A PHILOSOPHICAL APPROACH TO UPPER-LEVEL ONTOLOGIES

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF ARTS
IN
THE DEPARTMENT OF PHILOSOPHY

SEPTEMBER 2015

Approval of the Graduate School of Social Sciences

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ABSTRACT

A PHILOSOPHICAL APPROACH TO UPPER-LEVEL ONTOLOGIES

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September 2015, 101 pages

The aim of this thesis is to provide a philosophical approach to upper-level ontologies. The ontologies and/or categorical system of Aristotle, Kant, Husserl, and Quine are evaluated in order to give a philosophical understanding of ontologies. After an explanation of the developments in ontology as a new interdisciplinary study, the most well known upper-level ontologies, BFO, DOLCE, SUMO, and Cyc, are analysed technically. In the light of philosophical ontologies and categorical systems, these upper-level ontologies are criticised in terms of the fundamental constituents of upper-level ontologies.

Keywords: ontology, upper-level ontologies, philosophical approach

ÖZ

ÜST DÜZEY ONTOLOJİLERE FELSEFİ YAKLAŞIM

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Yüksek Lisans, Felsefe Bölümü

Tez Yöneticisi: Doç. Dr. Aziz Fevzi Zambak

Eylül 2015, 101 sayfa

Bu tezde üst düzey ontolojiler felsefi bir bakışla analiz edilmiştir. Ontolojinin felsefi olarak nasıl ele alındığını göstermek için Aristoteles, Kant, Husserl ve Quine'nın ontolojileri ve/veya kategori sistemleri incelenmiştir. Disiplinlerarası bir bilim olarak karşımıza çıkan ontolojinin gelişmesi anlatıldıktan sonra, en çok tanınan üst düzey ontolojilerden BFO, DOLCE, SUMO ve Cyc teknik özellikleri bakımından analiz edilmiştir. Felsefi ontolojilerin ve kategori sistemlerinin ışığı altında, bu üst düzey ontolojiler, üst düzey ontolojilerin temel yapıtaşlarına göre araştırılmıştır.

Anahtar Kelimeler: ontoloji, üst düzey ontoloji, felsefi yaklaşım

To Truth and Beauty,
and to the those who partake of the both

ACKNOWLEDGMENTS

In spite of many difficulties, this thesis has been completed. I owe my gratitude to all lovely people who made this work possible.

My deepest gratitude is to my supervisor, Aziz Fevzi Zambak, without whose patience, encouragement, and faith, this thesis could not have been started, continued, or finished.

I would like to thank my colleagues in the Laboratory for Computational Ontology for their various forms of support.

Special thanks to my friends, especially Onur Eylül Kara and Berk Yaylım who have always encouraged me during my master studies; and Refet Şaban who has always been a dearest friend that reminds the truths.

I would like to express my heartfelt gratitude to Başar Yargan, who experienced all the difficult and glorious moments with me throughout this endeavor.

Lastly, I would like to express my deep love and gratitude to my family, especially Yavrukuş and Bobi, without whom something is always missing.

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In this work, while citing from Aristotle, I use Bekker numbers without mentioning the names of books of the corpus. Similarly, citations from Kant include both Kant's first (A) and second (B) editions. Further, the belief that citing Husserl's *Logical Investigations* as "*LI*" may confuse readers because of the usage of Roman numerals, which are used for indicating the chapters, make me use the German name of the book, *Logischen Untersuchen,* when citations are made.

CHAPTER 1

INTRODUCTION

Ἀρχή, in a philosophical sense, means the first principle that is the ultimate cause of everything there is; and the history of philosophy, if it finds its roots in Ancient Greek, starts with questioning what *ἀρχή* is. In the course of investigation, this question is modified to "What is there?", hence; obviously the first inquiry of philosophy is boiled down to ontology, the science of being.[1] Throughout the history of philosophy, the answer to what there is has taken various versions according to philosophers' doctrines. The versions can be derived by formulation, rejection, interpretation, or construction.[2] Ontology, moreover, has been given many names during centuries. At the very early phrase of philosophy, as mentioned before, ontology is the science of *ἀρχή*. Aristotle calls it the first philosophy, and then it is also called metaphysics after him; and in the doctrines of Plotinus, and Al-Farabi, for instance, it is nothing but theology. Today, understandably, it has a different guise. Whether it is called the first philosophy, metaphysics or theology, ontology is the science of the things that exist in reality and the hierarchical relations between them.[3] Therefore, the difference lies between different ontologies on that what has to be taken as reality and how the relations between these realities have to be mapped.

The developments of philosophical ideas and/or concepts have been classified even from the ancient times; moreover, classifications depart from one

[1] Etymologically, ontology comes from the Greek word *ὄν*, meaning "being", that is the present participle of *εἰμί*, meaning "to be". When *λογία* is added to *ὄν*, the word ontology is constructed as the study of being.

[2] Formulation, e.g. Thales' statement that everything is ultimately water; rejection, e.g. Anaximenes' statement that everything is not water but ultimately air; interpretation, e.g. statements of Zeno of Elea who is a passionate advocate of Parmenides; construction, e.g. the works of St. Thomas Aquinas who adapted Aristotelian ontology to Christian theology.

[3] Any debate about the distinction between "that there is" and "that there exists" is ruled out.

another according to understanding of a thinker. Among the many readings of history of philosophy, I appeal to Brentano's theory of history of philosophy for the following reasons.[4] The first reason is based on Brentano's attitude to philosophy as a scientific effort, which holds also for ontology. As it will be explained in the following lines, ontology today is taken as a new science, so Brentano's reflection to history of philosophy can provide an appropriate approach to today's ontology. Thereby, the second reason is that Brentano's theory can help us to interpret the current situation of ontology, so that predictions can be done in order to flourish this new science. Hence, before the explanation of the current situation of ontology, Brentano's theory of history of philosophy has to be shown.

Philosophy, according to Brentano, has always had two phases, of which the first phase covers ascending development, and the second phase covers decadence.[5] These two phases of development and decline in the history of philosophy have recursive feature, and can be observed "in the periods of antiquity, in the Middle Ages, and in the modern period up to the collapse of the Hegelian school".

Brentano explains these two phases in the part three of his essay. The development in the first phase is gained either through "a lively and pure theoretical interest" or through the support of scientific methodologies, such as perfecting hypotheses, enlarging the scope of the inquiry, challenging new questions. The second phase, which is the decline of the first phase, is "in fact the first stage of decline". The decline starts when the pure scientific interests weaken and alter, so that theoretical interest fails its value, and only the practical intentions are primarily concerned. Accordingly, philosophy loses in scientific value; rather science is addressed for its assistance. This situation bears "a kind of spiritual revolution", which is called as the second stage of decline. This stage is under control of

[4] The idea of making use of Brentano's theory was influenced from the lectures of Barry Smith (Cf. n.d. Lecture I).

[5] It is worth noting that I am giving the excerpts of Brentano's theory of history of philosophy only using his own essay entitled "The Four Phases of Philosophy". It is translated by Mezei and Smith, and is inserted in their mentioned book as an appendix. See Mezei and Smith 1998, pp 81-111.

scepticism, for it is believed that reason is far away to capture knowledge. The scientific method loses its value, thereby becomes unworthy. Moreover, the essence of truth is about to be destroyed. Mentioning the first sentence of the first book of Metaphysics of Aristotle, “All men by nature desire to know”, Brentano believes that scepticism has to halt at a point due to the satisfaction of this very desire. Thereby, the third phase of decline occurs as a reaction to scepticism by constructing philosophical dogmas. Unnatural methods are employed to gain and reserve knowledge. The means that reach the truth are “lacking in all insight, ingenious ‘directly intuitive’ powers, mystical intensifications of the mental life”; as a consequence, truth is thought as beyond all human powers. With this stage, thus, the phase of decline reaches its climax. A desire to reach truth in a scientific approach paves the way to the first phase.[6] Although there are two main phases of ascending and decadence, Brentano labels the stages in the declining as phases in several places of his essay.[7] As the title of the stated essay suggests that there are four “phases” of philosophy, and Brentano labels them as following in several places in the text. The first phase is about the pure theoretical/scientific interest (Cf. part 4); the second phase is mainly clarified through practical interest (Cf. part 5); the third phase is named as scepticism (Cf. part 6), and the fourth phase is portrayed under mysticism (Cf. part 11).[8]

Brentano states that a new fruitful period of development, which is rooted in scientific responsibility, has started in his time, in the mentioned essay, in the part 16. Mezei and Smith suggest that the post-Brentanian period should be branched as Anglo-American Analytic Philosophy and Continental Philosophy (1998, pp37-76). Further, if Brentano is correct in his analyses, the position of philosophy in the twentieth century is a matter of comment. As Smith points out, the first phase is the

[6] In parts 4,5,6 and 7, Brentano explains how his theory fits to the period of antiquity. The same procedure is done for the Middle Ages in the parts 8,9, 10, and 11; for the modern period in 12,13,14, and15.

[7] Cf. p85, p90. Yet, he sometimes uses “period”, “phase” and “stage” interchangeably; Cf. p96.

[8] Hence, the ascending occurs in the first phase, the decline occurs in the second, the third, and the fourth phases.

periods of rediscovery of Aristotle and/or a new science, hence the analytical metaphysicians comes after the fourth phase of post-Brentanian age (n.d., Lecture I). Smith also reveals that the first phases are the inventions of new disciplines from the modern ages onward: philosophers Locke and Bacon invented empirical natural science, then physics is no more a part of natural philosophy; philosophers Brentano and Wundt invented psychology that has its own experimental field by its own; philosophers Frege, Wittgenstein, and Russell invented mathematical logic as a new discipline. This phenomenon plays its role again in the first phase of twentieth century as formulating a new independent discipline called ontology (ibid). Therefore, we are in the phase where ontology is being developed and flourished by the scientific interest and methods. The following table captures Brentano's theory of history of philosophy, named "Four Phases of Philosophy", constructed by Brentano, Mezei and Smith (1998, pp37-76), and Smith (n.d., Lecture I).

Table 1.1. "The Four Phases of Philosophy", from ancient times to today

		First Phase	Second Phase	Third Phase	Fourth Phase
First Period: The Period of Antiquity		From Ionic Thinkers to Aristotle	Stoics and Epicureans	Sceptics (New Academy, and Pyrrhonism), and Eclectics	Jewish Platonists, Neo-Platonists, and Neo-Pythagoreans
Second Period: The Middle Ages		The Scholastic Thinkers up to Thomas Aquinas (including)	The Scholastic	Nominalists	Mystical Thinkers
Third Period: The Modern Age		Francis Bacon, René Descartes, John Locke, Gottfried Wilhelm Leibniz	French and German Rationalists	David Hume, Thomas Reid	The Scottish School, Immanuel Kant, and German Idealists
Fourth Period: After Brentano	Continental Philosophy	Brentano	Husserl	The Early Heidegger, Sartre	The Later Heidegger, Derrida, Levinas
	Anglo-American Analytic Philosophy	Frege, The Early Wittgenstein, Russell	Vienna Circle (e.g. Gödel, Carnap, Schlick)	The Later Wittgenstein, Quine	Rorty
Fifth Period: The Twentieth Century and Beyond		Analytical Metaphysicians (e.g. Chisholm, Lewis, Armstrong, Lowe), and **Ontologists**			

It is predictable from the table above that ontology is under a rapid progress by a purely theoretical interest and by the applications of scientific methods.[9] Ontology has been preparing itself to leave the mothership of philosophy by constructing its own object of inquiry, and accordingly it suits scientific methods on (Smith n.d., Lecture IV). The term "ontology" was introduced to the computer and information science literature by S.H. Mealy for the first time in 1967 (Guizzardi 2007). Mealy classifies three separate realms in data processing: the real world; ideas about the world in human mind; and the means of representation. These three separate realms together bring about ontological questions to be considered. In the field of artificial intelligence, on the other hand, Hayes used ontology for his study on quantification of liquids for the first time in 1978 (ibid). Additionally, the immense interest on semantic web accelerates the employment of ontology in the field. In artificial intelligence and semantic web studies, ontology was regarded as a design for a domain, in a specific language. Besides, information systems analysts started to use ontology as well. They needed a system which would regulate all the information, which is enormous, so that they could both control and make use of them. Data analysts, thereby, have been constructing declarative representations of their database. In his essay "What Is an Ontology" written in 1992, Tom Gruber states a short answer as "an ontology is a specification of a conceptualization" (n.d.). This statement gives hints how a computer scientist conceives ontology. First of all, Gruber speaks of a *domain*. Hence, ontology is not a discipline that concerns reality in itself, but rather some part of it. As Gruber states, ontologies are designed for a purpose, thereby there are pragmatic reasons of designing them (ibid). So, for the ontology engineer, *what there is* is restricted by the things in the client's specific world. Namely, the reality in the world is not in the scope of domain ontologies. Secondly, when the application domain is determined, conceptualization process starts. "A conceptualization" says Gruber, "is an abstract, simplified view of the world that we wish to present for some purpose" (ibid). Hence, conceptualisation is an abstraction of all the entities -such as objects, and relations between objects- in

[9] Henceforth, I will distinguish abovementioned ontology as philosophical ontology, and continue to call ontology to this new-interdisciplinary study. Besides, I will abbreviate philosophical ontology as "philontology" for the sake of simplicity.

the specific domain, by a formal language that transfers the ontology in the designers mind to the machines with a specific vocabulary. That is to say, a programmer committed to an ontology, then s/he models the ontology by conceptualizations, which is represented by a language of a knowledge-based program. These conceptualizations form a set of representational terms. Again with Gruber's words, " what 'exists' is that which can be represented" for AI systems (n.d.). However, singling out what exists and representing them is a real issue. Philosophers often are criticised for making comments on sciences, nonetheless the authority of philosophy is also often underestimated. Smith complains that computer scientists "are interfering with [positive] sciences all the time, and the result is sometimes a disaster!" (n.d.). Although the aim of an ontology engineer is to enable knowledge sharing and reuse (Gruber n.d.), even the same databases have different terminological and conceptual structures, and worse, the conceptualizations were not reflecting the reality successfully. Yet, scientists in these fields most of the time fail in making definitions, which is very crucial.[10] Those kinds of struggles can be overcome case-by-case, yet in the midst of enormous information, there must have been a solution in order to save energy and time, even though domain ontologies are much more manageable and work well. However, when a new entity or a relation is to be considered in a domain, the ontology would not be manageable or even collapse; since databases, for instance, are too defined, so their construction. Therefore, there must be a science that makes higher-level claims about reality. It gives a map of the entire reality that is constructed upon formal theories with axioms and definitions in order to operate computational reasoning; so that, in midst of the enormous information mess, this kind of ontology can be used in any field, for instance data can be compared, and used for some specific purposes. Thereby, called upper-level ontology, this domain independent ontology establishes theories of all entities in reality and of relations between those entities, by defining and axiomatising the most general categories and concepts. The entities are not restricted to either physical entities existing in space and time or

[10] Moreover, one must keep in mind that making definitions is a philosophical work. Roughly, philosophers, whenever they are not asking questions, answer "what" questions, scientists answer "how" questions. A physicist, for instance, cannot define what motion is, but rather how to measure it.

abstract entities existing out of space and time, but also entities "tied to history and to specific contexts of human behaviour" (Smith n.d.). Moreover, in the course of time, new domains and/or new entities can appear, such as stock market and bit coin. Therefore, ontologists must keep in mind that all those entities are to be reflected in the system of categories. Stepping into philosophical waters, they have to derive a categorical system from a root that provides well-classified entities. Accordingly, designing categories is a true matter. Any claim that the reality of world can be grasped can be rejected by the massiveness, and complexity of reality. A list of most basic categories changes not only from person to person, even in time. Moreover, there are multiple perspectives on reality, which are not necessarily or even possibly, presented in one way. The domain independent ontologies are flourished by the interdisciplinary collaboration of computer science, logic, philosophy, and linguistics.

Consequently, history of ontology which moved from philontologies to domain ontologies has now moved from domain ontologies to domain independent ones. In order to differentiate the use of the term "ontology" – which is generally domain of interest – in computer and information sciences, and to point out the domain independent nature of ontologies, there are a number of alternative names in the literature, such as "universal ontology", "top-level ontology", "foundational ontology", "formal ontology",[11] "domain-independent formal ontology", "higher-order ontology", "high-level ontology", "high-level upper ontology", "upper ontology", and "upper-level ontology".[12] From now on, new discipline domain independent ontologies are investigated under the title "upper-level ontologies".

[11] It is necessary to keep in mind that what is given as formal ontology is not Husserl's philontological formal ontology, although the latter influenced the former.

[12] It is worth noting that the terms have definitional controversies. In different studies, they have different definitions, moreover, different references. For instance, formal ontology is defined as a domain independent ontology, but else where it is something like a subset of domain independent ontology. Further, "foundational ontologies" are the same as "formal ontologies", however foundational ontology is "a domain independent reference ontology". Hence, there are also reference ontologies, which are "is analogous to a scientific theory". I am not sure if reference ontologies are something like mid-level ontologies; yet they are also defined as domain ontologies. It is puzzling that whether core ontology and the reference ontology is one and the same thing. Cf. Onto-Med Research Group n.d.; Guizzardi n.d.;

Having roots in philosophy, ontology has become an interdisciplinary science that is applied in many areas. Although it has been used in specific domains in information sciences over years, the need for constructing domain independent ontologies emerged due to the very fundamental requirements of ontologies: reusability and shareability. Lacking sufficient tools, ontology applies philontologies in order to satisfy these requirements. When Brentano's theory is recognized, hence, ontology is in need not only of scientific methodologies but also of philosophical theoretical interests. This thesis aims to provide a philosophical approach to domain independent ontologies, namely upper-level ontologies (ULOs). Chapter 2 is designed to present ontological and/or categorical systems of Aristotle, Husserl, Kant and Quine due to their influence and contribution to ULOs. Beyond being the founder of sciences, Aristotle gives the roots of philontological investigation that is necessary for any study in ontology and categories. Kant's categories are one of the most essential philosophical systems, which must be mentioned in a categorical inquiry. Husserl, on the other hand, is an essential philosopher when ULOs are considered, since his attitude to what there is is very inclusive: his ontology includes not only things, but also events, and his logic has parallel features with his ontology. Quine's thoughts, lastly, are very crucial when domain ontologies are to be constructed. His theory of ontological commitment can be shifted to ULOs as well. Chapter 3 consists of technical analyses of upper-level ontologies, Basic Formal Ontology, Descriptive Ontology for Linguistics and Cognitive Engineering, Suggested Upper Merged Ontology, and Cyc, in order to reveal their characteristics and philosophical assumptions. Besides being the most popular and important ULOs, these ontologies have a large number of reports and documentations that make the analyses accessible. Chapter 4 is an analysis of these upper-level ontologies in the light of philosophical study in Chapter 2. In order to do that, the fundamental constituents of any ULO are listed, and accordingly these constituents are interpreted with respect to the selected ULOs and the ontological and/or categorical systems of the selected philosophers.

Munn and Smith 2008; Semy, Pulvermacher, and Obrst 2004; Borgo et al. 2002; Cope, Kalantzis, and Magee 2011; Smith n.d..

