate).

The belonging of an individual to the substantial universal \((\text{Inst}(x, y)\) according to Smith) is understood as judgment in type-theoretic sense, and the possession of a property by an individual \((\text{Exemp}(x, y)\) according to Smith) is expressed through the application of a predicate depending on the type of an individual, to this individual. That is, from the point of view of type theory, the following sentences:

\[
\begin{align*}
4 & \quad \text{Socrates is human} \\
5 & \quad \text{Socrates is wise}
\end{align*}
\]

will have a different logical form.

Let us compare three interpretations of sentences (4) and (5):

- Predicate logic (Montague grammar):
  \[
  \begin{align*}
  4 & : \text{human}'(s) \\
  5 & : \text{wise}'(s)
  \end{align*}
  \]

- Smith’s theory:
  \[
  \begin{align*}
  4 & : \text{Inst}(s, \text{Human}) \\
  5 & : \text{Exemp}(s, \text{Wise})
  \end{align*}
  \]

- Type-theoretic semantics:
  \[
  \begin{align*}
  4 & : s : \text{Human} \\
  5 & : (s, p) : \Sigma x : \text{Human}.\text{Wise}'(x)
  \end{align*}
  \]

We can see that propositions (4) and (5) have the same logical form from the point of view of predicate logic (and of Montague grammar as its composite extension), while Smith’s theory and type-theoretic semantics distinguish logical form (4) and (5). However, in the case of Smith’s theory “instantiation”, and “exemplification” are relations that are defined on the same universal, and only in type-theoretic approach does the analysis of sentences (4) and (5) differ in principle at the level of syntax.

3.4. Accidental particulars in type-theoretic semantics

We considered the type-theoretic approach to substantial and accidental
universals as well as substantial particulars analysis. Is the type-theoretic interpretation of accidental particulars possible?\textsuperscript{12}

Why do we speak of accidental particulars as objects of a particular type? Consider the following sentences:

(6) \textit{Socrates’ wisdom differs from Plato’s wisdom}

(7) \textit{Basil does not like this shade of red}

In the semantics of sentences (6) and (7), we are dealing with a reference to abstract individuals. In these sentences, abstract individuals can be replaced by concrete ones:

(8) \textit{This apple differs from that apple}

(9) \textit{Basil does not like this apple}

The fact that such substitution is possible proves that we are dealing with individuals (particulars), but not with the same individuals as substantial particulars.

We believe accidental particulars can be described by means of type-theoretic semantics as follows: a special type will correspond to these entities type: \textit{AbstrPart} (abstract particulars). In order to point out the object of this type, it is necessary to consider a function that would in some way contrast substantial particulars and accidental particulars. For example, a function

\[
\text{wise}_\text{of}' : \text{Human} \rightarrow \text{AbstrPart}
\]

will match a man to an abstract individual exemplifying its wisdom.

This function\textsuperscript{13} could be defined more accurately as follows:

\[
\text{wise}_\text{of}' : \Sigma(\text{Human, Wise}) \rightarrow \text{AbstrPart}
\]

\textsuperscript{12}The question of the need to include accidental particulars in the ontology is the subject of actual discussions in analytical metaphysics, see [Campbell, 1990, Moltmann, 2005, Simons, 1994, Lowe, 1998, Moltmann, 2003], but no type-theoretic solution to this problem has been presented to date.

\textsuperscript{13}This function works only for those people who are proven to be wise.
4. **Type-theoretic semantics as overcoming “fantology”**

Having examined the basic ideas of type-theoretic semantics, we try and show that it is not a “fantological” theory, that is, type-theoretic semantics allows one to formulate ontological differences postulated by the ontological square.

How can one define entities differentiated by the ontological square in terms of type-theoretic interpretation?

Consider four entities: 1) “Human” (substantial universal); 2) “Socrates” (substantial particular); 3) “Wise” (accidental universal) and 4) “Socrates’ wisdom” (accidental particular).

What is the type-theoretic representation for each of these entities?

1. In type-theoretic semantics, substantial universals correspond to the base types of CN universe. For example, entities “Person” will correspond to the type $\text{Human}$. In this case, it is possible to distinguish between types the relation “<” (to be a proper subtype), which allows us to express the sentence "All men are human" as follows:

   $$\text{Man} < \text{Human}$$

2. In type-theoretic semantics, substantial particulars correspond to objects of substantial universals. For example, “Socrates” is interpreted as an object populating type $\text{Human}$.

3. Accidental particulars in type-theoretic semantics would correspond to predicates with varying domain. It is important to note that one of the differences in type-theoretic semantics from Montague grammar is multifaceted typology; in type-theoretic typology object types “$e$” are divided into subtypes that allows for more subtle analysis of substantial particulars properties: the function domain corresponding to the property becomes a concrete type of common noun but not the whole set of objects.

   This approach allows us to analyze the sentence “Table is dancing” (in its literal non-metaphorical use) as meaningless, and not as false (as it would be analyzed in Montague grammar).

