

An ontology of descriptions and situations for Lyee's hypothetical world

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Abstract. Lyee is not only a tool for generating code in a language, but also a methodology with a solid philosophical background and cognitive basis. We can even envisage the existence of a Lyee's "hypothetical world", as stated by its inventor, Fumio Negoro. In this paper we present an ontology of descriptions and situations designed with a cognitive approach and we investigate its relationships with the world of Lyee, its methodology and hypothetical assumptions.

1. Introduction

From a practical point of view, Lyee can be seen as a tool for generating code in a language, for example Visual Basic. But Lyee is also a methodology for software design based on the "philosophical observation on the very nature of cognition", as Indurkha points out [1].

If we do not regard Lyee as a simple tool, but we consider the universe of its complex theoretical constructs, we can envisage the existence of a Lyee's "hypothetical world", as defined by its inventor, Fumio Negoro. Such world consists of recognizable existence, unrecognizable existence and relationships between these two [2].

In this paper we present an ontology of descriptions and situations designed with a cognitive approach and we investigate its relationships with the world of Lyee, its methodology and hypothetical assumptions.

The descriptions and situations ontology allows us to represent situations and contexts and has been applied to several domains. It has been designed as a plug-in to the DOLCE (Descriptive Ontology for Linguistic and Cognitive Engineering) *foundational ontology* [3].

A foundational ontology contains a description of the basic kinds of entities and relationships that are assumed to exist in some domain, such as process, object, time, part, location, representation, etc. DOLCE is a cognitively-oriented ontology, based on primitive space and time, 3-dimensional intuition (objects are disjoint from processes), distinction between physical and intentional objects, etc. DOLCE is a descriptive ontology, because it helps categorizing an already formed conceptualization: it does not state how things are, but how they can be represented according to some existing knowledge.

In this paper we sketch out the main features of foundational ontologies, then we shortly introduce DOLCE foundational ontology and the Descriptions and Situations (D&S) ontology, showing their analogies with Lyee's ontology.

2. Foundational ontologies

Ontologies are the fundamental infrastructures for modern interoperable information systems and are the groundwork for implementing the so-called *Semantic Web*.

But what kinds of ontologies do we need? This is still an open issue. Some people believe that *upper level* ontologies are important, others think they are a waste of time, and prefer

to concentrate on *lightweight* ontologies, focusing on the minimal terminological structure (often just a taxonomy) which fits the needs of a specific community.

The point is that ontologies can be used in different ways. On one hand, for instance, they can be used for semantic access to a specific resource; in this case the intended meaning of a single term is more or less known in advance, and the ontology can be limited to those structural relationships among terms which are relevant for the query (in many cases, taxonomic relationships are enough).

On the other hand, ontologies can be used to negotiate meaning, either for enabling effective cooperation between multiple artificial agents, or for establishing consensus in a mixed society where artificial agents cooperate with human beings. This is a completely different task for ontologies, which requires the explicit representation of ontological commitment in terms of a rich axiomatization. The axiomatization's purpose is to exclude terminological and conceptual ambiguities, due to unintended interpretations. In general, meaning negotiation is of course an extremely hard task (both conceptually and computationally), but it only needs to be undertaken once, before a cooperation process starts.

We use the term *foundational ontologies* for the ontologies aimed at negotiating meaning, ultimately devoted to facilitate mutual understanding. Our vision is to have a *library* of such ontologies, reflecting different commitments and purposes, rather than a single monolithic module. Indeed, we believe that the most important challenge for the Semantic Web is not so much the agreement on a monolithic set of ontological categories, but rather the careful isolation of the fundamental ontological options and their formal relationships.

In our view, each module in this library should be described in terms of such fundamental options. Rationales and alternatives underlying the different ontological choices should be made as explicit as possible, in order to form a network of different but systematically related modules which the various Semantic Web applications can commit to, according to their ontological assumptions. In this view, making people (and computers) understand one another (and possibly understanding the reasons of ontological disagreement) is more important than enforcing interoperability by the adoption of a single ontology.