CHAPTER 2

ANALYSES OF PHILOSOPHICAL ONTOLOGIES

2.1. Philosophical Ontologies

This chapter ponders on pure philosophical ontologies, or “philontologies” what I call. Although this thesis has an interdisciplinary approach, this chapter is intentionally prepared from a purely philosophical look, for philosophy provides wide range of different ideas over various issues. Still, the main reason of this chapter is to provide a philosophical look to ontologies and categorical systems that are very important for constructing upper-level ontologies (ULOs). The first philosopher to be mentioned is Aristotle. He is the philosopher who not only founded sciences but also approached ontology and categories systematically. Hence, his contribution to philosophical thought is essential for ontological investigations. Any study in ontology starts with Aristotelian views, moreover, this holds for ULOs as well. Therefore, he is an indispensible figure in this study. Similarly, Kant is a philosopher who comes to minds when philosophical categories are investigated. Although his ontological view cannot suit to ULOs, Kant’s categorical system influences construction of categories of some ULOs; moreover, his system is a challenge to Aristotle’s categories, which is usually the fundamental way of building ULOs. Husserl’s ontological system, which can be taken as his categorical system as well, has a very important role in today’s ontologies. On Husserl’s account, what there is is not limited with physical things or beings that have hylomorphic structure; rather each entity in reality can find its place in Husserl’s ontology. Accordingly, Husserl’s ideas are very crucial, supportive and fertile for ULOs. That Quine’s ontological commitment has shaped the approach to today’s domain ontologies is the reason why Quine’s ontology is in this chapter. On the other hand, his views are also very valuable when philosophical aspects of constituents of upper-level ontologies are examined.

When Brentano's theory is in charge, the abovementioned philosophers can be placed in particular periods, phases and stages. Aristotle is in the first phase of the period of antiquity, for Aristotle is in pure theoretical interest, and his opus was "the last momentous product in the ascending stage of ancient philosophy" (Mezei and Smith 1998, p88). According to Brentano, Kant is in the fourth phase of the modern age, since Kant attempts to rescue knowledge from Hume's scepticism by "unheard of and unnatural means" (Mezei and Smith 1998, pp98-99). The fourth period after Brentano is upgraded by Mezei and Smith (ibid). According to it, Husserl is in the second phase of the continental philosophical period, since Husserl's phenomenology leaves the "properly scientific method", and it is a philosophical application (pp48-52). Quine finds his place in the third phase of the analytic philosophy due to his idea of the ontological relativity, which rejects the absolute meanings, since meaning is subject to change according to a person's ontological commitment. Thereby, the table below encapsulates philosophers, their chronological order in the appearance in the history, and their positions in Brentano's theory of history of philosophy.

Table 2.1. The Selected Philosophers in the Four Phases of Philosophy

		First Phase	Second Phase	Third Phase	Forth Phase
First Period: The Period of Antiquity		Aristotle			
Third Period: The Modern Age					Kant
Forth Period: After Brentano	Continental Philosophy		Husserl		
	Anglo-American Analytic Philosophy			Quine	

2.1.1. Aristotle's Ontology

Aristotle's treatise, where he develops his **ontology**, is called *Metaphysics*, the name of which neither was used as a title nor was assigned as **the study of being** by Aristotle. Metaphysics, *τὰ μετὰ τὰ φυσικά*, literally means "the ones

[books] after the physical ones [books]" in ancient Greek. The reason the name **metaphysics** given to Aristotle's ontological studies is widely accepted over centuries is that Aristotle, generally, starts his discussions from the most obvious -for instance he states the ideas of previous thinkers upon a specific subject, or he points out the most obvious natural occurring-, then he shifts the topic into an upper level, where he points out the wisdom behind the appearance, and he contracts his doctrines gradually. Namely, the way Aristotle follows is from what-is-knowable-by-us to what-is-knowable-in-nature. So, it is legitimate to utter that his ontological investigations begins with physics to something 'after physics'. Moreover, Aristotle explicitly states that the subject matter of **the study of being qua being** is the study of the first causes and principles (1003a26-27). In 981b28, it is wisdom that deals with first causes and principles, thereby, Aristotle's ontology is also called **wisdom** (Cf. 1059a18). In the discussion of the characteristics of wisdom, wisdom has to be the best known in itself, and the most abstract science. Accordingly, wisdom is 'after physics'. Still, there is another name for ontology: **first philosophy**. Book E shows us that theoretical sciences are prior to all other sciences, and the first philosophy is prior to others within theoretical ones, for it deals with first principles and causes- further, it is also the **first science**. If first principles and causes are of divine (1026a17-20), lastly, the science of being in so far as they are beings is also called as **theology**. As a result, ontology, the study of being in Aristotle is to study being qua being, which deals with first principles and causes, and that causes and principles are of divine; and this science is prior to all sciences.

I start the philosophical investigation of ontologies with Aristotle. He merits to be examined in the first place, because not only is he placed in the first era of four phases of philosophy, and the one who lived earlier than the philosophers I have chosen for the other eras, but also the most influential philosopher who shaped ontological views that were constructed after him. In this part, I will investigate the grounds on which Aristotle has constructed his ontology, and the principles that he has used in his construction. My main concern is to give a rough study of science of being qua being.

Book Γ in *Metaphysics* starts with a sentence that states there is a science [*ἐπιστήμη*] whose object is being qua being [*ὂν ᾗ ὄν*] (1003a21).[13] The question that what is to be being qua being can be perplexing. Unlike Plato, whose philosophy lets only one gigantic science, Aristotle deals with being in various ways those lead different kinds of sciences [*ἐπιστήμη*]. Those special sciences, such as biology, mathematics, physics, study only one part of being by cutting of a specific part of being (Cf. 1003a25). Physics, for instance, deals with being as moving, or likewise, biology deals with being as living. Therefore, after striping all the attributes that do not belong to being in virtue of its own nature, there must be a science that deals with being as being. Before constructing such a science, Aristotle prefers to investigate what sort of things are called "being". There are several senses of being, he says, and that all the senses "are related to one central point [*πρὸς ἕν*], one definite kind of thing, and are not homonymous" (1003a34-35). Then, although being has several meanings, all those meanings mention one single definite thing. Therefore, the focal "being" that is the object of the science of being must be investigated.

> …some things are said to be because they are *substances*, others because they are affections *of substance*, others because they are a process *towards substance*, or destructions or privations or qualities *of substance*, or productive or generative *of substance*, or of things which are relative *to substance*, or negations of one of these thing *of substance* itself (1003b5-10).[14]

The emphases on substance explicitly prove that the starting-point [*μίαν ἀρχήν*] is substance. If, accordingly, the focal point, -viz. *πρὸς ἕν*, is substance, I think, it is legitimate to say that being is divided into two parts, substance and others, where the latter must ontologically and epistemologically depend on the former. Then, it is substance that merits being the subject matter of the science of being qua being (Cf. 1028a31). In brief, what being is can be reduced to what substance is, and other things that are also called as being *are* in virtue of their relation with substance.

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[13] Although the inquiry of being is started from the very first book of *Metaphysics*, I prefer to begin from Book Γ, for it is the most obvious introduction to the subject matter.

[14] Emphases belong to me.

Now, one step further must be taken in the investigation of Aristotle's ontology by discussing what a substance is. In 1069a30-1069b2, Aristotle states that one of the types of substance is sensible and it has subtypes as eternal and perishable sensible substances; the second type is depended on sensible substances but is of quantity; the last type is immovable. In order to solve this puzzled expression, one may take help from the sciences that study each substance. Physics deals with things that are inseparable from matter and movable, mathematics deals with things that are inseparable from matter and immovable, and the science that is prior to both deals with the things that are separable and immovable (1026a13-17). So, types of substance are categorised with respect to movable and separable. However, this gives the idea that we need some more Aristotelian concepts, which are beyond substance, upon which separable and movable can apply. In 1028b20-31, Aristotle speaks of nature of substance in the light of previous thinkers, and, inquiries whether there is a separable substance -e.g. lines, points and/or Platonic Forms, numbers-, accepting there are sensible substances -e.g. bodies both earthly and heavenly- in advance. Then, he gives four senses of substance: substratum, essence, universal, and genus (1028b33-35).

Substance is said to be *substratum*, for it is thought that it is everything else is predicated, while it is not predicated anything else (1028b36). When the investigation of substratum is taken deeper, we are said that the nature of substratum is either matter, or form, or the compound of matter and form (1029a1-2). Aristotle extends this proposal as follows. The candidates of substratum are taken one by one. It may be matter, since it is what remains when we strip all the other predications on it; it is the formless matter that ultimately composes the substance. However, it cannot be the case, he says, for substance must be separate, and matter fails to meet this fundamental requirement (1029a28-29). Thus, substance is either form or the compound of matter and form. That form is prior to matter, so as to compound can be found in many places in Book Z (1029a5-7; 1029a30-33). It is form, therefore, to be spoken of as substance.[15] Then, it can

[15] That there is "pure form" in Aristotle's doctrine is a matter of controversy, and that shapes one's attitude towards Aristotle's ontology being theology. In order to save the limits and the aims of this thesis, I am ignoring this debate.

be stated that the substance of a thing is its form, which is the primary substance of it.

In Z.3, substance, the subject matter of first philosophy, is substratum, only if by substratum we understand the form of that substance. In Z.4, Aristotle moves a step further from what is knowable by us to more abstract realms; he comes to the second discussion that substance is *essence*. "The essence of each thing is what it is said to be in virtue of itself [*καθ' αὑτό*]" (1029b13-14),[16] so it is the definition of a thing that signifies the essence of a thing (Cf. 1030a6), namely a definition of a thing points out the *per se* attributes of that thing.[17] However, Aristotle urges that not all the *per se* attributes are in the definition of a thing (1029b16). Z.4 tells us that there is one kind of formulation that gives *per se* attributes of a substance, yet not in its own right. These kind of *per se* attributes do not take part in the definition of a thing, rather that thing takes part of the definition of those *per se* attributes.[18] The other kind of formula gives definition of a thing in its own. These kind of *per se* attributes of a substance necessarily take part in definition of that substance.[19] Obviously, it is the second kind of definitions that we are looking for. Moreover, Aristotle explicitly claims that "definition is the formula of essence, and essence must belong to substances either alone or chiefly and primarily and in the unqualified sense" (1031a10-15), and further necessarily a substance and its essence are one and the same (1031b18-19; Cf. 1042a16-17). If a substance is primary and self-subsistent, then it is one and the same as its essence (1032a4-5);

[16] I prefer using *per se,* Latin translation of *καθ' αὑτό*, instead of *in virtue of itself*.

[17] It is better to note that definitions are of things rather than words. Further, epistemology and ontology, and even ethics, go hand-in-hand in Aristotle's doctrine.

[18] For instance, 'female' and 'male' cannot be explained without reference to 'animal'. Such attributes are of compound substances. Matter and form are one and same thing, for one cannot be explained without the other. See Z.5.

[19] For instance, Callias is *per se* an animal, therefore in the definition of Callias there has to be 'animal'. 'Straight', similarly, is involved in the definition of line, for a line is *per se* straight.

accordingly we have an immediate explicit conclusion: the essence of a thing and its primary substance is form (1032b1-2; Cf. 1035b31).[20]

Before examining whether substance is universal, I would like to add a new characteristic of a substance: a 'this'/thisness. Book Z propels that a substance is separate, which has shown above, and a 'this' [*τόδε τι*]. *τόδε τι* refers definiteness, then, it has to be of form, since "matter is unknowable in itself" (1036a8). Moreover, *τόδε τι* chiefly related with essence.

The analysis of substance being substratum and essence gives us that the object of our inquiry is form. What we have found so far must be compatible with substance being universal. Surprisingly, Aristotle speaks of universal as something "which naturally belongs to more than one thing" (1038b11-12). Then, he fortifies this definition, with a comparison, stating that substance is "not predicable of a subject", whereas universal is always predicable of some substratum (1038b15-16). Universal, then, cannot satisfy this characteristic of substance, i.e. separateness. If a 'this', the other characteristic of substance, were universal, then it would act like a quality, but it is impossible, since a quality cannot be prior to substance (1038b24-27).

Z.10 examines formula and its parts. If substance is either form, or matter, or the compound of these two, then parts of the formula may be part of those. Since matter is not definable, there cannot be a definition of matter. Accordingly, for compounds, the part of the formula must be of form, namely it is the form of a substance that makes the matter of that substance knowable.[21] Although, it is true that universal does not exist apart from the particulars (1040b27), Aristotle still suggests that universals are definable and "definition is of the form" (1036a27), and continues, "only the parts of the form are parts of the formula, and the formula is of the universal" (1035b33-35). However, Aristotle explicitly utters that neither universal nor genus is substance in the résumé of Book Z that can be found in Book H -this book and Book Θ are where Aristotle introduces his new concepts,

[20] Similarly in 1032b14-15: "I call the essence substance without matter".

[21] That is why compounds are definable in one sense, and indefinable in the other sense.

potentiality and actuality.[22] Without going into deep in this teaching, it is the actuality of a thing that takes place in definition, which is also differentia. Genus, just like differentia, takes place in definition; however, it points out matter (1058a23). Then, genus of a substance refers to its matter, and the differentia refers to the form of the substance that actualizes the matter of it. In final analysis, I believe, we should rule out universal and genus from the inquiry of substance, for this puzzlement cannot be solvable in the scope of this thesis.

To sum up, in *Metaphysics,* Aristotle constructs his science of being qua being. His ontology has two levels (Cf. the first paragraph of Θ.1).[23] At the first level there are substance and categories; the existence of the latter necessarily depends on the former. We can find the discussions of this level mainly in *Categories* and in *Metaphysics*, where Aristotle inspects sensible beings.[24] At the second level, Aristotle examines substance with respect to his own doctrines of actuality-and-potentiality, and of hylomorphic analysis. I restrict the investigation of substance only in *Metaphysics*, since it is where Aristotle formulates the science of being qua being. Hitherto, I have showed that the inquiry of being is reduced to the inquiry of substance, because substance is the focal point, -viz. substance is self-standing and others, which are also called as being, necessitates substance for their existence. Then, the propelled senses of substance are examined: substratum, essence, universal, and genus. The last two candidates are ruled out from the investigation of being, for they cannot satisfy the fundamental requirement of being

[22] Since genus is universal, the abovementioned discussion is also valid for genus.

[23] This view can be supported by the following passage: "[…] 'being' has several meanings, (1) of which one was seen' to be the accidental, and (2) another the true ('non-being' being the false), while besides (3) these there are the figures of predication (e.g. the 'what', quality, quantity, place, time, and any similar meanings which 'being' may have), and again besides (4) all these there is that which 'is' potentially or actually" (1026a33-b2).

(1) cannot be in the in the scope of the science of being qua being, since there cannot be any scientific examination of accidental (1026b3-4); (2), again, cannot be in the investigation of being qua being, since true is not in things, rather in thought (1027b25); (3) points out the first level investigation; (4) points out the second level investigation. Therefore, Aristotle rules out accidental and true meanings of being from his ontological inquiry.

[24] Categories will be discussed in the second part of this chapter.

a substance, which is separateness. The investigation of the former two ends up with that the substance is reduced to form. Hence, what merits to be being in Aristotle's ontological hierarchy is form, which is actual, separate, and individual.[25]

2.1.2. Husserl's Ontology

Husserl is of the second phase-continental philosophers from the fourth period according to Four Phases of Philosophy.[26] The first two philosophers, Aristotle and Kant, are indispensible examinations for this thesis, for not only their influences play very crucial roles in the history of philosophy, but also they are the most dominant characters at their position in the Four Phases of Philosophy. Among the intersection of second phase and fourth circle, however, there would not be any other philosopher to be chosen; for Husserl merits to be chosen as the greatest philosopher in his era, just like Aristotle and Kant. He is the first one who introduces the term "formal ontology", which makes him a point of attention. That his "formal ontology" is analogous to his "formal logic" attracts today's ontologists, for such whole and consistent attachment may inspire them. Before going into details in formal ontology, I firstly deal with the constituents of his ontology, then the sciences that study these ontologies.

He ramifies his general ontology in two realms:[27] fact, as concrete entity, and essence, as ideal entity (*Ideas I*, §2). The main characteristics of the realm of fact are that these entities are spatiotemporal, and they are particulars with contingent characteristics (*Ideas I*, §2). The very characteristics of the realm of essence are, on the contrary, that these entities are generalizable, universal, unchanging and timeless (*Ideas I*, §§6,8). Thus, the realm of essence, or eidos, is independent and separable from the realm of fact. On the other hand, the factualness of matters of fact requires eidetic universality because the being of

[25] There are other attributes of the object of science of being, such as immovable, unchangeable, eternal. I used the ones that are shown here.

[26] See Introduction.

[27] Later, there will be a third one.

concrete entities is contingent, whereas that of ideal entities is necessary (*Ideas I*, §2). "An individual object is not merely an individual object as such", for it is not only under change, but also its own specific character must be explained through essential characters (ibid). That is to say, again, the realm of fact cannot be separated form the realm of essence. Moreover, experience of, or intuition of an individual can be turned into an ideation (*Ideas I*, §3). Every science of matters of fact, then, must depend on eidetic sciences, as well (*Ideas I*, §8).[28] According to Husserl, concrete entities are object of perception and experience, moreover, studied by empirical sciences (*Ideas I*, §1), such as psychology, biology. At this point, that the matter of fact is founded on the realm of essence must be carefully considered with respect to the relation between science of fact and of essence. There are pure eidetic sciences, such as pure logic, pure mathematics, and pure theories of time, space, and so forth. These sciences study essences of corresponding possible individua that are the factual singularizations' of those essences (*Ideas I*, §7). The experiences of those sciences, of course, differ from the experiences of empirical ones. When a geometer, says Husserl, draws factual existing lines on the factual existing board, through them what he "experiences" is beyond the physical production (*Ideas I*, §7). Since science of fact is the same concept as experiential science, an "experience" of essence must have another approach. Husserl, here, introduces "seeing of essences" for the pure eidetic sciences instead of experiencing, for seeing of essences is the same thing with the ultimately grounding act; hence, in this sense geometry is a study of essence (*Ideas I*, §7).

A closer look is needed to each realm, after stating the general features of them. **The realm of fact** has three constituents per se: individuals, states of affairs, and events (Smith 1997, p329). By individuals, Husserl points out the concrete empirical individuals, which is either independent or dependent.[29] Independent

[28] Namely, empirical sciences depend on material ontologies. This statement will be meaningful in the course of this part.

[29] The definition of the notion of dependence can be given as follows (See Smith and Smith 1997, p30):

individuals, also called substrates, are concrete objects, such as window and head (*LU*, III, §6). Dependent individuals, whereas, are called "moments" that their existence depends on the independent concrete entities. (Cf. *LU*, III, §13; *Ideas I*, §28). In order to explain the dependency on substrata, the following can be given as an example. "A pink window" is an object of perception and can be experienced. "Window", as stated before, is an independent concrete entity; on the other hand "pink" cannot be observed without that window. Hence, the moment of the window is a part of the window, thus cannot exist without it.[30] States of affairs belong to objects of presentation, and they are constructed by substrates and moments either syntactically or categorically (Smith 1997, p329). For instance, the window and its pinkness form a state of affair: the window is pink. Events are the obvious part of the realm of fact. Concrete empirical events, which include experiences as well, have duration in time and happen in space. Experiencing the pink window is an example of concrete events (Cf. *Ideas I*, §23; §45).

The realm of essence has two distinct hierarchies: material and formal (*Ideas I*, §12).[31] Each essence falls under either hierarchy with respect to organization of generality and specificity. Essences are parts of hierarchies of species and genus. It is called hierarchy, for "eidetic singularities are essences as their genera, but do not have under them any particularizations in relation to which they would themselves be species" (*Ideas I*, §12). At the top of the both hierarchies there is a highest genus, or highest essences. From the highest genus down, there are higher genera, which are more general essences. At the bottom of the hierarchies, there are infimae species, or called as the eidetic singularities, that are most determinate essences (*Ideas I*, §12).

