Towards a Bridge between Cognitive Linguistics and Formal Ontology

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To build an ontology of a domain, it is necessary to categorize this domain with objects, relations between objects, process acting onto objects, process transforming a state and building an event and so on ... Often, these different entities and relations must be identified inside linguistic segments (nominal phrases, clauses, sentences, paragraphs titles •..) by means of syntactic and semantic annotations. The Cognitive and Applicative Grammar (CAG) is a polystratal model (Desclés, 1990, 2004, 2005), that extends the Shaumyan's Universal Applicative Grammar (1987). This model opens a way towards a sound bridge between Formal Ontology, Logics, Cognitive Linguistics and Natural Language Processing to annotate texts.

The underlying formalism of all levels of CAG is always applicative or functional one. We consider the follow applicative scheme (AS) $[\xi_1 = \omega @ \xi_0]$, where ξ_1 is the place of the result build by the application, designated by '@' of an operator at the place 'ω' in (AS), acting onto an operand in the place 'ξ_0' in (AS). Fundamental distinctions are basic: operator, operand, object (individual or class). Operator/operand is context relative since the same applicative expression can either be an operator applied to an operand, sometimes to itself, or an operand of another operator. However, by definition and following Frege, an "object" is never an operator and it cannot stand for the place 'ω' in (AS).

While describing specific domains by ontologies, it is useful, on one hand, to take into account different types of entities and, on other hand, to compose basic operators by means of composition schemes. The Church's functional types are used to generate, at different levels, different types of operators with the following rules: (i) basic types are functional types; (ii) IF α and β are functional types THEN $\underline{F}\alpha\beta$ is the functional type of operators that can be applied to

operands with the type α for building results with the type β . The composition mechanisms are described inside the Combinatory Logic of Curry (1958) by abstract operators, called "combinators"; these abstract operators combines more elementary operators, by intrinsic ways - that is independently of interpretations inside any domain – for building new and more complex operators. For instance, the composition of functions (or operators) in set theory is realized with the combinator '**B**' that is applied to the two operators 'f' (with the type $\underline{F}\beta\gamma$) and g (with the type $\underline{F}\alpha\beta$) to build the complex' operator '(**B**@f)@g)' (with the type $\underline{F}\alpha\gamma$) and such that $(((\textbf{B}@f)@g)@ \ a \rightarrow f@(g@a)$.

The Combinatory Logic with types is a sound formalism (with different results and algorithmic process of reductions of complex expressions), able to unify: (i) syntactic descriptions given by Categorial Grammars using the adjunction of some combinators for making compositions of syntactic units (with syntactic annotations) in linguistics and logics (for instance, to formalize different types of predication, of quantification, of determination, to build singular objects from predicates ...) ; (ii) the study of categorization process of objects (typical and atypical objects, determined and undetermined objects) with Logics of Determination of Objects (LDO) that establishes formal relations between "extension" and "intension" of a concept (Desclés, 2002; Desclés and alii, Flairs); (iii) to associate applicative descriptions to sentences of different natural languages - by reducing process to elementary sentences -, and to give a first semantic applicative interpretation of sentences, with only operators applied to operands of different (semantic) types; (iv) to define more semantic descriptions, with semantic-cognitive schemes (SSC), applicative expressions formalizing semantic notions of natural languages and also some concepts of philosophy

(for instance the phenomenology) used in Formal Ontology.

CAG is a logical and linguistic model with three levels of applicative representations, where each level is formally articulated with the other. In a bottom up presentation, we describe these levels as follows: (i) the first level contains the syntactical and morphological configurations of sentences and texts; Extended Categorial Grammars, seen as Grammars of operators (whose functional types represent syntactic categories) are formal devices used to annotate sentences in a text; (ii) from the results obtained on the first level, the second level expresses the applicative decompositions into operators and operands of sentences and texts; the calculus of reduced expressions (whose the unicity follows from the Church-Rosser' s theorem) leads towards semantic interpretations of grammatical operators (abstract cases - Agent, Localizer, Instrument, Experiencer . . . - , tenses and aspects, modalities, voices, ...) (Desclés, 1990, 2005); (iii) At the third level, the semantic representations of the meanings of lexical predicates and lexical operators are built from the lower level, in terms of "change", "movement", "control of change or movement by an agent", "intentional teleonomy which aim is fixed", "locating an object inside a locus", "topological determinations of loci (temporal, spatial, abstract loci)".

In general, each unit (a *definiendum)* from any level is decomposed into a complex of more elementary units (its *definiens)* of an upper level, the relation between *definiendum* and *definiens* being described by a combinator (an operator for a semantic composition). By using Curry's Combinatory Logic (a logic without bound variables), and not the Church's λ-calculus, deductions are easer and more explicit, from a computing viewpoint, since we do not have to manage the changes of names of bound variables during a deduction process (Desclés, 2004, 2005)

The model of CAG, essentially with the third level, is an useful tool to define and to formalize the general representations in the semantic of natural languages, by means of cognitive and formal conceptualizations, more complex than the descriptions with only boolean features. It permits to give different (syntactic and semantic) annotations in texts in a Web-semantic perspective, in complement of the EXCOM methodology (Desclés and alii, Flairs) with "semantic maps" (for a processing of discursive categories). The talk will present the general concepts of CAG and its cognitive and computational architecture, the applicative underlying formalism with the help of some illustrative examples.

References

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