ONTOLOGY: from Philosophy to ICT and related areas

Abstract. This paper briefly highlights the development of the concept Ontology, from its philosophical roots up to its vision in the ICT field and related areas. Philosophically, Ontology is a systematic explanation of Being that describes the features of Reality. Nowadays Ontology is proliferating in organizing Knowledge of different domains managed by advanced computer tools. Ontology qualifies and relates semantic categories, dragging, however, the idea of what, since the seventeenth century, was a way to organize and classify objects in the world. Ontology maximizes the reusability and interoperability of concepts, capturing new Knowledge within the most granular levels of information representation. Ontology is subjected to a continuous process of exploration, formation of hypothesis, testing and review. Ontological thesis proposed today as true, tomorrow may be rejected in light of further discoveries and new and better arguments.

Keywords: ontology, knowledge, semantic, interoperability, computer science.

1. Introduction

Webster’s Third New International Dictionary defines Ontology as “1. a Science or study of Being; specifically, a branch of Metaphysics relating to the Nature and relations of being; 2. a Theory concerning the kinds of entities and specifically the kinds of abstract entities that are to be admitted to a language system”. Literally, the word Ontology comes from the Greek ὄντος (önos) and λόγος (lōgos), that means “speech about Being”, but may also derive explicitly from τὰ ἄνθρωπα (entities) variously interpreted according to different philosophical points of view.

Philosophical ontology building is related with providing category systems that stand for a certain vision of the world. Aristotle, who considered Ontology a branch of Metaphysics, was the pioneer in proposing the first known category system in relation to what is judged to exist in practice and, in a broader sense, as the investigation of Being beyond its borders through which it is manifested to us in appearances. Heidegger conceived Ontology as a "phenomenology of the exploration" of what there "is" and in how it turns out [3;8]. The ontological conceptualization, as a cohesive philosophical area, was introduced in 505-504 BC by Parmenides. He was the first to pose the argument about Being in its totality, presenting issue of the ambiguity among the conceptual level, Ontology and language. Parmenides recognized the ontological dimension as dominant able to subject to itself any other aspect of Philosophy. Over the centuries, the meaning of Ontology was changing depending on different visions and knowledge of other philosophers: Leucippus, Democritus, Plato, Aristotle, Descartes, Kant, Lorhard, Hegel, Trendelenburg, Brentano, Stumpf, Meinong, Husserl, Heidegger, Gockel [8]. Some of them gave more value to an absolute principle, another to the empirical things largely based on experience, thus enriching the heritage of Philosophy with the question of what is considered "par excellence" (the problem of existence in its fullest extent and universality: the relationship
between particular and universal, intrinsic and extrinsic, essence and existence).

2. Towards a new Ontology

The advent of Semantic web [2; 3], aimed at multi-objective optimization of ICT environment and technological innovation in general, has coined a new vision of "doing Philosophy" and, as a result, of a "new Ontology" so that it is considered today as "formal, explicit specification of a shared conceptualization" [17]. Representing a set of shared conceptual meanings, different Ontologies cover a quite wide range of practical realizations: from simple organizations of terms (very similar to Thesauri) to conceptual taxonomies and formal Ontologies [21], thus forming the explicitly defined Models of Knowledge representation, the elements and relations of which are defined by specific vocabularies and written in a machine-readable languages [4; 18; 27; 28; 31; 33; 34].

Studies dedicated to the construction of Ontologies as semantic organizations in themselves and as semantically based tools for managing documents on the Web are covering today a broad interdisciplinary area, involving Philosophical speculation [13], the researches in Artificial Intelligence [9] and different scientific domains dedicated to Knowledge Management [17; 25]. In recent years, the modern approaches of Ontology have been related closely to issues of Content Management [37] regarding innovative problem solving techniques and new methods of electronic data management in e-commerce, on-line marketing, business management [29] etc. There has been also created a strong connection between issues traditionally studied in the sphere of Library and Information Science [24] and research and applications developed in advanced fields of Computer Science [35], where Ontologies have been viewing under the vision of the Ontology object, focusing on its nature, characteristics, core notions and lifecycle as well as of the Ontology engineering that is the branch of Knowledge Modelling, developing ontology-oriented computable models of some knowledge domains, focusing on the rationale design and the assisting tools [15]. Today in Digital Libraries and other Knowledge portals for scientific and cultural information resources [26; 38] it is of great interest to integrate computer Ontologies as new "software components" of information systems with Cataloging systems using semantic Metadata [10; 36] in order to improve deductive reasoning with natural language, to enhance automatic classification, to promote cross-cultural and intercultural communication in CMC [12], as well as to improve interoperability among different computer systems.

Almost every knowledge domain can be represented through an Ontology, the idea behind it is to entrench semantic meaning to the describing data. Ontology helps to retrieve better the information, providing meaningful suggestions to different users as well as giving the possibility for searching not just by the keywords but by the meaning of those keywords [14]. To enhance the quality of Information Retrieval it is of a great importance to normalize Ontological categories through well-constructed specific lexical resources such as terminologies [19] and Thesaurus [5] as well as to harmonize different Ontology-oriented systems through ontology interoperable standards, that enable two or more information systems to exchange met(data) with minimal loss of information [1]. The Philosophical study in the ICT field reflects the need to affirm the theoretical modalities of Ontology on the basis of comparisons between alternative theories, models and conceptual frameworks and to contribute to investigation of modern ontological approaches such as "Ontological Engineering", "Ontology Learning", "Ontology-based metadata integration methodology", "Design of Ontologies used for Knowledge Sharing" etc.