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a is dependent on b =: a is a matter of necessity such that it cannot exist unless b exists.

[30] Wholes and parts play very essential roles in Husserl's formal ontology, one can refer to *Logical Investigations, III*.

[31] In the introduction sentence of §12, Husserl states the distinction of essences as materially fully or empty. That is to say that each essence is either materially full or materially empty.

The sphere of **materially filled essences** contains all objects whatsoever (*Ideas I*, §12). Material essences, which are same as the world's essential and unchanging essences, are not completely isolated, since they are the generalization of the realm of fact.[32] That is to say materially filled singularities such as the eidetic compositions belong to the determinate physical things, hence, most of the ideal entities have material essence characteristics.

In this sphere, the highest material essences are called regions (*Ideas I*, §9). Although regions are any material things whatsoever, a concrete entity can be examined in various regions.[33] Thus, starting from the lowest species as an eidetic composition, generalization of a material essence leads to several zeniths, namely regions, hence, this very material essence is the highest material genus of that region. Therefore, there must be a number of regions, which are studied by material ontologies or regional ontologies (*Ideas I*, §9). Although the determination of the number and the distinguishable features of the regions is a complex task,[34] Smith (1997, p329) suggests that there are mainly three regions: the region Nature (Cf. *Ideas I*, §9), the region Consciousness, and the region Spirit or Humanity. Nature subsumes all entities in nature; Consciousness subsumes all conscious experiences; Spirit subsumes "entities formed by human affairs" (ibid).

The very characteristic of **formal essences** is their being empty, thus they are purely logical (*Ideas I*, §12). Hence, they do not have extension and spatiotemporal characteristics. Formal essences are pure forms of material species or regions, so, they involve what material species or regions have in common. Further, a formal singular essence contains a higher formal essence, so level by level an eidetic essence lies "one inside another"; thus, the higher essence lies

[32] I am, for instance, a concrete entity, and equally, a human, an animal, a living body, a physical thing. All these generalizations over the fact "I am" are subsumed by the eidetic composition of the essence "I am".

[33] That is to say the totally of individuals cannot be subsumed by a single zenith genus. Moreover, the following should be considered: An independent individual, certainly, has spatiotemporal characteristics; besides, it has a shape, a colour, extension, as physical characteristics.

[34] In *Ideas I*, §152, Husserl utters the "interwovenness of different regions".

inside the lower one (*Ideas I*, §12). Therefore, the highest formal essences must be the "genus of all genera", or in other words, categories (*Ideas I*, §§12-13). Object-in-General is a highest category and it includes special categories, such as Individual, Essence, State of Affairs, Unity, Plurality, Space, Time (Smith 1997, p330).

Husserl makes equalization between the realm of pure logic and the sphere of formal essences. In *Ideas I*, §12, he argues that the pure logic consists of significations, thus the highest genus of pure logic is "any signification whatever"; besides he continues, the lowest species, namely eidetic singularities, are each determinate propositional form, and each determinate proposition-member, and an intermediate genus is any proposition whatever. Therefore, logical forms behave as formal essences. The reason why Husserl discusses pure logic at first, and then equalises pure logic, or formal logic, with formal ontology will be discussed after explaining material or regional ontologies.[35]

As stated above, there are two kinds of ontologies in the realm of essences: formal ontology and regional ontology.

"A region is nothing other than the total highest genetic unity belonging to a concretum, i.e., the essentially unitary nexus of the summa genera pertaining to infimae species within the concretum" (*Ideas I*, §16). **Regional ontology** applies to all objects whatever. There are as many regional ontologies as there are essences of distinguishable concrete entities. "[T]o the pure regional essence, then, there corresponds a regional ontology" (*Ideas I*, §9). First of all, regional ontology defines the hierarchy of genus and species, as mentioned above. According to a highest regional essence, genus and species are ordered up to eidetic singularities, which are the individuals in the region. Moreover, regional ontology defines the set of regional categories (*Ideas I*, §16). It is regional essence that "makes up the content of the regional ontology", besides regional categories are grounded in the regional essence. Hence, the regional categories are eidetic universal and applicable to individual object (ibid). On Husserl's account, these categories pave the way to epistemology. "Each regional essence determines *"synthetical" eidetic truths, that is*

[35] I believe that the reader gets used to the interchangeably use of regional ontology and material ontology. From now on, I will use regional ontology for simplicity.

to say, truths that are grounded in it as this genetic essence" (*Ideas I*, §16). Accordingly, regional ontology also determines synthetic a priori knowledge about the region of entities, and by regional synthetical axioms it governs the given entities. An example can be taken from *Ideas I*, §9. There is Nature as a regional essence, and it corresponds "the eidetic science of any physical Nature whatever", namely the ontology of Nature. Ontology of Nature, therefore, explicates the categories of empirical science of Nature "with rational purity" in order to theorise the grounds of this empirical science.

Every object has a formal essence, and **formal ontology** is the eidetic science of "any object whatever" (*Ideas I*, §10). Like regional ontologies, there is not an overarching formal ontology. The essence of "any object whatsoever" can be applied a number of categories, namely the highest formal essences. Since "anything and everything" is in the scope of formal ontology, and formal ontology "always as pure logic in its full extent as *mathesis universalis*, then every empirical science has essential theoretical foundations in formal ontology (*Ideas I*, §10). Hence, a rough examination of formal logic is required in order to elucidate formal ontology.

There are two levels of formal logic. At the first level, which is called apophantic logic, logical statements are examined under the truth conditions. At the second level, on the other hand, the things and their syntactic forms are investigated by formal ontology by the help of the first level (Cf. *Ideas I*, §10). There can be another approach to formal logic, accordingly. Formal logic is divided into two parts: the first part deals with truth, and the second deals with things; hence formal ontology is the application of first part on the second part: Truth applies on the things (Cf. Smith and Smith 1997, p28). Therefore, "formal-ontological conceptions are like the concepts of formal logic in forming complex structures in non-arbitrary, low-governed ways" (Smith and Smith 1997, p29). Since formal essences are independent, formal logic is independent form experiences, and formal logic is equalized with formal ontology, then formal ontology is a prior science with pure

necessary propositions. That makes formal ontology is descriptive, and determines analytic a priori judgments (Cf. *Ideas I*, §16).[36]

Since Husserl does not give any criteria that help to distinguish formal and non-formal entities, it is the philosophers' duty to investigate the entities and their essences, and construct the regional and formal ontologies accordingly (Cf. *LU*, I, §71).[37]

Before ending this part, it is necessary to speak of the last realm of Husserl's ontology. Besides the realms of fact and essence, Husserl introduces **the realm of meaning** or sense (Smith 1997, p330). This realm subsumes contents and their components. Like essences, meanings are not spatiotemporal. They are contents of intentional experiences, which are a consciousness of something. The object of experience has a different feature in this realm as being the object of intentional experience, which is prescribed by the content of the experience. Therefore, "contents are meaning-entities which prescribe objects in the world outside consciousness" (ibid).

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[36] There are various interpretations of both ontologies. According to Poli, formal ontology has two different interpretations (1993). The analytic one says that formal ontology is analysed under the limitations of formal logic. Thus, formal ontology deals with "the logical characteristics of predication and the various theories of universals". The "phenomenological" interpretation says that formal ontology deals with the problems of parts and wholes and of dependence, which are found in *Third Logical Investigation*. As said by Poli, both interpretations overlap. Smith and Smith suggest that formal ontology studies "relations of part to whole and of dependence" (1997, p29). There is another argument that the theory of parts and the whole is not only in the scope of formal ontology, but rather both formal ontology and material ontology deal with it (See Poli 2003, pp 191-192).

According to Poli, regional ontology has two different interpretations, as well (1993). The genetic interpretation says regional ontology deals with perception and its foundations. This leads the claim that regional ontology precedes formal ontology. The descriptive ontology, however, says regional ontology is ontic, and deals with the highest genera. This claim leads to formal ontology precedes regional ontology. The problem may be converted to the following: is it analytic a priori truth or synthetic a priori truth prior?

[37] Moreover, it is worth noting Husserl's antipsychologism. According to psychologism, all the philosophical concepts and issues can be reduced and explained in the realm of psychology. If logic is the basis of all sciences, then the explanation of logic in terms of psychological concepts causes fallacy. Moreover, according to Husserl, psychology is an empirical science that cannot have any supremacy over phenomenology.

"Ontologie ist nur als Phänomenologie möglich" was said by the well known student of Husserl. History of philosophy encounters opposite doctrines between master and pupil, just in the case of Plato and Aristotle. So, what would Husserl say for this saying: would he support or reject? In *Ideas I*, § 17, Husserl states that the context of phenomenology is needed to clarify both regional and formal ontologies, namely without phenomenology, the fundamental structures of neither regional nor formal ontology can be comprehended. This makes phenomenology, or the theory of intentionality in other words, at the top of all ontologies. Still, empirical intuition makes material entities known; eidetic intuition makes eidetic entities known; phenomenological reflection on experiences makes contents of experience known. These three intuitions, therefore, make the whole world knowable. The abovementioned discussion of independent and non-independent entities are to be considered lastly. A concrete entity has its meaning in time, so its content of experience requires an entity that gives the meaning to that concrete entity. This entity is pure consciousness; besides being the pure entity, it is absolute existent, which establishes the world. Therefore, the subject matter of the phenomenology is the ultimate entity in Husserl's ontology.

In conclusion, it is obvious that Husserl's ontology is a sophisticated one. Unlike Kant or Aristotle, his doctrines of logic, epistemology, and, ontology, and of course phenomenology, are interwoven; without any of them, the whole Husserlian system would collapse. Moreover, the parts of his ontology, also, cohere each other: The ontology of fact is essentially dependent on the ontology of essence (Cf. *Ideas I*, §9), and ontology of essence is dependent on ontology of meaning (Cf. *Ideas I*, §17). Moreover, "genuine philosophy, the idea of which is actualizing of absolute cognition" says Husserl, "is rooted in pure phenomenology" (*Ideas I*, Introduction). Therefore, the whole consistent system, in which the phenomenology is at the zenith, can be called Husserl's ontology.

2.1.3. Quine's Ontology

Of the third phrase of fourth period among the analytic philosophers, Quine is the last philosopher to be mentioned in this thesis. Rising as a reaction to the

second phase of practical interest, the third phase, also called scepticism, is a philosophical approach that aims practical concerns issues meaningfulness in all areas, but not in itself, which leads sceptical glances upon such approach.[38] In this part, I speak of Quine's approach to ontological inquiry in his paper called "On What There Is".[39]

Quine starts his paper "On What There Is" with the indispensable question of any ontological investigation: What is there? The inevitable answer is quite easy: Everything. Nevertheless, over centuries philosophers have controversies on "everything". Quine, one by one, argues some ontological views, and comes to his ontological position eventually. Firstly, he analyses the ontology of physical entities. He starts with the Plato's beard, in other words the riddle of nonbeing. It says that nonbeing must *be* in some sense, for any utterance of nonbeing still requires nonbeing to *be.*[40] Therefore, some philosophers suggest that whenever an entity is talked about, it must be, otherwise it would be nonsense to say that entity *is* not. In this sense, they claim that even the fictional entities *are*. When the evidence of their existence is required, those philosophers continue their claim stating that their existence is out of empirical observation, and further they are ideas in men's mind. Pegasus, for instance, *is* not "a flying horse of flesh and blood", but *is* a mental entity. Quine, on the other hand, rejects this claim by stating that idea of Pegasus and idea of a concrete entity, e.g. Parthenon, cannot share the same ontological status. Though, Quine's dissatisfaction may be solved by the introduction of "unactualised possible being". In the idealistic sense, in men's mind, "Pegasus *is*" and "Parthenon is red" share the same ontological status, since they are not actual in this world. Quine's examples over possible situations lead him to think that the concept of identity is not applicable to unactualised possible entities. Although, here, Quine offers a solution that the modality of possibility should be limited to whole statements, Quine's disappointment remains since there may be an entity as

[38] See Introduction.

[39] Quine 1948.

[40] Throughout this part, the emphases belong to me, unless otherwise is stated.

unactualised impossibility, e.g. a round square cupola on Berkeley College. Accepting and rejecting the existence of this entity is nonsense at the same time. So, this dilemma may be solved by the following. Stating "the round square cupola on Berkeley College is" is not nonsense; however, stating the phrase "the round square cupola" is *meaningless*. For, a phrase is meaningfully used when it refers to something that exists. Quine, again, is not happy with the solution of equating naming and meaning, further he rejects the doctrine of meaninglessness of contradictions being an effective method to test meaningfulness. He applies himself to Russell's theory of singular descriptions for help. According to this theorem, descriptive names, even the complex ones, can be transformed into variables of quantifications without considering their existence or meaningfulness; all the burden of existence and meaningfulness is taken by the variables of quantifications, moreover, in order to be meaningful it is not necessarily that descriptive names have reference, but rather sense.[41] These quantificational words, says Quine, "are basic parts of language and their meaningfulness, at least in a context, is not to be challenged".

Quine has to go up against the philosophers who maintain there are universal entities by fighting on two fronts; since according to him, presupposition of such entity is pointless. If red houses, red roses and red sunsets had had something in common, it would be the attribute of redness, which is obviously a universal. On this front, Quine rejects redness being an entity, just like household, rosehood, and sunsethood. "Redness" in itself is a noun, but not a name that points out an abstract entity; rather "red" is a predicate of individual objects, such as houses, roses or sunsets. Claiming existence of universals is a fallacy of conceptual scheme; in which there would not be a necessity to give justifications. On the second front, Quine has to fight against the claim that "red" as an attribute names an entity, which is "redness", and "redness" is still meaningful; hence "redness" is more than being a name. "I do not", says he, "deny that words and statements are meaningful", but meaningfulness and meaninglessness are to be considered in

[41] One-word names or alleged names can be modified to descriptions under Russell's theory of descriptions.

linguistic forms. Therefore, he rejects to admitting meanings as entities, and, of course, as universals.

The ontology of abstract entities, secondly, is to be handled. According to Quine, the ontology of abstract entities, again, is controversy over universals. This part is explained within the modern philosophical mathematical approach, rather than the classical philosophical ones; for the former clearly and explicitly discusses the bond variables and their reference. In modern mathematics, "a theory is committed to those and only those entities to which the bound variables of the theory must be capable of referring in order that the affirmations made in the theory be true". When this approach is merged with ontology, linguistic problems occur. For, the bound variables, here, do not designate what there is, but rather what theory says about what there is. So, this is not an ontological inquiry. Obviously, while discussing what there is, semantical concerns should be withdrawn in order not to astray from ontological discussions. Consequently, Quine states that an ontology is similar to a scientific theory. In both, the simplest conceptual scheme is assumed, for the rule of simplicity directs the assigning sense data to objects. Accordingly, experiences are tailored and arranged. In this line of thought, the acceptance of an ontology, just the same as the acceptance of any system of scientific theory, is a matter of language.

The examples from modern mathematics are not given arbitrarily. As stated above, a theory is committed to entities, and further scientific approach to ontology is required. Quine, then, formulates a criterion that is based on logic in order to save ontology: the criterion of ontological commitment.[42]

> The variables of quantification, "something", "nothing", "everything", range over our whole ontology, whatever it may be; and we are convicted of a particular ontological presupposition if, and only if, the alleged presuppositum has to be reckoned among the entities over which our variables range in order to render one of our affirmations true.

[42] In the roots of the criterion, there lie two essential points: language is great tool to express the world, so modern logic must be used in any theoretical approach, and methods of quantification play the central role in stating forms of generality.

Quine explains the above saying with the following example: Some dogs are white. The variable of quantification, “some things”, ranges over the whole ontology, we may take it as our world. Then, the statement of daily language turns into a logical statement, “Some things are dogs and they are white”. Still, in order that this statement be true, the variable of quantification must refer to the things, “some things” must refer to “some white dogs”.[43] At last but not least, Quine’s famous slogan can be used to conclude the ontological commitment: “To be is to be the value of a variable”.[44]

Hitherto, Quine’s paper, “On What There Is” is analysed, however, except his slogan there is no clue of an articulated ontology of him. Is “to be is to be the value of a variable” enough to construct an ontology? This question, for sure, a wrong and meaningless one. Although the title suggests that Quine would speak of what there is, we are only committed to believing in such variables are entities, and in a given ontology. All this, then, leads us Quinean doctrine of ontological relativity.[45] Quine ponders that the entities are spoken of according to a language, either natural or artificial, or to a theory. Theorising, whose language is logic, is constructing an ontology on scientific grounds; that is to say if there is something like Quinean Ontology, it must rise up from the sciences. The only way to talk about an ontology, I believe, is possible within the framework of theories.

2.2. Categories

A category is an inventory of what there is in the scope of the highest genera. In other words, categories are the highest-level universals. According to doctrines of philosophers, an approach to category system varies, for philosophers differ over the entities, so the lists of entities do as well. In some systems,

[43] The statement does not commit the existence of either “doghood” or “whitehood”.

[44] “To be assumed as an entity is, purely and simply, to be reckoned as the value of a variable” is an alternative statement that is also found in the paper.

[45] I am not going to analyse Quine’s paper “Ontological Relativity”. I only give extract information that relates this thesis. See (Quine 1969) for detail.

universals are categorised hierarchically under highest-level universals; yet in the others, universals are grouped without a hierarchy.

The ontologies of Aristotle, Husserl and Quine were given with purely philosophical considerations in the first part of this chapter. In the second part, however, I will give brief information about the category systems of these philosophers and Kant without falling into deep philosophical worries.

2.2.1. Category System of Aristotle

The traditional arrangement of Corpus Aristotelicum begins with *Categories*, which is also the first book of the collection called *Organon*. *Categories* gives a list of the ten highest categories of things said of without any combination (1b25). Aristotle gives the list and examples to illustrate an idea in 1b25-2a5 as follows:[46]

i. Substance; e.g., man, horse
ii. Quantity; e.g., four-foot, five-foot
iii. Qualification; e.g., white, grammatical
iv. Relation; e.g., half, larger
v. Place; e.g., in the Lyceum, in the market-place
vi. Time; e.g., yesterday, last year
vii. Posture; e.g., is-lying, is-sitting
viii. State; e.g., has-shoes-on, has-armour-on
ix. Action; e.g., cutting, burning
x. Passion; e.g., being-cut, being-burnt

The number of categories differs throughout the corpus. Aristotle does not give a full list of categories, because he uses the necessary ones when discussing an issue. So, categorising is a tool for singling out the characteristics of substances. The spoken of substances must be perceived,[47] since such a list can be obtained by asking different questions to substances. The first question is about substance,

[46] As I promised at the beginning, I do not stick on Aristotle's use of the words; rather I prefer modern terms. For instance, instead of category of "when" I use "time".

[47] For the investigation of being is in the field of ontology.

"what is it?", then questions "how much", "where", or "in what condition" can be asked. When viewed in this light, the category of substance has a priority. It should be noted that the category substance ramifies: the primary substance and the secondary substance. The former are the individuals, such as Socrates, or an individual horse; the latter are the species of these individuals, such as man, or animal (2a14-19).[48] Although all the categories are equally highest kinds, there must be priority of primary substances, for the questions asked to find out categories are directed to the individuals (Cf. Ackrill 1981, p25). Therefore, if there were not primary substances, it would be impossible to find out any category at all (2b5-6).

In *Categories*, Aristotle considers the highest genera of physical beings. His system of categories can be enlarged, if more questions can be directed to things. To sum up, the category system of Aristotle has realistic approach to what there is, for it comes from observation.