In short, a foundational ontologies library has to serve as:

- a starting point for building new ontologies. One of the most important and critical questions when starting a new ontology is determining what things there are in the domain to be modeled. Adopting a high level view provides an enormous jump start in answering this question;
- a reference point for easy and rigorous comparisons among different ontological approaches;
- a foundational framework for analyzing, harmonizing and integrating existing ontologies and metadata standards (by manually mapping existing categories into the categories assumed by some module(s) in the library).

In addition, we intend the library to be:

- *minimal* – as opposed to other comprehensive ontology efforts, we intend the library to be as general as possible, including only the most reusable and widely applicable upper-level categories;

- *rigorous* – where possible, the ontologies in the libraries will be characterized by means of rich axiomatizations, and the formal consequences (theorems) of such characterizations will be explored in detail;
- *extensively researched* – each module in the library will be added only after careful evaluation by experts and consultation with canonical works. The basis for ontological choices will be documented and referenced.

3. DOLCE: a Descriptive Ontology for Linguistic and Cognitive Engineering

The first module of our foundational ontologies library is a Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE). According to our vision, we do not intend DOLCE as a candidate for a “universal” standard ontology. Rather, it is intended to act as starting point for comparing and elucidating the relationships with other future modules of the library, and also for clarifying the hidden assumptions underlying existing ontologies or linguistic resources such as WordNet.

As reflected by its acronym, DOLCE has a clear *cognitive bias*, in the sense that it aims at capturing the ontological categories underlying natural language and human commonsense. We believe that such bias is very important for the Semantic Web (especially if we recognize its intrinsic social nature [4]). We do not commit to a strictly referentialist metaphysics related to the intrinsic nature of the world: rather, the categories we introduce here are thought of as cognitive artifacts ultimately depending on human perception, cultural imprints and social conventions (a sort of “cognitive” metaphysics). We draw inspiration here from Searle’s notion of “deep background” [5], which represents the set of skills, tendencies and habits shared by humans because of their peculiar biological make up, and their evolved ability to interact with their ecological niches. The consequences of this approach are that our categories are at the so-called mesoscopic level [6], and they do not claim any special robustness against the state of the art in scientific knowledge: they are just descriptive notions that assist in making already formed conceptualizations explicit. They do not provide therefore a prescriptive (or “revisionary” [7]) framework to conceptualize entities. In other words, our categories describe entities in an *ex post* way, reflecting more or less the surface structures of language and cognition.

DOLCE has four top categories: *endurant* (including object- and substance-like entities), *perdurant* (event- and state-like entities), *quality* (individual attributes), and *abstracts* (mainly conceptual regions for structuring attributes). Some of the basic “leaf” categories defined in DOLCE are reported in Table 1.

It is not in the purpose of this paper to present DOLCE in detail (see for example [8]). Here we would like to point out some analogies between DOLCE and Lyee’s ontology, for example the antinomy *endurant* / *perdurant*.

In fact, DOLCE is based on a fundamental distinction between *enduring* and *perduring* entities, i.e. between what philosophers usually call *continuants* and *occurents* [9], a distinction still strongly debated both in the philosophical literature [10] and within ontology standardization initiatives. Again, we must emphasise that this distinction is motivated by our cognitive bias, and we do not commit to the fact that both these kinds of entity “do really exist”.

Classically, the difference between enduring and perduring entities (which we shall also call *endurants* and *perdurants*) is related to their behavior in time. Endurants are wholly present (i.e., all their proper parts are present) at any time they are present. Perdurants, on the other hand, just extend in time by accumulating different temporal parts, so that, at any

time they are present, they are only partially present, in the sense that some of their proper temporal parts (e.g., their previous or future phases) may be not present. E.g., the piece of paper you are reading now is wholly present, while some temporal parts of your reading are not present any more. Philosophers say that endurants are entities that are in time, while lacking however temporal parts (so to speak, all their parts flow with them in time). Perdurants, on the other hand, are entities that happen in time, and can have temporal parts (all their parts are fixed in time).