   Therefore, the presence of substantial and accidental properties will be described differently in type-theoretic semantics. The sentence “Socrates is human” is defined as an assertion of an object belonging to type

   $$s: \text{Human}.$$  

The sentence “Socrates is wise” is described as a judgment
It should be noted that this variety of type-theoretic semantics is constructed in a proof-theoretic, rather than in model-theoretic way. Compositionality in semantics of this type is based on the application of inference rules. For example, the calculation of the value of the whole sentence “Socrates is wise” (in semantics of which it is implied that Socrates is a human) is done through the application of the rule of introducing a dependent sum:

\[
\Gamma \vdash s : Human \quad \Gamma \vdash p : Wise'(s)
\]

\[
\Gamma \vdash (s, p) : \Sigma x : Human.Wise'(x)
\]

4. Within the type-theoretic framework, accidental particulars are taken to correspond to a special type

\[AbstrPart\]

that is filled with such entities as “Socrates’ wisdom”, “this shade of white”, “Helen’s beauty”, etc (in metaphysics such objects are referred to as “tropes”). Compared to concrete objects it is hard to refer to abstract objects through their names, so it is convenient to create a function that would make some sort of a correspondence between a concrete and an abstract object. For example:

\[wise'_of : Human \rightarrow AbstrPart, –\]

a function that contrasts a human to an abstract individual. We present the semantic analysis of four entities in Table 3.

Table 3. The ontological square in type-theoretic interpretation

<table>
<thead>
<tr>
<th>1. substantial universals</th>
<th>3. Accidental universals</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Human”</td>
<td>“Wise”</td>
</tr>
<tr>
<td>(Human : Type)</td>
<td>(wise' : Human \rightarrow Prop)</td>
</tr>
<tr>
<td>2. substantial particulars</td>
<td>4. Accidental particulars</td>
</tr>
<tr>
<td>“Socrates”</td>
<td>“Socrates’ wisdom”</td>
</tr>
<tr>
<td>(s : Human)</td>
<td>(wise'_of(s) : AbstrPart)</td>
</tr>
</tbody>
</table>
5. Conclusion

It should be noted that this paper does not attempt to propose an ontological thesis; the question of the truthfulness or the adequacy of the ontological square as a metaphysical theory was also omitted. Our thesis is a weaker one: we have tried to demonstrate that type-theoretic semantics, firstly, can be considered as a relevant method for formalizing entities that are different in the ontological square. Secondly, compared to B. Smith’s solution, it has a number of advantages such as compositional analysis and a syntactically different interpretation of substantial and accidental entities.

Acknowledgements. The article was prepared within the framework of the Academic Fund Program at the National Research University Higher School of Economics (HSE) in 2017–2018 (grant № 17–05–0040) and by the Russian Academic Excellence Project “5-100”.

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«Онтологический квадрат» и теоретико-типовая семантика*

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Аннотация: Настоящая статья посвящена конкретному эпизоду в большой дискуссии о соотношении семантики и онтологии: а именно, поиску адекватной семантической интерпретации для набора сущностей, постулируемых так называемым «онтологическим квадратом» или «четырех-категорными онтологиями».

Онтологическим квадратом называется теория, восходящая к работам Аристотеля (в частности, ко второй главе трактата «Категории») и утверждающая необходимость различения между четырьмя типами сущностей: субстанциальными универсалиями, субстанциальными партикуляриями, акцидентальными универсалиями, акцидентальными партикуляриями.

В программной статье «Против Фантологии» Б. Смит пытается продемонстрировать, что онтологический квадрат не может быть адекватно описан в рамках логики предикатов. Б. Смит упрекает Г. Фреге в том, что тот, будучи отцом современной логики, стал одновременно и отцом «фантологии», теории, в рамках которой все разнообразие сущностей сводится к объектам («а») и предикатам («F»).

Избавление логики от «фантологии», с точки зрения Б. Смита, возможно благодаря обогащению логики предикатов целым набором отношений, которые соответствуют допущениям «онтологического квадрата» и тем самым обогащают постулируемую логическими теориями систему онтологических допущений. С нашей точки зрения, подход Б. Смита обладает рядом недостатков: формулируемая им теория рассматривает в качестве универсалий только предикаты разного типа. То есть, богатая система отношений, которая предлагается в рассматриваемом подходе, не лишена «фантологических» черт.

* Статья подготовлена в результате проведения исследования (проект № 17–05–0040) в рамках Программы «Научный фонд Национального исследовательского университета “Высшая школа экономики” (НИУ ВШЭ)» в 2017–2018 гг. и в рамках государственной поддержки ведущих университетов Российской Федерации «5–100».
все рассматриваемые Б. Смитом отношения на уровне метаязыка соответствуют множеству кортежей.

В настоящей статье мы предлагаем другой вариант формализации сущностей, постулируемых «онтологическим квадратом» — вариант, который базируется на теоретико-типовой семантике и обладает рядом преимуществ перед подходом Б. Смита.

Мы оставляем за скобками вопрос об истинности или адекватности «онтологического квадрата» в качестве метафизической теории. Наш тезис носит более слабый характер: мы постарались продемонстрировать, что теоретико-типовая семантика может рассматриваться как релевантный инструмент для формализации сущностей, которые различаются в «онтологическом квадрате».

Ключевые слова: теория типов, онтологический квадрат, формальная семантика


Литература