Aristotle's categories were systematically organised by Brentano as a single tree, which is given below (Sowa, 2000, p57). Some nodes of the tree are not found in *Categories*, Brentano took them from Corpus Aristotelicum. It is worth reminding that the right side of the tree is not organised hierarchically, whereas there is a strict hierarchy between substance and accident. The substance mentioned here is the primary substance; and further Brentano's tree of Aristotle's categories is first level investigation of being.[49] The tree is given in the Figure 2.1.

[48]It is obvious that secondary substances would not be in the absence of primary categories.

[49] See Chapter 2, 1.1.

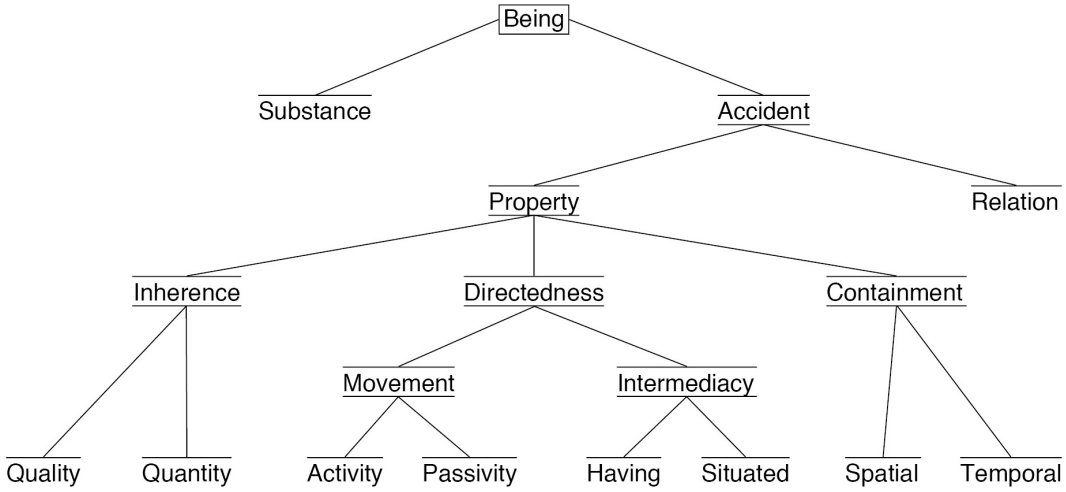

Figure 2.1. Brentano's Tree of Aristotle's Categories (Sowa, 2000, p57)

2.2.2. Category System of Kant

In the *Critique of Pure Reason*, Kant examines categories, which are also called a priori concepts. Categories structure all of the human thoughts, for they construct experience by applying to "objects of intuition in general *a priori*" together with the a priori forms of sensible intuition (A79/B105). Further, categories, as a priori concepts, find themselves in the principles of human understanding. However, how to discover these pure concepts of understanding requires close examination.

> … there arise exactly as many pure concepts of the understanding, which apply to objects of intuition in general *a priori*, as there were logical functions of all possible judgments in the previous table [Table of Judgments; A70/B95]: for the understanding is completely exhausted and its capacity entirely measured by these functions. Following Aristotle we will call these concepts **categories**, for our aim is identical with his although very distant from it in execution (A79-80/B105).

Kant makes use of logic in order to investigate logical function of the understanding in judgments (A70/B95). The reason of giving the forms of possible judgments, the twelve logical functions in other words,[50] is to find out all of the most general

[50] The table of judgment has four titles, and three moments in each title. The titles are: quantity, quality, relation, and modality. The moments are regarding on quantity, a judgment may be universal, particular, or singular; regarding on quality, a judgment may be affirmative, negative, or infinite; regarding on relation, a judgment may be categorical,

concepts that are employed in making judgments, and thus employed in cognition of objects. That is to say, categories can be discovered by studying the forms of possible judgments.

Empirical judgments refer to objects, and they are universally valid. The objectivity of empirical judgments are ensured by the a priori concepts that are contained the related forms of judgments. So, the categories can be listed as long as the forms of judgment are listed from the empirical realm by the assistance of logic.

> …the objective validity of the categories, as a priori concepts, rests on the fact that through them alone is experience possible (as far as the form of thinking is concerned). For they then are related necessarily and a priori to objects of experience, since only by means of them can any object of experience be thought at all.
>
> The transcendental deduction of all a priori concepts therefore has a principle toward which the entire investigation must be directed, namely this: that they must be recognized as a priori conditions of the possibility of experiences (whether of the intuition that is encountered in them, or of the thinking). Concepts that supply the objective ground of the possibility of experience are necessary just for that reason (A93-94/B126).

Therefore, the concepts of understanding corresponds the concepts of judgment.

The table of system categories, which is given in Table 2.2., according to Kant, delineates "the plan for the whole of a science", because it is embedded on *a priori* concepts, and further divides the whole of science with determinate principles mathematically. As a result of these, table of categories "is indispensable in the theoretical part of philosophy" (A833/B109).

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hypothetical, or disjunctive; regarding on modality, a judgment may be problematic, assertoric, or apodictic (A70/B95).

Table 2.2. Kant's System of Categories

1.
Of QUANTITY
Unity
Pluraty
Totality

2.
Of QUALITY
Reality
Negation
Limitation

3.
Of RELATION
Of Inherence and Subsistence
(substantia et accidens)
Of Casuality and Dependence
(casue and effect)
Of Community
(reciprocity between agent and paitent)

4.
Of MODALITY
Possibility - Impossibility
Existence - Non-existence
Necessity - Contingency

The last words will be on the completeness of this list. Although Kant accuses Aristotle for being inconsistent about the number of categories (A81/B107), he reserve himself doing another thing instead of completing the list of categories (A81/B108). The difficulty lies here, although for Kant this work is quite possible and easy, is that "the categories combined either with the *modis* of sensibility or with each other yield a great multitude of derivative *a priori* concepts (A81/B107). The complete catalogue of categories has not been prepared over the centuries (Sowa, 2000, p58).

To sum up, the applications of judgments to objects require pure concepts, hence Kant uses table of judgments as a basis to reach those a priori logical concepts, viz. categories. Categories apply universally and necessarily to all objects of experience thanks to the mind, and they are the principles of judgements; then by the means of them, humans get a priori knowledge.

2.2.3. Category System of Husserl

In the first part of this chapter, I gave the definitions of Husserlian categories.[51] For the sake of recall, Table 2.3. gives Husserl's system of categories (Smith, 2006, p157, modified).

Table 2.3. Husserl's System of Categories

Fact
- real individuals
  - independent individuals
  - dependent individuals
- states of affairs
- events
  - natural events
  - mental events, experiences, acts of consciousness
  - cultural events

Essence
- **Formal Essence**
  - **Category**
    - Individual or Substrate
    - Species, Quality or Property, Relation
    - State of Affairs
    - Connection [And, Or, Not, If-Then]
    - Neccessity, Possibility
    - Dependence, Indepence
    - Whole, Part
    - Unity, Plurality, ...
    - Number
    - Set, Group, ...
    - Manifold
    - Value
    - ...
- **Material Essence**
  - **Region**
    - Nature
      - ..., Plant, Animal, ..., Human, ...
    - Consciousness
      - Subject ("I"), Act of Consciousness, Stream of Consciousness
    - Culture or Spirit
      - Person, Cociety, Value, Artifact, ...

Meaning or Sense
- Individual Sense
- Predicative Sense
- Proposition(al Sense)
- Connective Sense
- Quantifier Sense

[51] See Chapter 2, 1.3.

Sowa states that Husserl constructs a “logic of ideal content” in his *Logical Investigations* as follows (2000, p62):

i. Meaning and expression
ii. Genus and species
iii. Parts and wholes
iv. The role of grammar in combining meanings
v. Intentional experiences and their contents
vi. Knowledge in terms of meaning intention and meaningful fulfilment.

Since intentionality takes a front place in Husserl’s ontology, accordingly Husserl develops a triadic categorical system in *Ideas* (Sowa 2000, p62). The first category is called noema, which is “abstract content or meaning of perception”; the second category is called noesis, which is “the process of recognizing an object according to some noema”; the third category is called intentionality, which is “the mental mediation that directs the noema to its object in the process of noesis” (ibid). Hence, this categorisation requires, like the previous one, that the first ones are necessary for the actualisation of the third categories.

To sum up, the category system of Husserl has descriptive approach to what there is (Cf. *Ideas I*, §75). The first category, I think, resembles to Aristotle’s system of categories; and the second one resembles Kant’s system of categories. In order to get his categorical system as a whole, Husserl, then, adds his most distinguishable ingredient upon the first two categories: intentionality.

2.2.4. Category System of Quine

Quine criticises the use of category words in “Existence and Quantification” (1969, p91). Each category covers different style of variables in terms of quantification theory, for the style of variable is a matter of choice (ibid, p92). An ontology, and the choice of categories respectively, depends on the ontological commitment of the thinker; moreover not only in the semantic categories, but also in the existential categories respond to ontological commitment.

Unlike abovementioned philosophers, Quine does not say anything about the objects of his category system. According to Sowa, Quine's famous slogan, "to be is to be the value of a quantified variable", is a criterion for identifying the ontological categories (2000, p52). The criterion, however, points out the implicit ontologies of the people, and the categories of those ontologies accordingly. Therefore, categories can be found when the criterion is applied to domain specific ontologies.

CHAPTER 3

ANALYSES OF UPPER LEVEL ONTOLOGIES

Ontology is a new interdisciplinary science with empirical outcomes, and today studying it is no more simply a philosophical enterprise. Arisen from conceptualization of a domain, ontologies surpass entities in closed worlds: they generalise all kinds of entities in reality. The main purposes for construction an upper-level ontology (ULO) are to provide interoperability across all kinds of domains, and to reuse an ULO without further worries. This purpose can be achieved by specifying general concepts that are common in all kinds of domains. Hence, once an ULO is constructed, it is applicable to all fields. Yet, before analysing the most famous ULOs, I give terminological definitions and the procedure of constructing an ULO for the readers outside of the field.

One of the main purposes of an ULO is expressed by the term "**interoperability**", which simply means that the interchange the information. An ontologist must consider designing tools that make various translation mechanisms in order to provide import and/or export of different ontologies at the level of implementation languages (Poli, Healy, and Kameas 2010, p167). Tools are to "support the translation of an imported/exported ontology with the minimum loss in expressiveness", for instance, from OWL to SUO-KIF (ibid). What an **implementation language**, then, is a formal language that represents an ontology and is used to create computer implementations. These languages are constructed upon the requirements of being an ontology; for instance the axioms, taken from logical systems, concepts, relations, and attributes. The most used ontology implementation languages are the following. **Ontolingua**, which is built up on the basis of KIF, is designed to operate as a lingua franca between ontologies, so that different ontologies can be merged on a common platform by translation of Ontolingua (Smith 2002). **KIF** (Knowledge Interchange Format) is an interface between knowledge representation systems (Smith 2002). It, which is even though not an ontology language, is required mentioning, for some ontologists derive their

ontology language from KIF in order to support the definitions and axioms of their ontologies; for instance SUO-KIF was driven from KIF in order to support the Standard Upper Ontology. Sometimes the implementation languages are expressed as the logical systems, such as **FOL**, **SOL**, **HOL**; stands for first order logic, second order logic, higher order logic, respectively. This kind of terms is used for remarking the axioms and constrains that are expressed using the regarding logical system. As an example, then, we can have an idea of the axiomatic system and constrains of an ontology, when it is said to be syntactically expressed in FOL (including KIF); moreover KIF is itself "a variant of the language of the first-order predicate calculus" (Smith 2002). **RDF Schema** (the Resource Description Framework Schema, or RDFS) is a language that allows representing vocabularies of **RDF**, which is "a standard model for data interchange on the Web" (W3C 2004a). At last but not least, **OWL** (the Web Ontology Language), the ontology language of the Semantic Web, is designed to be processed the content of information by the applications (ibid). OWL does, thus, surpass other ontology languages by interpreting content of information on the Web. Providing more advanced concepts, OWL has three "increasingly-expressive sublanguages", as OWL Lite, OWL DL, and OWL Full (W3C 2004b). **DAML**, **DAML+OIL**, and **LOOM** are other implementation languages.

No matter what kind of philosophical assumptions made in the background of an ULO, there is a highest genus from which the categorical system emerges. It is called "**entity**", "**object**", or "**thing**", depending on the preference of the ontologists. Most of the time, calling "object" or "thing" causes problems, since both have physical connotations, nevertheless what constructs an ontology range from theses, computers, books to tax systems, computer systems, and even to electrons, numbers, relations, emotions. From now on, I call "entity" to the highest genus of a category, and "entities" to what is in reality. Constructing **categories** is the fundamental job of an ontologist. Categories are enriched by definitions and axioms in order to cover all possible entities and relations between those entities, so that an ULO is prepared to be applicable in all domains. A category cannot instantiate all entities, so it needs some conceptualizations. Smith states that **conceptualization** is "defined in terms of sets of objects, properties and relations of certain sorts." (2002, p41). **Concepts** are systematized in a category. Not only

entities, but also concepts have relations. The **relations** are defined through the implementation languages. The most fundamental relation is *is_a relation*, in which categories are organized to get the **taxonomy** of the ULO.

Leaving technical issues behind, I continue uttering ontological choices, which are philosophical assumptions for building an overarching ontology. There are two main ontological choices for conceptualization of reality in the philosophical literature: multiplicative vs. reductionist, and descriptive vs. revisionary (Borgo et al. 2002). A **multiplicative ontology** aims maximal expressivity by using large number of basic concepts in order to give reliable account of the reality (ibid). Contrarily, a **reductionist ontology** aims at using minimal number of basic concepts in order to model the reality (ibid). The distinction between these two contrary approaches can be illustrated by an example of co-localised entities (ibid). The answer to the question, "is there any difference between a vase and the amount of clay it is made of?", illustrates the philosophical approach. A multiplicativist says "Yes", since the vase and the amount of clay it is made of are co-localised in the same time and space, further they have distinct essential properties: an amount of clay constitutes a vase, yet it is not the vase. A reductionist, on the contrary, says "No", since there is only one entity in the same time and space. Although the distinction of essential properties is admitted by a reductionist, this distinction is a result of a point of view; the vase and the amount of clay it is made of is one and the same entity.

A **descriptive ontology** aims to capture all kinds of entities, as much as possible, in an unrestricted way by taking the actual structure of natural language and commonsense (Borgo et al. 2002). Due to its perspective of adequacy to all levels of reality, it is also called **realist ontology** (Smith 2002).[52] A **revisionary ontology**, or **prescriptive ontology**, on the other hand, aims to model the reality as it is (Poli, Healy, and Kameas 2010). In order to create a better structure of the reality, a revisionist thus refrains from any ontological assumptions that cause debates in science or philosophy, hence s/he "suggests paraphrases of linguistic

[52] Since a reductionist aims to reduce the entities by generalizations, and a realist tries to capture all levels of reality, these two assumptions are contraries of each other as well.

expressions or reinterpretations of cognitive phenomena" (Borgo et al. 2002).[53] The distinctive philosophical approach is the distinction between things and events.[54] In commonsense, spatial objects, as books and computers, are different from temporal objects, as bank transfers and writing a thesis (ibid). Accordingly, "human perception, cultural imprints and social conventions" must be considered as cognitive artefacts, and those must be referred in the categorical system of a descriptive ontology (ibid). However, a revisionary ontology claims that all the entities extend in space and time; therefore, such distinction is irrelevant (ibid).

There are some more ontological choices. **Actualism** admits only "what is real exists", whereas, **possibilism** admits also the possible worlds or situations as well (Borgo et al. 2002). In actualism, all the modal and temporary operators are determined from the very beginning, while in possibilism, modal and temporary operations are added later as predicates (ibid). For instance, "it is possible that she is happy" is an example of the former; "there is a world in which she is happy" is an example of the latter. In a similar manner, **presentism** admits "what is present exists", **eternalism**, on the other hand, admits all the entities exist in the past, in the present, and in the future (ibid).[55]

A fundamental constituent of ULOs is the views on time, as seen above. **Endurants** are entities that are present wholly at each time when they exist; **perdurants** are the entities that happen through time, and have time intervals (Poli, Healy, and Kameas 2010). Accordingly, endurants are present with all of their parts, namely they do not have temporal parts. Further, events are obviously perdurants. My book, for instance, is an endurant, while my reading the book is a perdurant. The matter of persistence through time is also discussed under terms continuants and occurrents. A **continuant** can be defines as entities that have stable attributes, for instance I am a continuant; whereas an **occurrent** can be defined as a state of flux, for instance my life is an occurrent (Sowa 2000). According to Borgo et al.,

[53] A revisionary ontology thus resembles to a reductionist ontology.

[54] Things and events are sometimes called as objects and processes, respectively.

[55] It is obvious that possibilism and eternalism, and actualism and presentism go together.

endurants and perdurants are the same terms as, continuants and occurrents, respectively (2002); however, according to Poli, Healy, and Kameas, these terms are different from the former ones (2010, p43). Moreover, discussions on continuants and perdurants raise the distinction between 3D and 4D ontological objects. According to **3D view**, the entities are wholly present at any time of their existence (Niles and Pease 2001). When this view is hold, there is a categorical distinction between things and events (ibid). According to **4D view**, time is the fourth dimension added to three spatial dimensions, thereby occurrents are considered as 4D objects (Munn and Smith 2008). Namely, 4D objects are entities with both spatial and temporal extensions. Hitherto, by introducing endurants and perdurants, only concrete entities, both things and events, are mentioned, on the other hand there are **abstract entities** that are independent of space an time, such as numbers. Taking abstract entities into categorical systems is a matter of choice. There is another issue that depends on the philosophical views of an ontologist: are there universals in the ontology? **Universals** are entities that can be instantiated, whereas **particulars** are entities that cannot be instantiated (Borgo et al. 2002). Universals need to be defined thoroughly, since that abstracts, predicates, sets are to be considered as universals is crucial when using an ULO.

Upon philosophical assumptions, an ULO is constructed with ontological tools. Considering all the entities and even using the same language, two ontologists most probably introduce different conceptualizations due to their philosophical assumptions. In the following, the most popular and important ULOs, namely Basic Formal Ontology, Descriptive Ontology for Linguistic and Cognitive Engineering, Suggested Upper Merged Ontology, and Cyc and OpenCyc are examined.

3.1. Basic Formal Ontology

The Basic Formal Ontology (BFO) is an upper-level ontology that is designed to provide interoperability in scientific (especially), and other domains. Since 1998, Barry Smith and Pierre Grenon have developed and formulated the theory behind BFO that has been presented in a series of publications. In 2002, the

BFO Project was started under the project *Forms of Life* sponsored by the Volkswagen Foundation (BFO n.d.). Subsequent to the BFO versions 1.0 and 1.1., in 2012, the current version of BFO, BFO 2.0, was released as a draft for generating lively discussions and welcoming public comments. BFO 2.0 has implementations of FOL and OWL-DL, yet both in draft. The first two versions of BFO were constructed as a tree, whose nodes represent mutually exclusive universals. Preserving most of the original taxonomic structure, BFO 2.0 has additional set of relations and related axioms (ibid).

BFO bisects two sub-ontologies - SNAP and SPAN- from one common root, which is called “Entity”. BFO contains 1 top Entity class, 25 SNAP classes, and 8 SPAN classes for a total of 34 classes connected via *is_a* relation. As BFO’s new feature that mentioned before, these classes have relations between each other. BFO 2.0 has 78 object properties and over 130 axioms (Release Notes, 2012). The dichotomy of the Entity class rests on the treatment of defining entities in space and in time. The Continuant class, whose entities exist at a time, is formulated in the SNAP ontology, and the Occurrent class, whose entities have process though time, is formulated in the SPAN ontology. The classes and the modularity of BFO will be examined later on. For updated information about BFO, the home page can be visited: http://www.ifomis.org/bfo.