<i>basic category</i>	<i>examples</i>
Abstract Quality	<i>the value of an asset</i>
Abstract Region	<i>the (conventional) value of 1 Euro</i>
Accomplishment	<i>a conference, an ascent, a performance</i>
Achievement	<i>reaching the summit of K2, a departure, a death</i>
Agentive Physical Object	<i>a human person (as opposed to legal person)</i>
Amount of Matter	<i>some air, some gold, some cement</i>
Arbitrary Sum	<i>my left foot and my car</i>
Feature	<i>a hole, a gulf, an opening, a boundary</i>
Mental Object	<i>a percept, a sense datum</i>
Non-agentive Physical Object	<i>a hammer, a house, a computer, a human body</i>
Non-agentive Social Object	<i>a law, an economic system, a currency, an asset</i>
Physical Quality	<i>the weight of a pen, the color of an apple</i>
Physical Region	<i>the physical space, an area in the color spectrum, 80Kg</i>
Process	<i>running, writing</i>
Social Agent	<i>a (legal) person, a contractant</i>
Society	<i>Fiat, Apple, the Bank of Italy</i>
State	<i>being sitting, being open, being happy, being red</i>
Temporal Quality	<i>the duration of World War I, the starting time of the 2000 Olympics</i>
Temporal Region	<i>the time axis, 22 june 2002, one second</i>

Table 1. Some DOLCE basic “leaf” categories.

Lye has a similar antinomy, by distinguishing between *the changing world* and *the unchanging world*, although with a different approach which does not reflect the constructs of Western philosophy, but relating the unchanging to the whole and the changing to the part [2].

Part and whole also play a role in DOLCE's endurants and perdurants, but in a different way. Endurants can change in time, in the sense that the very same endurant as a whole can have incompatible properties at different times; perdurants cannot change in this sense, since none of their parts keeps its identity in time. To see this, suppose that an endurant say “this paper” has a property at a time t “it’s white”, and a different, incompatible property at time t' “it’s yellow”: in both cases we refer to the whole object, without picking up any particular part of it. On the other hand, when we say that a perdurant “running a race” has a property at t “running fast” (say during the first five

minutes) and an incompatible property at t' “running slow” (say toward the end of the race) there are always two different parts exhibiting the two properties.

Another way of characterizing endurants and perdurants – quite illuminating for our purposes – has been proposed recently by Katherine Hawley: something is an endurant iff (i) it exists at more than one moment and (ii) statements about what parts it has must be made relative to some time or other [11]. In other words, the distinction is based on the different nature of the parthood relation when applied to the two categories: endurants need a time-indexed parthood, while perdurants do not. Indeed, a statement like “this keyboard is part of my computer” is incomplete unless you specify a particular time, while “my youth is part of my life” does not require such specification.

In DOLCE, the main relation between endurants and perdurants is that of *participation*: an endurant “lives” in time by participating in some perdurant. For example, a person, which is an endurant, may participate in a discussion, which is a perdurant. A person’s life is also a perdurant, in which a person participates throughout its all duration.

4. Descriptions, situations and reification

The Descriptions and Situations ontology (D&S) is an attempt to define a theory that supports a first-order manipulation of theories and models, independently from the particular foundational ontology it is plugged in [12].

In general, D&S commits only to a widespread and very ancient ontological distinction between flux, or an unstructured world or context, and logos, or an intentionality. D&S is neutral with respect to realism issues, such as whether we conceive a structure because it is in the flux, or because it is in our intentionality. D&S as a representation mechanism makes no pretense in either direction. Hence, a flux can have as many inherent structure (parts, boundaries, qualities, etc.) as one might want to believe in or might claim to have discovered, but without a logos, a flux would have no description of that structure.

When logos is applied to the description of the flux, some structure emerges (this reflects the so-called structuring cognitive process). The emerging structure is not necessarily equivalent to the actual structure.