3. Evolving contexts, problems and perspectives

"Ontology is a description (like a formal specification of a program) of the concepts and relationships that can exist for an agent or a community of agents. This definition is consistent with the usage of Ontology as set of concept definitions, but more general. And it is a different sense of the word than its use in Philosophy" [16]. The different levels of generality, achieved in the modeling of ontological concepts and relationships, determine different types of Ontologies, targeted to satisfy multiple information purposes. According to Guarino [19;20], there are Top-level (Upper-level, Foundational), Domain, Task and Application Ontologies which we summarized schematically in Figure 1.
Moreover Ontology can be Formal, Descriptive and Formalized. The first one was introduced by Husserl [23], who described the leading regional concepts, proceeding with the eidetic lessening method coupled with the method of categorical intuition. According to Cocchiarella [6] “Formal Ontology is the result of combining the intuitive, informal method of classical Ontology with the formal, mathematical method of modern symbolic logic”. Descriptive Ontology concerns a set of information about dependent or independent items (real or ideal objects), while Formalized Ontology attempts to construct a formal codification for the results descriptively acquired at the preceding levels.

Ontology intended as a first-order axiomatic theory and expressed by a description logics [36] is fundamental to design advanced Knowledge Based software systems [11;20]. Currently, these systems in different Knowledge domains are designed in various ways, so that they often cannot share data with each other, being structured on local purposes. Indeed, even today many scholars often fail to agree about a common interdisciplinary methodology for Ontology modeling, so they continue to work independently of each other, pursuing separately their different approaches. Persists, therefore, the need to establish more general frameworks, defined to make the Ontological Models useful to provide a general description (and a good interoperable functioning of different programs) consistent for multiple domains in question. Here there is a clear need for the rigorous use of qualitative foundational domain theories and insights from Philosophical Ontology that can improve the collaborative approach to Ontology design [22]. The philosophical reflection on a “new Ontology” should become an appealing challenge in creating new scientific environments in which philosophers and other scholars can meet to discuss and develop strategies for classifying and organizing data to be shared efficiently and to describe and implement qualitatively the reality of different conceptual domains [30;31;32].

In Figure 2 we can observe philosophical reflection in the field of Computer Science and Information Technology [7;13;18;35]. Here Thought (which is regulatory/normative to Reality) is connected through Language (which defines the existing categories reflecting Thought and Reality) with Ontology and Epistemology, creating the descriptive and prescriptive approaches. Ontology refers to objective validity [23] of terminology waiting to be discovered by domain knowledge experts and Epistemic (providing model reasoning in class-based representation formalisms through description logics).

**Figure 1. Classes of Ontologies**

<table>
<thead>
<tr>
<th>Top-level Ontology</th>
<th>Domain Ontology</th>
<th>Task Ontology</th>
<th>Application Ontology</th>
</tr>
</thead>
<tbody>
<tr>
<td>describes very general concepts like space, time, event independent of a particular domain</td>
<td>describes the vocabulary related to generic domain by specializing concepts introduced in the top-level Ontology</td>
<td>describes the vocabulary related to a generic task or activity by specializing the top-level Ontology</td>
<td>concepts often correspond to roles played by domain entities</td>
</tr>
</tbody>
</table>
Automated reasoning and Ontology manipulation in description logics allow to present and emulate the human logic-based knowledge of entities in different domains, managing simultaneously dissimilar types of objects (concrete and abstract, independent and dependent) and their ties (relations, dependencies and predications). Consolidation in the current pattern of reasoning of information systems of Epistemic and Ontological philosophical approaches aims to transform existing information services in high quality digital environments, where the published documents (HTML pages, XML files, images etc.) are associated with descriptive semantic metadata, thus better specifying the semantic context in a format suitable to different ontology queries, their interpretation and, more generally, to the automatic elaboration of highly granular information content. This approach can provide computer programs with more advanced information retrieval functionalities as well as with other specialized operations such as the implementation of intelligent networks with semantic connections among heterogeneous digital content objects of different computerized information systems at the international level.

Considering a plentiful cognitive background of different Ontologies (Cyc, Wordnet, SUMO etc.) reflected through different modeling canons and descriptive languages (CycL, XML Schemas, KIF, OWL, RDFS, RDF, SKOS etc.) it remains an appealing challenge to bring everything to a single knowledge sharing paradigm that is not easy nor immediate task, considering also that the sharing of knowledge resources requires to overcome non-trivial technological obstacles. Also it is still very vague to understand how Ontologies can be created and maintained within applications having to ensure their consistency and validity vs. time and the evolution of information technology. And here, once again, an important role must be played by Philosophical Ontology which, through its excellent logic explanation, should contribute to the creation of a fundamental and enduring Ontology in digital environment, although this task requires time and an enormous effort in "negotiation among different parts" for the reconciliation of various viewpoints and needs, most notably those represented by different semantic systems associated with language differences.

References