Assumptions

The ontology developers have some assumptions that will shape the construction of their designs. Changing in kind and in degree, these assumptions are like the keynote of the taxonomies. Then, an underlying objective of BFO is to be an ontology for scientific domains. The authors of BFO, thus, mainly consider the scientific phenomena while building this upper-level ontology (Release Notes, 2012). Moreover, the modular feature of BFO provides continuant and occurrent differences; both things and events are in the scope of the Entity class. When viewed in this light, BFO has been generated as a descriptive ontology. Further, its descriptive approach invokes multiplicative view. A multiplicative upper-level ontology includes as many concepts as that reality requires to be expressed. The Continuant class and the Occurrent class warrant that any property of an entity can

be identified with respect to time; continuants –entities that exist fully at some time- belong to the former, occurrents –entities that exist in part at any instant- belong to the latter. Therefore, entities are not reduced to a minimum number of classes; rather they are defined in a very articulated manner both in space and in time. Moreover, BFO also attempts to merge 3D and 4D views with continuants and occurrents, or endurants and perdurants, respectively (BFO n.d.). Lastly, there is not any distinction between necessary and possibility; thus BFO only admits actual entities. To sum up, the rationale behind the construction of BFO has been influenced from descriptivism, multiplicativism, and actualism.

Equipped with abovementioned approaches, BFO has constructed originally holding realist attitude by the developers who build their philosophy progressively (Magee 2011).

Hierarchical Structure

It comes to employ philosophical approaches into work. The primary distinctions are of importance. The Figure 3.1. illustrates BFO 2.0 is_a hierarchy (Release Notes, 2012). Each type will be explained briefly, and when it is possible, theorem, axiom, or elucidation about it will be given. Unless mentioned, the references of the following summary are from Release Notes (2012).

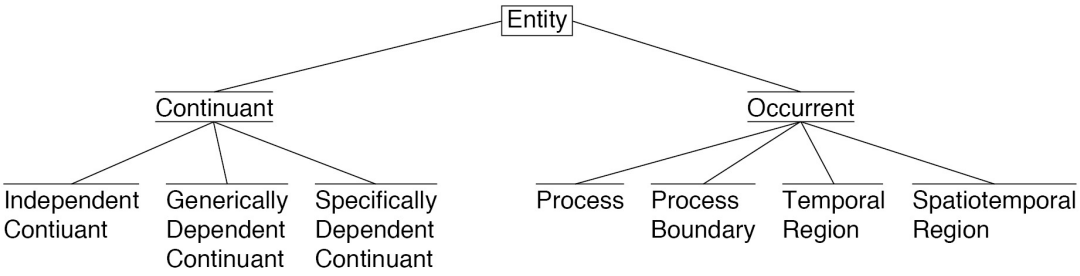

Figure 3.1. The BFO 2.0 *is_a* Hierarchy

The common root concept is “Entity”.

1. ELUCIDATION: An **entity** is anything that exists or has existed or will exist.

BFO, on the other hand, does not deal with all the entities, for instance mathematical entities. As mentioned before, the background mission of BFO is to serve scientific domains; hence the BFO developers aim to construct a basis of the entities, those entities are "studied by empirical science together with those entities which affect or are involved in human activities". Entities can either be universals/types or particulars/instances. In Release Notes (2012), there are two rules: (i) All entities are either particular or universal, and (ii) no entity is both a particular and a universal. They are connected to each other in relations, at any level, namely there are three groups of relations between universals, universal and particular, and particulars.

The most fundamental relation is "*is_a"*. The *is_a* relation is the subuniversal relation between universals. Once the *is_a* hierarchy is formed, other relations between entities are set with ease. Yet, what would be the next consideration that creates primary distinction?

The first dichotomy comes from views of Zemach on spatial-temporal entities. Continuants are the entities that exist along spatial dimension as a whole; whereas non-continuants, occurrents, are entities that exist along spatial-temporal dimensions as a part of a whole. Obviously, with respect to occurrents, continuants rule out time, hence continuants are of 3D; instead occurrents are of 4D. In order to proceed, firstly the Continuant class, then the Occurrent class will be examined.[56]

1.1. ELUCIDATION: A **continuant** is an entity that persists, endures, or continues to exist through time while maintaining its identity.

1.1.1. Independent Continuant:

DEFINITION: *b* is an **independent continuant** = Def. *b* is a continuant which is such that there is no *c* and no *t* such that *b s-depends_on c* at *t*;

where "*b"* and "*c"* stand for instances, "*t*" for temporal regions, and "s-depends_on" relation means

[56] Emphasises, like italics, are done for the sake of ease with reading. However, in the reference document emphasises differ for various purposes. One should check it properly.

ELUCIDATION: To say that *b* s-*depends_on c* at *t* is to say that (i) *b* and *c* do not share common parts, (ii) *b* is of its nature such that it cannot exist unless *c* exists, and (iii) *b* is not a boundary of *c* and *b* is not a site of which *c* is the host.

An organism, or an orchestra is an independent continuant. This type is divided in two subtypes: material entity and immaterial entity. A **material entity** is an independent continuant that has some portion of matter as proper or improper continuant part, whereas an **immaterial entity** is an independent continuant that contains no material entities as parts. Better to note, matter contains both mass and energy.

1.1.2. Specifically Dependent Continuant

DEFINITION: *b* is a **specifically dependent continuant** = Def. *b* is a continuant and there is some independent continuant *c* which is not a spatial region and which is such that *b* s-depends_on *c* at every time *t* during the course of *b*'s existence; where "*b"* and "*c"* stand for instances, "*t*" for temporal regions (for *s-dependence_on* relation see 1.1.1).

The smell of this potion of mozzarella, the role of being a teacher, and the relation of authority between the professor and his subordinates are examples of specifically dependent continuants. The subtypes of this type are **quality** and **realizable entity**. A **quality** is a specifically dependent continuant that, in contrast to roles and dispositions, does not require any further process in order to be realized; e.g. the smell of this potion of mozzarella. A **realizable entity** is a specifically dependent continuant that inheres in some independent continuant that is not a spatial region and is of a type instances of which are realized in processes of a correlated type; e.g. the role of being a teacher.

1.1.3. Generically Dependent Continuant

DEFINITION: *b* is a **generically dependent continuant** = Def. *b* is a continuant that *g-depends_on* one or more other entities;

where "*b"* stands for an instance, and "g-depends_on" relation means

ELUCIDATION: *b g-depends* on *c* at t_1 means: (i) *b* exists at t_1 and *c* exists at t_1, (ii) for some type *B* it holds that (*c* instantiates *B* at t_1), (iii) necessarily, for all *t* (if *b* exists at *t* then some instance_of *B* exists at *t*), and (iv) not (*b s-depends_on c* at t_1); where "*b"* and "*c"* stand for instances, "*B*" for a universal, "*t*" and "t_1" for temporal regions.

The sequence of this protein molecule and the sequence that is a copy thereof in that protein molecule can be given as an example of a generically dependent continuant. Entities in this type can migrate though a process.

1.2. ELUCIDATION: An **occurrent** is an entity that unfolds itself in time or it is the instantaneous boundary of such an entity (for example a beginning or an ending) or it is a temporal or spatiotemporal region which such an entity occupies_temporal_region or occupies_spatiotemporal_region.

1.2.1. Process

DEFINITION: *p* is a **process** = Def. *p* is an occurrent that has temporal proper parts and for some time *t*, *p* s-*depends_on* some material entity at *t*.

A process of writing thesis, the purring of a cat, or histories can be examples of process.

1.2.2. Process Boundary

DEFINITION: *p* is a **process boundary** =Def. (i) *p* is a temporal part of a process and (ii) *p* has no proper temporal parts.

The boundary between the 2nd and 3rd year of a cat's life is a process boundary example.

1.2.3. Temporal Region

ELUCIDATION: A **temporal region** is an occurrent entity that is part of time as defined relative to some reference frame.

This type consists of two parts: **zero-dimensional temporal region** and **one-dimensional temporal region**. The former is a temporal region that is without an extent, for instance the moment of death; the latter is a temporal region that is

extended, for instance the temporal region during which a baby grows in the mother's womb.

1.2.4. Spatiotemporal Region

ELUCIDATION: A **spatiotemporal region** is an occurrent entity that is part of spacetime, which refers to maximal instance of the universal spatiotemporal region.

The spatiotemporal region occupied by a human life is an example for this subtype.

Analysis

In this part, some philosophical and methodological features of BFO will be deducted with respect to data from the previous part. Above all, the way the concepts are selected and designed is explicitly drawn. The relations between types and subtypes are explained in detail in order to be understood fully. Moreover, definitions, axioms, theorems, and elucidations are the crucial tools that make BFO be clear to the minds of users. Secondly, BFO is a top-to-down construction. As seen above, the common root is defined in a metaphysical way: an entity is anything that exists or has existed or will exist. Settling this on the top, the developers take into account the features of both physical and social entities, and then construct the hierarchal structure. Hence, BFO is constructed as an ontology, rather than a data model. Thirdly, BFO has extensive and flexible structure that is provided by both SNAP and SPAN sub-ontologies. Next, thus, BFO supports mutually exclusive 3D and 4D views ontologically, rather than terminologically; for the SNAP and SPAN sub-ontologies are indispensible part of BFO. On the other hand, I believe that there is no essential place for metaphysics in BFO, because, for example, it leaves the determination of universals to the BFO applicators. That is to say that entities are determined as universals or particulars with respect to needs of a domain. The sixth point is there is no abstract-concrete distinction in BFO. Indeed, in Release Notes, it is noted that BFO does not support non-spatial and non-temporal entities (2012). Lastly, BFO has no room for probabilistic ontologies. Although the developers noted that non-spatiotemporal entities will be considered in the future releases, they do not forecast anything on this issue.

Technical Information

BFO is one of the most popular upper-level ontologies for several reasons. It is a product of hard work of years, both theoretical and practical. It is being developed constantly by supporting public comments thanks to providing free access to anything related with it. The Basic Formal Ontology proves its reliability by the list of users that can be found on http://ifomis.uni-saarland.de/bfo/users, which also shows its application domains that vary from mainly medical domains to business domains. BFO is freely available, and its OWL and FOL versions can be downloaded from http://ifomis.uni-saarland.de/bfo.

3.2. The Descriptive Ontology for Linguistics and Cognitive Engineering

DOLCE, the Descriptive Ontology for Linguistics and Cognitive Engineering, is an upper-level ontology that was developed by the Laboratory for Applied Ontology, which is headed by Nicola Guarino. As a part of WonderWeb Project, DOLCE was developed as a library of foundational ontologies, which are linked to each other in order for establishing interoperability and for serving different needs and preferences (Masolo et al. 2003). The developers of DOLCE did not intent it to be an upper-level ontology. As it is understood from its name, the Descriptive Ontology for Linguistics and Cognitive Engineering has a tendency to capture the categories rooted in language and common-sense (Masolo et al. 2003). Thereby, these categories are assigned from a mesoscopic worldview. On the other hand, its stance that an upper-level ontology must be consistent with different ontological constructions requires clear ontological perspective and explicit structure (Poli, Healy, and Kameas 2010). DOLCE have been encoded in various implementation languages FOL (including KIF), OWL, DAML+OIL, LOOM, and RDFS (ibid). According to Cope, Kalantzis, and Magee (2011), it has 159 classes, 280 properties, and 439 concepts; moreover, according to (Mascardi, Cordì, and Rosso 2007), it has 100 terms and 100 axioms. The WonderWeb Project lasted two years - since 2002- that is why DOLCE is among the expired projects; on the other hand, DOLCE has been used in years (ibid). The home page for DOLCE was http://www.loa.istc.cnr.it/old/DOLCE.html.

Assumptions

As stated in the introduction, DOLCE has been shaped according to the biases in human cognition and linguistic nature. Besides, the developers ruled out the intrinsic nature of the world from their philosophical standpoint (Masolo et al. 2003). They present categories as cognitive artefacts "depending on human perception, cultural imprints, and social conventions" (ibid). So, one of the assumptions of designing DOLCE is rooted in Searle's notion that humans share a set of skills, tendencies, and habits due to their specific biological make up and their evolved capability to interact with their habitat. This stance allows making already formed conceptualizations more explicit in favour of reflecting cognitive and linguistic structures clearly. In other words, DOLCE does more than distinguishing between things and events. It, therefore, adopts the descriptive approach (ibid). DOLCE is a multiplicative ontology, as well. This approach is explained by the well-known vase-clay example in (Masolo et al. 2003). The question is whether the vase and the clay are the same things, if a vase is made from an amount of clay. According to DOLCE with regard to language and cognition, entities have different essential properties, for instance a vase and the clay that is the row material of the vase are separate objects. Then, they co-locate in some space and co-occur in some time, yet each exists simultaneously. This brings the further approach that DOLCE admits due to its cognitive bias: there are both endurants and perdurants (Masolo et al. 2003). Endurants as a whole are same in time, while perdurants cannot keep their identity in time (ibid). The next approaches that DOLCE holds are possibilism and eternalism in order to reflect quantifications over instances and worlds; as possibilism admits possible situations and worlds, and eternalism admits the past, the present and the future exist (ibid). Lastly, domain of DOLCE is restricted to particulars (ibid). Universals takes place in DOLCE only when they are characterized in a particular ontology. To sum up, the rationale behind the construction of DOLCE has been influenced from descriptivism, multiplicativism, possibilism, and eternalism.

In the following lines, the hierarchical structure of DOLCE will be expounded in the light of abovementioned assumptions.

Hierarchical Structure

DOLCE puts “Entity” as the common root to the top of its hierarchy; that is to say, it is the topmost class of individuals (Masolo et al. 2003). Figure 3.2. shows the top level categories in DOLCE.

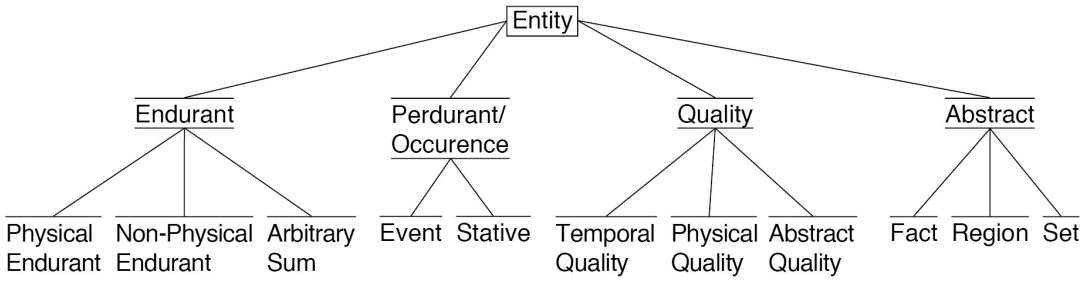

Figure 3.2. Top Level Categories in DOLCE

1. **Entities** are either ontological or conceptual; the former ones exist independently of our mind, whereas the latter ones are the conceptual outcome of our minds (Poli, Healy, and Kameas 2010). However, this distinction is not reflected on the mapping. Entity is divided into 4 subcategories: Endurants, Perdurants, Quality, and Abstract. Above all, the most fundamental division in DOLCE, which is derived from OntoClean Methodology, is between Endurants and Perdurants (Masolo et al. 2003).

1.1. Endurants: According to (Masolo et al. 2003), an entity is an **endurant** if and only if (i) it exists at in several times and (ii) statements about its part must be relative to different instants. **Physical endurants** and **non-physical endurants** differ each other according to whether they have spatial qualities (Cf. 1.3. below). **Arbitrary sum** refers to any set of physical and non-physical endurants.

1.2. Perdurants: An entity is a **perdurant** if it extends in time partially, namely, some parts of it present in some time, and some parts may not be present.

A perdurant can be **stative** or **eventive** according to whether it is cumulative or not (Masolo et al. 2003).

1.3. Quality: A **quality** is an entity that can be perceived or measured. Every entity, including qualities themselves, has per se qualities. There are three quality-types: **temporal quality** –that directly inheres to perdurants-, **physical quality** –that directly inheres to physical endurants-, and **abstract quality** –that directly inheres to non-physical perdurants (Masolo et al. 2003).

1.4. Abstract: An **abstract** an entity that (i) it has neither special nor temporal quality, and (ii) it is not a quality itself. There are three abstract-types: **fact**, **region**, and **set** (Masolo et al. 2003).

The relations are as crucial as listing categories. Table 3.1. shows the basic primitive relations. Of all the basic relations, participation relation is the most fundamental one, since it enables that some endurants "involve" in a perdurants.

Table 3.1. Basic Primitive Relations of DOLCE

Parthood: *"x is part of y"*
Participation: *"x participates in y during t"*
Temorary Parthood: *"x is part of y during t"*
Constitution: *"x constitutes y during t"*
Quality: *"x is a quality of y"*
Participation: *"x is the quale of y (during t)"*

Analysis

In the light of previous parts, some philosophical and methodological features of DOLCE will be deducted. First of all, DOLCE has distinction between conceptual and ontological approach. Secondly, this top-down ontology's categories are as conceptual containers. Therefore, there is no deep metaphysical implication (Smith n.d.).

Next, there is spatial-temporal distinction. DOLCE models both endurants and perdurants, and, according to (Semy, Pulvermacher, and Obrst 2004) DOLCE takes a 3D view. However, I think that DOLCE embraces both 3D and 4D views. Next,

there is abstract and concrete distinction. Abstract entities do not have spatial nor temporal qualities, as stated above. On the other hand, abstract entities cannot be taken as universals. As stated in (Masolo et al. 2003), DOLCE is an ontology of particulars. There is room for universals only if they are used as properties. DOLCE is intended as a single module within a larger set of foundational ontologies. This provides strong prospects for interoperability with other foundational ontologies (Semy, Pulvermacher, and Obrst 2004). According to (Cope, Kalantzis, and Magee 2011), DOLCE contains eight different subsidiary and interconnected ontologies: SpatialRelations, TemporalRelations, ExtendedDnS, ModalDescriptions, FunctionalParticipation, InformationObjects, SocialUnits, and Plans. These ontologies generate more complex structures by importing classes and properties from each other. On the other hand, this does not mean that DOLCE is divided into modules. The following is that DOLCE is an original composition, yet its philosophical background is imported from Searle, Aristotle, and others (Cope, Kalantzis, and Magee 2011, p248). Moreover, the stance of Searle in DOLCE makes this upper-level ontology constructivist. Further, it includes possible entities, namely, it is a probabilistic ontology.

Technical Information

DOLCE has been used in various fields, for instance linguistic, textile industry, and computing (Mascardi, Cordì, and Rosso 2007). DOLCE's versions are freely available on http://www.loa.istc.cnr.it/old/DOLCE.html. Although it is an expired project, this descriptive, constructivist, multiplicative, possibilist, and theoretical upper-level ontology is one of the most important examples that helps improving the views on constructing an upper-level ontology.