Due to its neutrality with respect to realism, D&S can generalize the flux/logos distinction, in order to obtain an epistemological layering. Epistemological layering consists of assuming that any logical structure L_i (either formal or capable of being at least partly formalised) is built upon a flux-like structure that it describes according to a more abstract, logos-like theory T_i (either formal or capable of being at least partly formalised).

In other words, T_i describes what kind of ontological commitment L_i is supposed to have within the epistemological layer that is shared by the encoder of an ontology O .

D&S implements reification rules for any T_i , called a description, and a basic framework for any L_i , called a situation.

Flux-like structures are not reified in D&S, but they result to be the structures that include all the (ground) logical dependencies of the components of a situation S classified within an ontology O , plus any additional elements that could be part of the ground context of S according to some encoder of O , but that are not inside O . A flux-like structure is called a *state of affairs* (SOA) in D&S. Any element of a SOA that is outside O is called external to that SOA.

Within DOLCE, D&S is plugged in as follows. A situation is a (new) top category, a description is a non-physical endurant. Description is disjoint from situation. A description may be satisfied by a SOA. The satisfaction relation is reified in D&S as a first-order

referenced-by relation. A description satisfied by a SOA is an s-description. A SOA satisfying a description is a situation.

Examples of descriptions and situations include:

- A clinical condition (situation) has an associated diagnosis (s-description) made by some agent.
- A case in point (situation) is constrained by a certain norm (s-description)
- A murder (situation) has been reported by a witness (functional role) in a testimony (s-description)
- Information science as a topic (s-description) references the manipulation of data structures (situation), both as a pure or applied science (parent s-descriptions)

D&S supports reification of descriptions into situations and - in general - concept from a theory are logically reified as individuals. There is a similar abstract mechanism in Lyee which is called *objectification*. Its task - according to Negoro - is "to create existence that has a mass from something that does not possess a mass".

D&S results to be a theory of ontological contexts because it is capable to describe various notions of context (physical and non-physical situations, topics, provisions, plans, assessments, beliefs, etc.) as first-order entities.

Lyee's hypothetical world, on the other hand, does not explicitly formalize contexts, however it has a strong commitment with respect to considering cognitive issue, intentions and personal interpretations.

5. Conclusions

In current Western philosophy, two positions are roughly opposed as far as ontology is concerned: *skeptical* or *constructivist* against *metaphysical*. There are many variants and intermediate positions, but the main argument can be stated according to that opposition.

Constructivism assumes that epistemology is more relevant than ontology, since ontological categories are built by humans according to the available knowledge of the world, or based on particular needs. More generally, constructivism assumes *context-dependence* of an ontological commitment. On the contrary, (prescriptive) metaphysicians assume that ontology should aim at stating actual, 'true' categories, prior to whatever epistemological investigation.

Due to its flexibility, the skeptical position seems in general more adequate to the heterogeneous set of domains taken into account by today's information systems. Due to its rigidity, the metaphysical position can hardly produce a widely-scoped, "tolerant" foundational ontology, able to describe alternative, even conflicting ontological commitments.

On the other hand, the investigation methods and the principles adopted by metaphysicians are very precious in order to construct foundational ontologies, even though they are not based on metaphysical assumptions. Therefore in our approach, although we take profit from the millenary philosophical debate around metaphysical themes, we do adopt the constructivist position.

It is not easy to assess how our ontological commitments can contribute to the world of Lyee and, conversely, in which way our ontology can benefit from Lyee. We have shown that some ontological assumptions made in Lyee present interesting similarities with our foundational ontology. However, Lyee's ontological commitments reflect a conceptualization which, for instance, do not adhere to the classic Western philosophy distinction between *endurant* (e.g. an object) and *perdurant* (e.g. a process). Lyee recognizes a similar duality, but with different definitions, as discussed in section 3 of this paper.

We are not surprised by cultural diversities and different approaches. They just remind us that ontologies are arbitrary cultural artifacts and reflect different cultural conceptualization of the world. Every different interpretation of the reality enriches the cultural debate and contribute to the cross-fertilization of knowledge between East and West.

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