3.3. The Suggested Upper Merged Ontology

The Suggested Upper Merged Ontology (SUMO) is an upper-level ontology that was initially started as a project prepared by engineers, philosophers, and information scientists from The Standard Upper Ontology Working Group (Niles and Adam 2001). Its starter document was written by Ian Niles and Adam Pease at Teknowledge Corporation, and currently supported by Adam Pease at Articulate

Software (Semy, Pulvermacher, and Obrst 2004). The project aimed merging publicly available ontological designs into a single, comprehensive, and organized structure in order to provide a basis for domain-specific ontologies (Niles and Adam 2001). The rationale behind constructing SUMO is the following. Many researchers from computer science, artificial intelligence, linguistics, philosophy, and library science are trying to improve upper-level ontologies from their perspectives those arise from their disciplines, and those disciplines, however, have their own descriptions and terminologies that explain the world around us. Nonetheless, these researchers are not able to construct an upper-level ontology by their own. Hence, they came together to build such merged ontology in 2000 (Niles and Adam 2001, and Pease n.d.). SUMO has its own KIF version called SUO-KIF (Standard Upper Ontology Knowledge Interchange Format). There is OWL version, as well (Pease n.d.). According to Magee SUMO has 630 classes, 236 properties, and 866 concepts (2011, p249). The latest version of SUMO with approximately 25.000 terms and 80.000 axioms, when all domain ontologies are merged, is available on http://www.ontologyportal.org.

Methodology

As its name suggests, SUMO contains a number of ontologies, whose libraries are already available on the Ontolingua server. In order to construct such a unite, the developers of SUMO took the libraries form Institute of Biomedical Technology-the National Research Council (in Italian, ITBM-CNR), Sowa's upper-level ontology, Russell and Norvig's upper-level ontology, James Allen's temporal axioms, Casati and Varzi's formal theory of holes, Barry Smith's ontology of boundaries, Nicola Guarino's formal mereotopology, and several formal representations of plans and processes including Core Plan Representaion (CPR) and the Process Specification Language (PSL) (Niles and Adam 2001). Then, it came to determining the relevant content, and to translate all those relevant content into the private implementation language of SUMO, namely, SUO-KIF (ibid). Hitherto, the developers identified the assumptions that would maintain "a single,

consistent and comprehensible framework" (ibid).[57] Nevertheless, the next work, combining these ontologies, is the most difficult part of the project. To ease, firstly, the ontologies were divided into two groups according to their defining high-level or low-level concepts (ibid). All the ontologies were in the latter group, except Sowa's upper-level ontology and Russell and Norvig's upper-level ontology. This distinction relies on that the lower-level concepts are taken from a structure in order to support high-level concepts. Since, all the "materials" were grouped, it came to merging them step-by-step. Firstly, the two upper-level ontologies were merged. According to Niles and Adam, this operation did not cause any significant practical or theoretical difficulties (2001). Secondly, this merged ontology served as the basis for aligning lower-level concepts. The aligning process had four stages. Initially, which concepts and axioms were mapped was decided as follows: (i) the concepts and axioms of the merged ontology stay the same, (ii) concepts and axioms must be useful, and (iii) no concept or axiom would be mapped into the basis for the sake of unity of philosophical stance. At the second stage, some axioms and/or concepts, even if those were crucial both theoretically and practically, were ruled out for the sake of pragmatic reasons. Then, the overlapping concepts and axioms were mapped by considering the overall attitude of SUMO. At the final stage, the developers had to consider partial overlaps, which is the toughest stage among other stages. The research team overcame these challenges either by modifying definitions of concepts or formalizations of axioms or by revising the whole concepts and/or axioms. Finally, SUMO is ready to be used. In the next part, the top-level Categories of SUMO will be examined in order to ease understanding how it properly works.

Hierarchical Structure

The top category of SUMO is (1) "**Entity**". The top-level categories are shown in the Figure 3.3.[58] Entity is divided into two: Physical and Abstract.

[57] Explaining all the assumptions in detail goes beyond the scope of this section. The philosophical background of SUMO will be driven from its categories; however, it will be sometimes difficult to determine.

[58] I did not confront any information about how the definition of "entity" is decided.

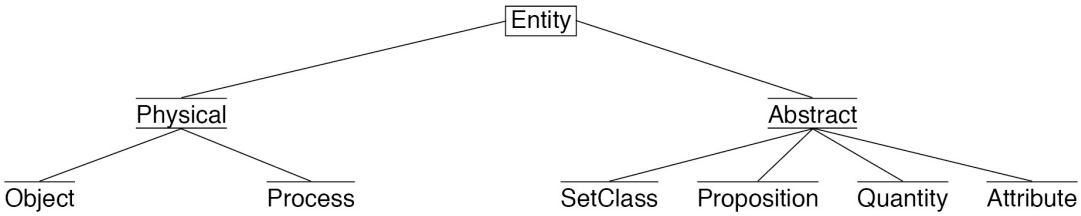

Figure 3.3. The Top Level Categories in SUMO

1.1. **Physical entities** are everything that exists in space and time. SUMO adopts 3D orientation due to interoperate contents between different ontologies (Niles and Adam 2001). This concept subsumes "**Object"** and "**Process"**. Niles and Adam offers definition of objects as entities that are completely present at any moment of their existence; whereas, there is no consensus on definition of processes (2001).

1.2. **Abstract entities** are everything that is not physical. This concept consists of four disjoint concepts. **"Set"** in SUMO takes its definition from the set theory. **"Proposition"** relates semantic or informational content. The third concept **"Quality"** expresses entitles in numbers, both in independent and dependent measurement systems. Lastly, **"Attribute"** points our all entities that are not considered as "Objects" (Niles and Adam 2001).

Before analysing SUMO, the modular feature of it must be mentioned. There are 11 modules with dependency structure as shown in the Figure 3.4. (Pease 2006).

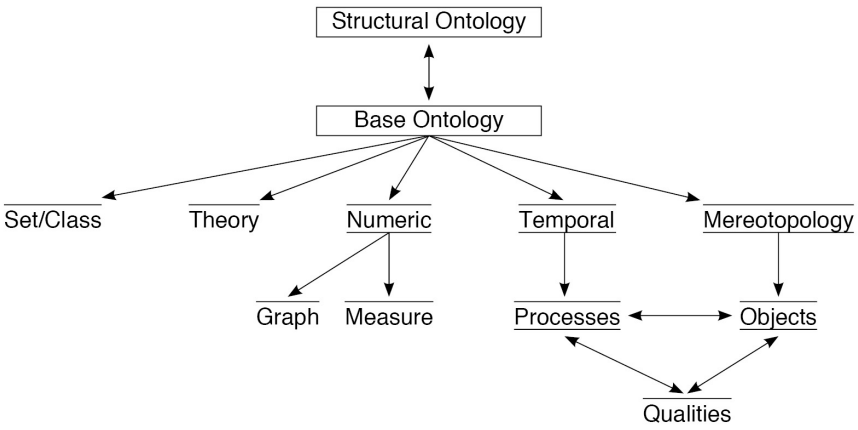

Figure 3.4. The Hierarchy of SUMO Theories

The Structural Ontology contains fundamental relations that define the ontology accurate (Pease 2006). The Base Ontology consists of fundamental classes, such as Abstract and Object (Pease, Niles, and Li 2002). The next section, Set/Class ontology contains set theoretical operations (Pease 2006). The Numeric Ontology includes numeric operations (Pease 2006). The Graph Ontology provides graph theoretic notions (Pease 2006). The Measure Ontology provides definitions of the SI and other unit systems (Pease, Niles, and Li 2002). The Temporal Ontology has taken its notions from Allen's temporal relations (Pease, Niles, and Li 2002). The Mereotopology Ontology contains axiomatization of part-and-whole relations and Casati and Varzi's formal theory of holes (Pease, Niles, and Li 2002). Other three ontologies are explained above.

Analysis

SUMO is developed as a merged upper-level ontology that covers general concepts in common-sense reality (Pease and Fellbaum 2010). On the other hand, there is not sufficient discussion that could illuminate its philosophical assumptions (Cope, Kalantzis, and Magee 2011). Therefore, there exist controversial ideas on SUMO's ontological choices. Above all, it is crystal clear that SUMO is derived ontology. It is neither "home-grown" nor imported philosophy. It is true that it is merged from existing ontologies, but, on the other hand, the four stages of its construction are evidence of that it has its own specific approaches. According to

Cope, Kalantzis, and Magee, with which I agree, SUMO is descriptive, because it aims to capture common-sense categories (2011). On the other hand, yet without a sufficient explanation, (Borgo et al. 2002) claim that SUMO is neither explicitly descriptive nor revisionist. The next point is the discussion whether SUMO is multiplicative or reductionist. According to Semy, Pulvermacher, and Obrst (2004), SUMO is instinctively multiplicative, where as, Borgo et al. (2002) hold a claim that it is not easy to assign only one of these approaches to SUMO. Again, it is not clear whether SUMO assumes actualism or possibilism, as said by Semy, Pulvermacher, and Obrst (2004). The opinion of Semy, Pulvermacher, and Obrst (2004, p4-2) on SUMO's universal-particular distinction is that SUMO does only classify particulars. As stated by the developers, however, SUMO is an upper-level ontology of both universals and particulars. Indeed, there are mathematical entities. Again, its modular structure provides wide range applications of SUMO. Further, according to Magee the distinction between continuant and occurrent is done, and SUMO's orientation is 3D and 4D. But, as stated in above, SUMO assumes 3D view due to pragmatic reasons. Lastly, SUMO has high degree of formality, for it explains how it is structured in detail (2011, p254)

Technical Information

SUMO is one of the largest public upper-level ontology. It has been designed particularly for search, linguistics, and reasoning (Mascardi, Cordì, and Rosso 2007). It has been used in various fields: world government, finance and economics, and biological viruses, automobiles and engineering components, food, dining, sports (Pease n.d.). For the full picture of its application areas, the homepage of SUMO can be visited. This descriptive, multiplicative, and constructivist upper-level ontology's all versions are free and available on http://www.ontologyportal.org.

3.4. Cyc and OpenCyc

The gigantic investment over 30 years, Cyc is "the world's largest and most complete general knowledge base and commonsense reasoning engine" (Cycorp "OpenCyc" n.d.). The name Cyc was driven from the stressed syllable of

"encyclopedia" (Sowa, 2000, p 54). The project Cyc started in 1984 in the Microelectronics and Computer Technology Corporation to develop a computer program that has large amount of commonsense knowledge (Borgo et al. 2002; Mascardi, Cordì, and Rosso 2007). In 1994, the ontology firm Cycorp was founded by Douglas Lenat in order to advance, and commercialize Cyc technology (Mascardi, Cordì, and Rosso 2007). Cyc system's ultimate goal is to accommodate *all* of human knowledge, so huge database of concepts and axioms are defined to cover all things. Cycorp offers no-cost license to ResearchCyc for research purposes, further it provides the core of Cyc ontology, OpenCyc, into public domain, which can be obtained from http://www.opencyc.org.

Cyc aims to capture naïve concepts of the world in order to serve as an encyclopaedic source to all human knowledge, so it supports natural language processing (Borgo et al. 2002). Cyc contains more than 500,000 concepts, "forming an ontology in the domain of human consensus reality"; nearly 5,000,000 assertions (facts and rules), using more than 26,000 relations (Cycorp, n.d.).[59] The Release 4.0 of OpenCyc, which is the core Cyc ontology, includes nearly 239,000 terms, 2,093,000 triples (Cycorp "OpenCyc", n.d.). Cyc has its own implementation language CycL, and it can be found in OWL as well. For updated information and commercial solutions offered by Cycorp, home page can be visited: http://www.cyc.com.

Assumptions

The main purpose of the Cyclists is to capture naïve concepts of the real world, which requires the maximum number of entities to be expressed. Cyc is thus a multiplicative ontology (Borgo et al. 2002; Semy, Pulvermacher, and Obrst 2004). Accordingly, Cyc holds descriptive approach, which is indispensible for a purpose as being an encyclopaedic source of all human knowledge. Such approach entails assumption of abstract entities, moreover both particulars and universals. Cyc is divided into microtheories in order to provide minimal number of general categories, and links to natural language (Borgo et al. 2002). There is a set of assertions that is shared by all microtheories, further a microtheory can be contained by another one

[59] As of July 2015.

(Semy, Pulvermacher, and Obrst 2004). Cyc allows possible worlds approach in it (Cycorp, n.d.).

Hierarchical Structure

The top model node is labelled as “Thing” in the Cyc hierarchy. According to definition from the web site of Cyc, “Thing is the ‘universal collection’: the collection which, by definition, contains everything there is. Every individual object, every other collection”.

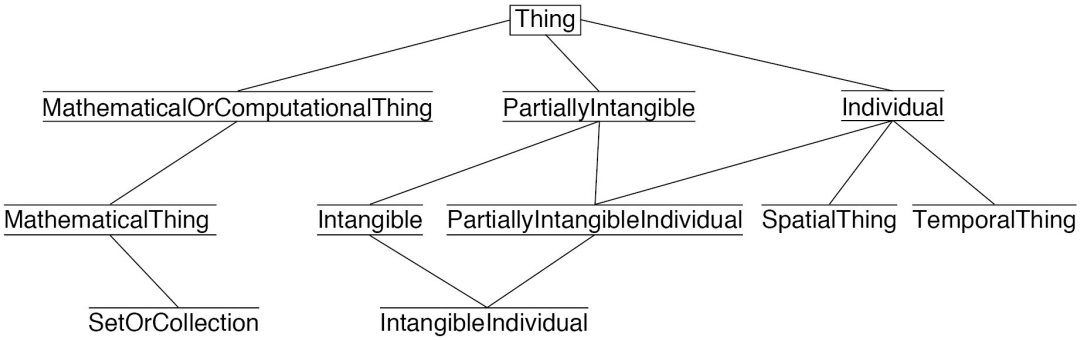

Figure 3.5. The Top Level Categories in Cyc

Figure 3.5 shows that the highest entity is separated into “Individual”, “MathematicalOrComputationalThing”, and “PartiallyIntangible” (Semy, Pulvermacher, and Obrst 2004; modified). According to Smith, “Things” is partitioned into individual objects (“Individuals) and set-like objects (“MathematicalOrComputationalThing” and “PartiallyIntangible”) (2002). Set-like objects are also divided into sets and so-called collections. Individual objects can be defined as a set of individuals that are not set or collections; namely a set cannot be taken as an individual (Cf. Semy, Pulvermacher, and Obrst 2004). On the other hand, set-like objects can include sets or collections as entities. The instances of “MathematicalOfComputationalThing” are abstract entities and they do not have any spatiotemporal properties, unlike the ones of “Individuals”. It is worth noting that, unlike other ULOs analysed in this chapter, Cyc has cross-cuttings. As seen in the Figure 3.5., IntangibleIndividual is an “Individual” in a set or collection of “Intangible”.

The most two important relations in Cyc are *is_a* and generalization (Smith 2002). Everything *is a* "Thing", for instance. Generalization is used as a specialization of subset property in collections. For instance, generalization holds between two Collections, say C_1 and C_2, when all instances of C_1 are the instances of C_2.

The documentation of OpenCyc is criticised for being too sketchy, and accordingly, for inadequacy of references to the established literature (Borgo et al. 2002).[60]

Analyses

In this part, I am going to evaluate Cyc in the light of previous parts. As Sowa notes, the highest category "Thing" has no noticeable feature for itself (2000, p 54), everything, thus, is in the Cyc ontology. That leads various interpretations. Firstly, Cyc has realistic view, which is reserved by its encyclopaedic aspiration; that also says that abstract entities, as well as concrete ones, are categorised in Cyc; for instance SetOrCollection contains abstract entities, while Individuals, both in TemporalThing, and SpatialThing are concrete entities. As stated above, secondly, Cyclists construct this ontology with multiplicative considerations. Semy, Pulvermacher, and Obrst expound that Cyc admits 3D view, and thus, endurants are classified as SomethingExisting, and perdurants SituationTemporal (2004).[61] Thirdly, Cyc admits both particulars and universals (ibid). Further, one of the most distinguish character of Cyc is its modularity. As spoken of above, Cyc is divided into microtheories, and this leads possible worlds in Cyc. The distinction between descriptions and individuals having the characteristics defined by descriptions establishes the notion of possible worlds (ibid, p3-9). This peculiarity allows contradictions in Cyc. As next point, Cyc admits bottom-up approach (Borgo et al. 2002). Lastly, being commercial enterprise, Cyc is a home-grown ontology.

[60] To my knowledge, because of the commercial virtue of Cyc, there are no deep analyses of Cyc's hierarchy.

[61] On the other hand, they claim that perdurants are admitted to a level. See p5-9.

Technical Information

Cyc is one of the foremost ontologies, not only for its gigantic investment, but also for its application fields. It aims to primarily support artificial intelligence applications, encompassing speech understanding, auto-routing, summarizing, and annotating (Cycorp n.d.), further it is used in natural language processing, network risk assessment, and representation of terrorism-related knowledge (Sowa, 2000). Unlike the previous ULOs, Cyc requires a license; yet OpenCyc is available under no-cost licence. The microtheories enable OpenCyc to expand by the changes and additions to these modules, which remain public (Semy, Pulvermacher, and Obrst 2004). Although Cyc has the most comprehensive definitions and axioms for its concepts (Sowa 2000, p412), OpenCyc neither allows its content to be copied, nor offers rules that defines the meaning of the terms (ibid), due to, I believe, its being a commercial product.

3.5. Other Upper-Level Ontologies

The upper-level ontologies I have mentioned in my thesis are the leading ones, the rest is given in a nut shell in this part.

The **CIDOC Conceptual Reference Model** (CRM) has been designed for supporting interoperability and accessibility between various cultural heritage databases by the CIDOC Documentation Standards Working Group and the CIDOC CRM Special Interest Group since 1990s. The CIDOC CRM seems to be a domain ontology, since it focuses on developments in documentation interests of museums and cultural heritage organizations; however, it is constructed as an upper-level ontology. (CIDOC CRM n.d.).

COSMO, the COmmon Semantic MOdel, was started as a project of COSMO Working Group of the Ontology and Taxonomy Coordinating Working Group in 1995, whose primary goal was to develop an upper-level ontology that

allows representing all the basic ontology elements that have to be in any domain ontology. Recently, The COSMO ontology has focused on representing all the vocabulary in the Longman Dictionary of Contemporary English fully with a controlled defining vocabulary (Cassidy 2009).

The **gist** ontology is designed by Semantic Art concerning a minimalist upper-level ontology to serve maximum number of fields. The gist ontology is not only comprehensive as a whole, but also its modules enable gist-usage with ease. Although its initial target is business information systems, it has been used medical, governmental, and financial areas. Further, gist holds Creative Commons share alike licence (Semantic Arts n.d.).

GFO, short for the General Formal Ontology, has been developed by Heinrich Herre, Barbara Heller and collaborators from Research Group Ontologies in Medicine (Onto-Med). GFO is one of the long-term projects of Onto-Med since 1999. The aim of this project is to create an ontology that holds entities together from material, mental and social areas by locating categories into three-layered meta-ontological architecture. Although it is designed firstly for medical areas, its domain-free nature provides its application in various fields (Onto-Med Research Group n.d.).

The **IDEAS** ontology actually developed as a domain-specific ontology, eventually became an upper-level ontology. Set in 2005, the IDEAS Group, the International Defense Enterprise Architecture Specification, has had the purpose of developing an ontology for military enterprise architecture, so that all nations could use this ontology for their military purposes. Since its publication as an upper-level ontology in 2008, IDEAS has been used by many defense departments of countries; further, it is applicable in business models (Ideas Group n.d.).

The Marine Top-Level Ontology, short for **MarineTLO**, is a marine domain specialized top-level ontology developed by the Institute of Computer Science (ICS)

of the Foundation for Research and Technology - Hellas (FORTH). MarineTLO is designed to represent a core model that is constructed upon the data from the marine studies in order to support the research about species and biodiversity by formulating the research results and answering queries within the model. MarineTLO is regarded as an upper-level ontology, and thus, for instance, it is applicable for terrestrial domain as well (Information Systems Laboratory n.d.).

The Object-Centered High-level REference ontology (**OCHRE**) was developed by Luc Schneider at the Institute for Formal Ontology and Medical Information Science at the University of Leipzig. As the designer of OCHRE and a co-designer of DOLCE, Luc Schneider formalized OCHRE in the light of formal simplicity and transparency in order that OCHRE can be applicable in all domains (Schneider 2003)

PROTON, the PROTo ONtology, whose initial name was Base Upper Level Ontology (BULO), is called a basic upper-level ontology, for it is designed to be a minimal and sufficient ontology. PROTON is developed by Sirma Group of Ontotext Lab in the scope of the Semantically-Enabled Knowledge Technologies (SEKT) project in order to serve as a basis for various domains. PROTON is being developed constantly, and thus its ongoing improvement provides its application in various domains, such as telecommunication, media, and business domains; nevertheless it is developed to serve as an ontology-generator (Terziev et al. 2003).

John F. **Sowa** explained his own upper-level ontology in his book called Knowledge Representation: Logical, ad conceptual Foundations that was published in 1999. His aim was to create an open-ended system, so that it could be used by any particular purpose. In order to do that, he did not construct a concrete category system; rather he built his ontology on a framework of distinctions. By selecting an appropriate set of distinctions, the hierarchy of categories is generated

spontaneously. Sowa's ontology inspired many upper-level ontologies (Mascardi, Cordì, and Rosso 2007; Sowa 2000).

The Unified Foundational Ontology, **UFO**, was developed by Giancarlo Guizzardi and associates in order to serve as a foundation for conceptual modeling. It is called "unified", for it is a unification of two well-known upper-level ontologies, the General Formal Ontology (GFO) and Descriptive Ontology for Linguistics and Cognitive Engineering (DOLCE); that were chosen for personal familiarity and preferences of developers. This upper level ontology provided applications mainly in linguistics and business modeling problems (Guizzardi and Wagner 2010).

UMBEL, standing for Upper Mapping and Binding Exchange Layer, is a lightweight ontology that aims to construct (1) the UMBEL Vocabulary, which serves as references to various domains, and (2) The UMBEL Reference Concept Ontology, which is to set a standard reference structure that locates any datasets and domain vocabularies. Created by Structured Dynamics LLC and Ontotext AD, UMBEL is designed to interoperate different ontologies (e.g. OpenCyc, GeoNames), contents (e.g. Wikipedia) or schemas with each another on the Web (Structured Dynamics LLC. n.d.).

Yet Another More Advanced Top Ontology (**YAMATO**) is built and carried on by Riichiro Mizoguchi since 1999. YAMATO is developed on the purpose of meeting the need of three issues -quality description, representation, and differentiation process and event- that existing upper-level ontologies could not explain satisfactorily. Although, YAMATO has been still axiomatized in a project, it has been used extensively in various domains, such as medical, instructional, genetic, and cultural studies (Mizoguchi n.d.).

CHAPTER 4

ANALYSES

Giving general information about ontologies and categorical systems of selected philosophers, and about the most well known upper-level ontologies, I aim to analyse ULOs in the light of philosophy in the last chapter of my thesis. In the first part of this chapter, I speak of two constrains on constructing ULOs that are originated from the limitations of machine languages, and the reflection of ontologists on the reality itself. Fundamental constituents of any ULO and the positions of the selected philosophers upon those constituents is the subject of the second part. Namely, BFO, DOLCE, SUMO, and Cyc are analysed under the light of Aristotle, Kant, Husserl, and Quine's views on categories, universal-particular dichotomy, abstract-concrete entities, endurants and perdurants, and the issue of possible worlds. In the last part of this chapter, a comparison between philontologies and ontologies is given in order to present the need for constructing ULOs.

In the midst of enormous data and constantly increasing scientific information, ULOs are constructed for the interoperability and the inference of the knowledge. Even though ULOs are designed to capture all the reality of the world, however, unlike philontologies, they are designed to be expressed in machines. Such expression requires conceptualizations and use of various sorts of logical systems. Therefore, construction of an ontology is restricted by mainly two things: does "language" restrict the representation of the reality and do they *really* aim to capture *all* the reality?

That whether language is a means of expressing the reality is debatable in the philosophy. The constructions between language and reality, and entities and conceptualisations are to be concerned by the ontologists. Ontologists must accept that language is a tool that expresses the reality; they must even further accept the

fact that formalizations can be done by employing the tools of logic. Having plenty of types, logic is used as a basis for implementation of ULOs. Depending on the needs of an ULO, either ontologists utilise existing ontology languages, such as OWL, or they construct their own ontology languages, such as CycL, or they use a basis on which the language is built up, such as SUO-KIF. Hence, a specific type of logic may be inefficient for constructing an ULO, so that ontologist must refer to other types as well. Nonetheless, language and logic confront the vagueness of words. Since ontologists use controlled vocabulary to explain the reality, they necessitate new approaches of logic. Consequently, the more reality is expressed, the more logical systems are to be considered. Thereby, ontologists may want to rule out some realities, such as some relations, for the sake of simplicity. On the other hand, they do consciously rule out some areas of reality. Unless they are scientifically expressed, the facts in aesthetics and ethics are not in the agenda of an ontologist; however they do care epistemology, logic, and of course, ontology as the main philosophical areas, and the other subareas of philosophy as well. Frankly, I believe that all the areas of philosophy must be considered by an ontology developer, even though s/he never uses in the construction of categories. With the developments in logical systems, I think, such constrains would be achieved by ontologists in the future.

From the main philosophical areas, there are some branches of philosophy that brighten ontological approaches, which are considered only in the construction of an ULO.[62,63] First of all, I believe that all of the ULOs hold pragmatic approach by their nature, since they are designed for practical purposes by making use of any relevant tools. Thereby, ontologists commit themselves to instrumentalism, since, for instrumentalists, scientific processes enrich ULOs and help predictions, which are aimed by scientists for pragmatic reasons. Next, ontologists are reductionists in

[62] The definitions are taken from Akarsu 1998.

[63] Scepticism, for instance, which denies there would be adequate justification of beliefs, cannot be a philosophical presupposition of any ULO. Idealism, solipsism, relativism, subjectivism are other examples. On the other hand, even though ontologists may commit themselves to materialist, physicalist or positivist views, it cannot be deducible from the analyses of ULOs, unless it is stated by the ontologists. Rationalism, scientism, phenomenalism, representationalism are other examples.

philosophical sense, since they analyse the complicated system of reality by reducing categories. The relations between entities and concepts can be extended on new findings; hence, these new entities are explained in terms of fundamental components of the categories.

In the following, I speak of fundamental constituents of any ULO, and then give the approaches of the selected philosophers to each constituent. Immediately afterwards, examination of an ULO with respect to a fundamental constituent is analysed philosophically.

Categories, I believe, is worth mentioning at first place, for it is the most fundamental constituents of any ontology. A category is a classification of entities in the world. Understanding of categories from philosophical view was given in second part of Chapter 2, and from ULO-view in Chapter 3, one can refer those for recall. Nonetheless, I want to recall the followings. Firstly, the roots of categories for each philosopher vary according to their doctrinal attitude. It is “being” for Aristotle, and “object of experience” for Kant. Although Quine leaves this labelling to the categorical system to its developer, Husserl prefers to call “entity”. Secondly, among ULOs, when these names are compared with the roots, or highest genera of the categories, “entity” is the most used one; since other than Cyc, which names the highest genera as “Thing”, BFO, DOLCE, and SUMO identify their roots as “Entity”. Husserlian categorical affect is crystal-clear. Although Aristotle’s incomplete categorical system lets more entities, which are dependent to substance, be inserted, it is restricted due to its function. Unlike Husserl’s categories, Aristotle’s categories are used as an *organon*, thus they cannot deepen physical discussions, which are in the scope of the natural sciences. However, Husserl’s system is constructed to cover all the entities, that is why the root is called “Entity” instead of “Being”: ULOs contain the entities, which include beings. Therefore, Aristotle’s categories are the basics: their essential distinctions are fundamental to all ULOs; still Husserl’s are more convenient due to its range. In Kantian doctrine, categories are the concepts that structure the objects of experience. Kant insists that there cannot be species-genus hierarchies, unless they are defined by us. Accordingly, what we perceive can be modified by us to accord with the categories. It seems that domain-ontology designers benefit from Kantian categories; yet, this is not the

case, for Kant's ontology is not structured hierarchically. Further, for construction of an ULO, this category system cannot be recommended due to its closed world perspective, besides it has never been used as basis up to my knowledge. Hence, none of the ULOs discussed in this thesis has Kantian categorical perspective. Quine's categorical system, if there is any, can again be utilised by domain ontologies. According to me, it may be possible that the modular structures of both SUMO and Cyc are constructed by Quinean way of categorising.

Consequently, BFO has both Aristotelian and Husserlian categorical orientation. Its hierarchy is Aristotelian, plus its theory of ontological structure, such as part-whole, universal-particular, is driven from Husserl. Next, the hidden distinction of the root "Entity", ontological and conceptual, makes DOLCE Husserlian, because the distinction of the realms fact and essence is similar. SUMO is more Aristotelian, I believe, because of the first dichotomy is "Physical" and "Abstract"; Aristotle's "substance" and "accident" dichotomy resembles, yet it has the widest range. At last, the categories of Cyc have a different kind of structure. Unlike other ULOs, it has cycles in the top-level categories. This construction can be explained in a Kantian approach, however the over all structure is totally non-Kantian.

What a particular is does not need too much to ponder on, whereas what a universal is needed to be defined not only in philosophy, but also in ontologies. Particulars, or individuals, in the simplest sense, are the specific entities. In the realm of ULOs, they can also refer to instances of classes/sets, facts, or events. From a different point of view, by means of the relation of instantiation, particulars are defined as the entities that which cannot have instances; whereas the entities that which have instances are called universals. As stated before, universals need to be defined thoroughly, since that abstracts, predicates, sets are to be considered as universals is crucial when working with an ULO.

Universals can be taken as (1) the instantiated entities. They may (2) exist independently, as in the case of realism; that is to say, universals are real entities. In reverse, (3) they exist dependently as in the case of conceptualism, or of nominalism, in the interest of categorising objects, classifying things. Having said

that, it is obvious that (2) cannot be in the consideration of ontologies, since ontological existence of universals is not in the scope of any scientific inquiry, viz. an ULO is interested in particulars primarily. Still, there would be two separate realms as universals and particular, yet their relations are of another issue to study.

Universals are the things that are said in many ways, on Aristotle's account. Accordingly, particulars are the things that are not universals. Being said in many ways, "being", and "quality" are examples of universals. It is of importance that the categorical system of Aristotle has hierarchy among the universals. For instance, the universal "being" is the highest level of universal. Although universals are most generic items in the categories, particulars have priority over universals. Without particulars, there would be no universals; hence Aristotle holds approach (3) to universals. However, above all, for him, universals are part of reality. Kant and Quine are nominalists, hence, they hold (3) for universals if universals are taken in the sense of (1). Husserl, opposed to Kant and Quine, rejects nominalism, and in favour of Aristotle, admits the real existence of universals, which can be comprehended by mind.

Above all, universals are defined as (1) in all ULOs. BFO accepts universals. Although it leaves which entities are to be defined as universals to the BFO applicators, yet it is very difficult to decide whether it holds only nominalist view, since it divides entities as being either universal or particular. DOLCE, on the other hand, is an ULO of particulars, indeed it does accept universals either as properties or in specific ontologies; thus, I believe, it holds more positivist view. That, as stated before, there are universals in SUMO is controversial, yet most of the time it is given as an example of an ULO of particulars. Lastly, Cyc accepts universals from nominalist point of view; hence, it is not designed only on empiricism, further it enjoys conceptualism. Thereby, DOLCE, SUMO, and Cyc are more Kantian and Quinean with respect to this fundamental constituent. Due to strict division of universals and particulars, BFO is Husserlian; additionally it holds nominalist approach, as well.

That concrete entities are considered by ULOs is needless, nonetheless, whether abstract entities are defined in an ULO is needed to mention. Abstracts can

be defined as non-concrete entities. Similarly, they are often illustrated as entities that which do not have extensions in space and in time. With this respect, abstracts must be differentiated from universals: universals can be localised in space and in time; further, some abstracts are not universals, such as sets.

Aristotle speaks of non-concrete entities in his ontology: the forms, which are separable from matter. Mathematical beings, for instance, are abstracted from physical beings, and have formal structure. What is of the most importance for Husserl's doctrine is an abstract entity: meaning. Quine, up to my knowledge, uses "abstract entities" interchangeably with "universals"; accepting abstract entities is of no wonder for a nominalist.

My interpretation that analysis of universals on BFO has the Husserlian approach is surprising when abstracts are considered. Mostly, abstract entities and universals are used interchangeably, and intuitively one evokes the other. Husserl's fundamental entity is not in the scope of BFO. BFO considers only concrete entities. This choice, however, cannot make BFO Quinean, for mathematical entities are crucial for Quine. Abstract entities are located under the conceptual section of the root "Entity" in DOLCE: there are "Abstract" class and "Abstract Qualities" subclass, under "Quality" class. Next, the Abstract – Physical distinction is very fundamental for SUMO, hence no further explanation is required. In Cyc, the subclass of "SetOrCollection" does not have any spatial or temporal features, in which there are abstract entities.

The features of abstracts entities more or less are the same across all the ULOs, except Cyc. Cyc seems to allow only mathematical entities as abstracts, for abstracts are limited in the "SetOrCollection", which is under the class of "MathematicalOrComputationalThing". Consequently, all the philontologies and ULOs discussed in this thesis contain abstract entities.

There are entities endurants (continuants) and perdurants (occurrents) in ULOs. The former are the entities that are wholly and completely present at each time instants in their existence, and the latter are the entities whose temporal parts are present at different time instants, and that, accordingly, happen in time. It is obvious that the nature of the persistence through time makes the difference of

these entities. If an ULO admits only endurants, then there is no place for events or processes in the categories. Thanks to that all the ULOs discussed in this thesis do also admit perdurants, events take place in the categories. An example for the distinction of these entities is that “a thesis” must be defined as endurant, since it does not suffer any change during a time interval; “writing this thesis”, on the other hand, must be defined as perdurant, since it changes over time and it requires persistence through time, and further it has temporal part: it is not same at different time instants in a given interval. Mostly, endurants are equated with 3D view, and perdurants with 4D view. Lastly, generally, things are spoken of within the 3D view, and events are spoken of within the 4D view.[64]

Aristotle makes similar distinction in his categories: state and posture vs. action and passion. However, these distinctions are not considered with respect to persistence through time. Besides, he would handle this issue in the realm of natural sciences, for time and movement are studied by physics. Kant’s doctrine may give room for this kind of distinction, but it is hard to drive such distinction from his categorical system. Husserl obviously makes this distinction in the realm of facts. Quine, on the other hand, accepts 4D model, but rejects the difference between object and event.

It is very characteristic of admitting endurants and perdurants in ULOs. Of all the ULOs, the distinction of endurant and perdurant is most striking in BFO. Ontology of endurants, SNAP-BFO, and ontology of perdurants, SPAN-BFO, are the two main sub-ontologies of the BFO ontology. Moreover, SNAP entities participate in SPAN entities. This distinction, again, is very clear in DOLCE: it is located under the ontological section of the root “Entity”. Similar to BFO, endurants participate in perdurants in DOLCE. For SUMO also, this distinction is very fundamental. Under the “Physical” class, SUMO accepts object and process distinction, namely endurant and perdurant distinction, respectively. Cyc, however,

[64] However, the equalization is not valid as in the case of Quine. Moreover, there are controversies between the analyses on ULOs, for instance, in one analysis, DOLCE is said to hold only 3D, although its holding 4D is obvious. So, most of them skip this issue (Cf. Semy, Salim K, Mary K Pulvermacher, and Leo J Obrst. 2004). I believe that a profound study is needed for the distinction between endurant-perdurant and 3D-4D.

defines “Event” and “Process” subclasses implicitly; due to its cyclic feature, these two subclasses have direct relations.

Endurants and perdurants have their own definitions from the new interdisciplinary study, viz. ontology. Although uttering that BFO has Husserlian approach is reasonable, since it belong to our age, any philosophical interpretation would be irrelevant.

Lastly, it is worth mentioning the notion of possible worlds, even though it is not a necessary constituent of an ULO, for instance DOLCE does not have such notion. Due to OWL’s canonical forms, any ULO that is encoded in this language can present both necessary and possible modalities. Modalities can be possibility, existence, spontaneity, necessity, contingency, belief, or time. Modalities can be reflected in an ULO insomuch as the implementation language provides available logical formalisms, and those modalities are in the agenda of the ontologist, who in this case is a possibilist.

Aristotle, Kant, and Husserl give room modalities in their doctrines. Quine, besides, caricatures the notion of possible worlds in his essay “On What There Is” by speaking of the characteristics of an imaginary man standing behind the door.

Assertions in Cyc sometimes can be contradictory in itself. This deficiency is, however, turned to an advantage by introducing this situation should be considered as an implementation of possible worlds, since by the very nature of Cyc’s modular based microtheories, possible worlds are involved in Cyc. Even though BFO and SUMO have modular structures, the motivation behind is not possibilism. This constituent is inserted to ontologies with respect to scientific concerns; on the other hand, philosophers take this issue within their doctrines. Therefore, any comparison between ULOs and philontologies is irrelevant. Since, for instance, from Aristotle’s perfective, coincidence is taken as a cause, which is *per accidents*, in his metaphysics; formal languages of ULOs, on the contrary, conceptualise coincidence, and do not take it as a cause. Hence, an interpretation stating that both an ULO that holds coincidence is Aristotelian is misleading.

Hitherto, the analyses done were mostly terminological and within philontologies and ULOs. In the last part of this chapter, a comparison between

philontologies and ontologies, and thereby a summary of history of ULO are given. The rationale behind this part is to present the conditions that pave the way for constructing an ULO.

Philontology seeks a description of reality by figuring out the classes of entities, which encapsulate all the entities, and give an explanation of them. In order to ease the intensive nature of such classifications, philontology seeks a categorical system, with which the reality can be given at all levels. However, this is not a reduction of reality as sciences do. Reductionism is applied in sciences in order that the complex structures are explained by reducing them to smaller parts or fundamental things. On the other hand, philontologies avoid this approach, for its aim is to give the ultimate picture of what there is and the relations between what there is in terms of top-level categories. Thus, descriptiveness and generality go hand-in-hand in philontologies. While philontologists are occupying themselves with such taxonomical structures of reality, the term “ontology” was borrowed by the computer scientists, data analysts, and artificial intelligence designers. According to consensus between these experts, an ontology is the specification of a conceptualization. The world consists of objects, which have properties, and those properties are to change over time; there are relations between objects; there are also events, which occur at different times, and events cause other events as well. An ontology, then, is constructed on such world. However, the ultimate aim of these experts is not to give the truth of reality, rather their purpose is to *conceptualise* the truth of reality. Moreover, ontology holds strictly pragmatic approach. From the position of the experts of these fields, the entities of an ontology are limited by scientific studies and the requirements of customers. Hence, ontology is narrowed in a domain, most of the time. The experts, with the entities driven from scientific studies and with the requirements of customers or the limitations of the computer programs, provide terms for describing the domain by representing specialised controlled vocabulary, and represent a body of knowledge to describe the domain. The distinctions in handling the reality of the world between philontologists and these experts are crystal-clear. Firstly, as mentioned above, philontologists aim to give the reality at all levels, whereas these experts provide a definite classification of the reality. Secondly, philontologists are interested in highest genera as first

principles, whereas the experts in the fields in computer sciences are more interested in establishing controlled vocabulary. Thirdly, correspondingly, the former group builds the ontologies from top to down, while the latter group builds them from bottom to up, since they require scientific results to achieve the general results. Next, the former only takes care of their philosophical doctrines, whereas the latter must consider the limitations of machines, programs, and even the desires of the clients. It can be said that philontologists are more independent to express the reality in all levels: no restrictions either from technology or from customers. Further, the first group of ontology is designed to locate any entity; however, if an entity is not defined in the domain, the attitude of the second group is accepting the very entity as never having existed before. Besides, there is an exterior reality for the second group, an entity can be defined differently in different relations in different ontologies. Although there are different approaches to universals in philontologies, the main relations more or less remain the same; they do not much differ as in the case of ontologies of the experts. In the group of experts, indeed, the pragmatic concerns shape an ontology. There may be relations that are established by the demand of a customer, despite the fact that the validity of such relations is not verified through scientific studies or they may be bad conceptualised at all.[65] Apparently, the applicability of ontologies into computer sciences never, and even should not, be considered by a philontologist, who never shapes her/his ontology according to demands from outside her/his doctrines. Additionally, the experts maintain their system for the sake of computational efficiency; so they are more interested in concept hierarchies, the philontologists, on the other hand, consider both concept hierarchies and categorical hierarchies. Lastly, the ontologies in the second group do vary even considering the same domain with respect to the application area, or the conceptualisation in the programmers' mind. Even though, domain ontologies function very well, different classifications of the very same domain, thus, complicate, and even foreclose the knowledge sharing and reuse. Due to the last issue, designing an ontology, which is applicable in all domains,

[65] The difference between good and bad conceptualisations lies in that bad conceptualisations "deal *only* with created (pseudo-)domains, and not with any transcendent reality beyond" (Smith 2002).

becomes necessary. If it would be domain dependent, sharing and reuse, again, is a struggle due to diversity of defining the entities. Hence, there must be a new system, like philontologies, the definitions are defined beforehand, so that such ontology would function regardless of the domain. Here is where philosophy comes to scene: philosophical ontologies and their top-level categories can give advises to construct a general framework. The experts, then, today's ontologists make use of philosophical works of over centuries in order to construct upper level ontologies with technical and pragmatic considerations. Again, their main goal is not philosophical at all, but rather primarily pragmatic. Still, I believe, the aid of philosophy cannot be narrowed only within the framework of top-level categories and ontological structures. Philosophy must have a finger in the pie, and even more. Aristotle, the father of sciences, says that the objects of sciences are determined by philosophy, and any science cannot inquire on its own object, except philosophy. Thus, a biologist, for example, does examine living beings, but does not define what living is. S/he does not ask her/himself whether there are living things really, s/he just accepts that there are living beings. It is a philosopher who asks what there really is, and constructs a hierarchical relation between the beings, and meanwhile employs the objects to sciences accordingly. Thus, computer scientists and program developers have superiority when describing things in their fields, but up to a point. For instance, they can define temporal units, and construct relations; however, they cannot define "instant", which is a temporal unit, yet which cannot happen in time. That there are always inexpressible primitives requires explanations. If a system is designed to "rule them all", it is necessarily be defined by the expertise: philosophy. In computer sciences, there are many terms that have various definitions, and further, there are different terms that have the same meaning. If definitions are done in the realm of philosophy, even the implicit definitions can be derived very easily.[66] Further, the things (entities, relations, concepts, and so on) that ruled out for pragmatic and practical reasons will be in need in future, but since they are not defined in the program they can either be

[66] One may argue that philosophy has many definitional differences. What I believe is that since upper-level ontologies are scientific enterprises, it is more comfortable to construct more fixed definitions.

neglected or the program must be refined; it is again philosophy that can find solutions to those ruled out entities. Mathematical entities, for instance, are to be inserted to the categories under the class Abstract; yet the programmer may ruin all the system if s/he defines all these entities under a class, whose entities are driven from physical entities. Thanks to philosophy, one can interpret which mathematical view suits well to the mentioned ontology among different mathematical approaches. The reason I am insisting that philosophy must be involved in constructing upper-level ontology (ULO) is that if the reality is claimed to be conceptualised, then the reality must be taken as itself, with all the levels of it. Hence, such approach can be obtained with philosophical considerations. Of no concern, philontologies that are products of the holistic view of philosophers' own doctrines are more genuine, creative, and more productive than ULOs; for there are no worries of defining the ontologies by using logical systems, or expressing them in the computational codes while constructing a system which is compatible with the holistic view, and has complementary parts of the doctrine. ULOs thus can utilise philontologies freely. Philosophical approaches therefore not only ease abovementioned difficulties, but also nourish the ULOs. On the other hand, it is better to repeat again that "ontology" is no longer a philosophical enterprise. Ontology in today is an empirical science, like physics. As physics suffers under many doctrinal changes over years, the same will be true for ULOs. That is to say, ULOs are advancing through theoretical interest and scientific methodologies as Brentano's theory of four phases of philosophy suggests. It is worth mentioning here, once again, that ULOs use reduction with respect to philontologies. By mirroring natural categories, some theorems and commonsense expressions, for instance, are reduced to fundamental logical expressions. Consequently, today it is the ontologist's duty to determine such hierarchies and relations of beings mid of abundance of knowledge and information. Unlike philontologies, once an ULO has been constructed, it can be used in many disciplines. Scientists and ontologists work collaboratively to build such structures; the former provide data and information in the range of a domain, the latter identify various theories and methods in the light of what scientists provide, and formulate classifications and relations with controlled vocabularies in order that new data are integrated, related, retrieved with ease. Then, usefulness, shareability and reusability, essential

features of an ULO, are maintained. In order to maintain consistency between an ULO and the world, ontologists take advantage of the interdisciplinary feature of ULOs. Not only philosophical notions are in charge, like part-whole relation, or universals, but also mathematical notions are in charge as well, such as set-theory. With respect to needs of the axiomatic reflation of implementation language of an ULO, several logical systems can be utilised, which is under the determination of the ontologists. Moreover, the analyses of applied ontologies also promote the consistency.[67] Finally, I believe that ULOs remain as an interdisciplinary field that must be under the conduct of philosophy. As a summary from Chapter 3, Table 4.1. indicates the philosophical assumptions of selected ULOs.

Table 4.1. Philosophical Assumptions of ULOs

	BFO	DOLCE	SUMO	Cyc
Descriptive vs. Revisionist	Descriptive	Descriptive	Descriptive	Descriptive
Multiplicative vs. Reductionist	Multiplicative	Multiplicative	Multiplicative*	Multiplicative
Actualism vs. Possibilism	Actualism	Possibilism	Either one**	Possibilism
Endurants and Perdurants	Endurants and Perdurants	Endurants and Perdurants	Endurants and Perdurants	Endurants and Perdurants
3D and 4D	3D and 4D	3D and 4D	3D and 4D	3D
Universals and Particulars	Universals and Particulars	Particulars only	Particulars only***	Universals and Particulars
Abstracts	-	Involved	Involved	Involved
Modularity	SNAP and SPAN Modules	-	MILO and Domain Ontologies	Microtheory Modules
Implementation Language	FOL and OWL-DL	FOL (including KIF), OWL, DAML+OIL, LOOM, and RDFS	SUO-KIF and OWL	CycL and OWL

* SUMO is multiplicative, I think, due to its construction.
** Both are possible from the point of view.
*** That SUMO is an ULO of particulars only is controversial.

[67] "Applied ontology is a branch of applied philosophy using philosophical ideas and methods from ontology in order to contribute to a more adequate presentation of the results of scientific research" (Munn and Smith 2008).

CHAPTER 5

CONCLUSION

Specialisation is a very characteristic of our age. We have specialists across many fields; as an illustration, the departments in the universities can be taken. Years ago, it was hardly to find a department called “cognitive science”, even though there were studies addressing the subject matters of this department. Today, we are experiencing the same progress: philosophy shares the ownership of ontology with information and computer sciences. Within few years, ontology, as a new interdisciplinary science, will have its own position juxtaposing with philosophy, computer sciences, and others.

The journey of ontology started with the question what could be the ultimate cause of everything there is. In order to answer this question, philosophers have formulised what there is. According to Brentano’s theory of four phases of philosophy, not only the answers, but also the methodologies of approaching ontologies differ over time. In order to see current position of ontology, this thesis made use of this theorem. Before figuring out this current position, the ontologies and/or categorical systems of Aristotle, Kant, Husserl, and Quine were mentioned for their philosophical influences and practical uses in today’s ontologies.

The word “ontology” was borrowed and modified by information and computer scientists in order to serve their pragmatic purposes. In the first practises, ontology functioned as structuring the data in a given domain. In the later ones, a need for constructing an ontology that could be usable in all domains was emerged. Ontology has been modified as an interdisciplinary science that purposes to provide interoperability across all domains. These ontologies are called upper-level ontologies. In this work, I analysed the most famous and most used ULOs: BFO, DOLCE, SUMO, and Cyc with respect to their philosophical assumptions that made before their constructions, their hierarchical structure, and I gave some technical information about them.

The fourth chapter was dedicated for an analysis of the former two chapters: upper-level ontologies were analysed philosophically. I believe that the limitations of ULOs were required to be uttered at the beginning of the analyses. Although the level of expressiveness of a language is a matter of controversy in philosophy, in the case of ULOs, language is an obvious limitation. Besides, various logical systems are needed to be employed in order to reach a full-reflecting machine language. Further, as a scientific enterprise, ULOs limit themselves into a specific portion of reality, -viz. scientifically provable reality. Keeping these limitations in mind, I presented the fundamental constituents of any ULO, which are categories, universal-particular dichotomy, abstract-concrete entities, endurants and perdurants, the issue of possible worlds; and then inspected these constituents in BFO, DOLCE, SUMO, and Cyc. In the following, I provided possible reflections of the mentioned philosophers to the constituents, although in some cases it was very difficult to find out those reflections. In the last part of this chapter, a comparison between philontologies and ontologies were make in order to present the conditions that pave the way for constructing ULOs.

This work aimed to approach upper-level ontologies philosophically. The readers of this work are most probably either interested in ontology from a philosophical perspective, or dealing with upper-level ontologies with much more technical concerns. Each group, I believe, do not interact, or even does not have any idea of the other one. Thus, two groups of people can take advantage of this thesis. Firstly, the ones who are more prone to philosophical issues, besides want to learn the contemporary state of ontology, or the ones who are more interested in applications of philosophy can benefit from this work. Artificial intelligence, databasing, knowledge representation, and so on are in need of philosophical approaches for several reasons. Technical knowledge can stuck at either in the construction or in the application. Bad conceptualizations, poor definitions, missing or ignored considerations cause problems. The aid of philosophy comes to scene at this point: besides the holistic view it provides, philosophy can fix these problems. Hence, people in the philosophy departments can contribute to this new science; frankly, I believe that philosophical approach will flourish it. Secondly, the experts and analysts in the fields related to information and computer sciences can

benefit from this work as well. The pure philosophically stated brief explanations on ontologies and categorical systems in the second chapter can be useful: ontology is much more than what these people are using. Actually, what they do call as ontology is similar to categories. Even more, categories neither have to be constructed hierarchically, nor do they have to reflect all parts of an ontology. Above all, ontologies are the most essential part of the philosophers' doctrines, regardless their positions. This point helps these experts to approach the problems that they could not cope with in ontology. For instance, when categorical system of a philosopher cannot fulfil some needs, then checking her/his other works that can be supplementary to categories. Further, the use of the word "ontology" must be uttered rigorously. Aristotle's ontology is also called theology; Husserl's ontology includes phenomenology; Quine's ontology is bounded to ontological commitments. Hence, not all ontologies are to be constructed as categories. Although they aim to capture all the reality and making relations among those realities, ontologies are not categorical systems at all. In our case of the experts from information science and the related fields, they misuse the word, even if they have already defined the word "ontology". No matter my position to be found too susceptible, I would like to point out that ontologists today are not building up ontologies, but rather categories. From the ontologists point of view, without mentioning the categorical systems of the mentioned philosophers, their ontologies would be futile, since what the ontologists label as an ontology is nothing but a categorical system. Now, with all what I have said, it would be better to call upper-level ontologies as upper-level categorical systems in order to avoid the illusion that all ontologies designate categories.

When the abovementioned philosophers considered, Husserl's ontology and categorical system deserve to be nominated as the most suitable philosophical approach to ULOs. His taking the reality at all levels and from all perspectives, his ontology being interwoven with his logic, and his attitude toward ontology as a science make his ideas of supreme importance when constructing an ULO is

concerned.[68] Quine, on the other hand, can be taken as a philosophical guidance when building domain ontologies.

I faced some limitations and difficulties when writing this thesis. First of all, in the literature, there are a few philosophical criticisms to ULOs. Most of the works prefer considering ontologies with respect to scientific considerations; philosophy is issued only to give a historical outlook to ontologies, and categorical systems. Related to this, secondly, most of the analyses are purely technical. Either that definitions vary across documents or that the documentations of ULOs are very sketchy makes technical details be interpreted philosophically almost impossible. Definitions are of high importance, since upon the way the concepts are expressed, translations from technical considerations into philosophical grounds could be achievable. Besides, even the technical documents on ULOs are very imprecise, thus there are even different technical interpretations in the literature. Next, new concepts are appearing, of course, with the development in the field. However in this case, philosophical competency becomes essential, which is very difficult to acquire at this level of study. If so, the interpretations could be made within the doctrinal system of a philosopher, and possible answers could be pondered to the question of what the philosopher would say about that point. At last, but not least, I sometimes felt the necessity to learn ontology languages, and make use of some ULOs in order to get involved the ontological works, yet such enterprise is not directly related with this work.

[68] For instance, Husserl's distinction between independent entities from dependent entities, whose existence depends on another entity, is very useful in ULOs, since it provides levels of independence, and constructing part-whole relations. As an example, an apple is independent, since it continues to exist when it is picked up from a tree; and its seeds are also independent since they continue to exist when they are taken out from the apple. Correspondingly, part-whole relation is defined on this distinction. According to Husserl, a whole has parts, and parts can have independence existence. For instance, when an apple tree is considered a whole, the leaves of the tree, the apples on it, the truck and so on are the parts of it, and they continue to exist when they are detached from the tree. On the other hand, the weight of the tree, for instance, cannot exist independently, for such property requires the existence of the tree. Cf. Husserl 1970, *LU*, III.

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APPENDICES

APPENDIX A. TURKISH SUMMARY

Felsefe tarihini “varlık nedir?” sorusu çerçevesinde incelemek mümkündür. Varlığı inceleyen felsefe dalı olan ontolojinin hem tarih boyunca hem de filozofların öğretilere göre değişik biçimler ve isimler aldığı bilinir; örneğin felsefe tarihinin başı kabul edilen Miletliler için ontoloji nihai nedeni aramakken, modern çağda epistemolojik bir biçim almıştır, veya ontolojiyi ilk felsefe, teoloji ve metafizik adları altında da bulmak mümkündür. Günümüzde ontoloji yeni bir ad ve yeni bir yaklaşım biçimiyle karşımıza çıkmaktadır.

Felsefi düşüncelerin ve/veya kavramların gelişimleri antik zamanlardan beri düşünürlerin bakış açılarına göre sınıflandırılmışlardır. Bu tezde ise Brentano’nun “Felsefenin Dört Evresi” teorisi iki nedenden ötürü kullanılmıştır. İlki Brentano’nun felsefeyi bilimsel bir uğraş olarak ele almasıdır, ki bir bilim olan günümüz ontolojilerine uygun bilimsel yaklaşımları kazandırabilir. Bundan ötürü, Brentano’nun bu teorisi ikinci olarak, ontolojilerin günümüzde geldiği noktayı yorumlamaya, dolayısıyla bu yeni bilimin gelişmesi için faydalı olacak öngörülere olanak sağlayacaktır. O halde, ontolojinin özerk bir bilim olma durumu anlatılmadan, Brentano’nun teorisinin önce anlatılmasında fayda vardır.

Brentano’ya göre felsefe tarihi temelde birbirini takip eden iki evreden oluşur. Birinci evrede felsefe, tamamen teorik ve canlı bir merakın veya bilimsel metodolojilerin desteği ile doruğa ulaşır. İkinci evre ise birinci evrenin düşüşünden başka bir şey değildir. İkinci evre kendi içinde üçe ayrılır: birinci kısımda felsefenin uygulamaları ön planda iken, ikinci kısımda felsefenin bilimsel yapısı özünü kaybeder ve nihayet son kısım birinci evreye hazırlık aşaması olacak biçimde bilgiye ulaşmada bilimsel olmayan yöntemler kullanır. Dolayısıyla, en alt noktaya ulaşan felsefe tekrar en üst noktaya çıkmak için yeniden canlı merak ve/veya bilimsel metotlarla birinci evreye ulaşır. Bu haliyle, Brentano’nun teorisini dört evreye yaymak ve şu şekilde özetlemek mümkündür: birinci evre tamamen bilimsel ilginin, ikinci evre uygulamanın, üçüncü evre kuşkucu yaklaşımın, dördüncü evre ise

mistik bakışın egemen olduğu dönemlerdir. O halde, Brentano'nun bu teorisini kullanarak felsefe tarihini antik çağlardan günümüze beş dönemde incelemek mümkündür: antik dönem, ortaçağ, modern dönem, Brenatano sonrası kıta felsefesi ve analitik felsefe, ve son olarak ontolojinin disiplinlerarası bir bilim olarak ortaya çıktığı yirminci yüzyıl ve sonrası. Felsefe tarihini Brentano bakış açısıyla okumak günümüz ontolojilerinin bilimsel ve teorik merakla zenginleşen bir gelişim aşamasında olduklarını gösterir.

Bu tezin felsefi bir analiz sunabilmesi için felsefi ontolojiler hakkında bilgi vermesi gerekir. Aristoteles bilimlerin babası olmasının yanında ilk sistematik ontoloji çalışmasını yapmış, ontolojileri ve kategori çalışmalarının da ilk referans noktası olmuştur. Yine, Kant da kategori çalışmalarında akla ilk gelen filozoflardandır ve bazı günümüz ontolojilerinin kategori oluşturmalarında esin kaynağı olmuştur. Husserl ise üst düzey ontolojiler için vazgeçilmez bir filozof olarak düşünülebilir, çünkü onun gerçekliğe yaklaşımı diğer filozoflardan çok daha kapsayıcı olmanın yanı sıra mantık sistemi ile de paralellikler gösteren bir ontolojisi vardır. Quine ise daha çok alan ontolojileri kurulumunda referans alınabilecek bir filozof olarak değerlendirilse de üst düzey ontolojilerin kategorilerinin belirlenmesinde bilimsel yaklaşımı dikkate alınmaya değerdir.

Aristoteles'e göre varlık bilimi varlığın varlık olarak incelenmesidir. Bu incelemeye elbette ilk önce varlığın ne olduğunun bulunması ile başlanır. Varlığın çoklu anlamaları içinden sadece töz varlık olarak incelenmeye layıktır. Bu nedenle varlığın ne olduğu sorusu tözün ne olduğu sorusuna indirgenir. Aristoteles'e göre üç tür töz vardır: maddeye bağımlı ve hareket eden, maddeye bağımlı ve hareketsiz, ve maddeden bağımsız ve hareketsiz. İlk tözler fiziğin, ikinci tözler matematiğin, üçüncü tözler ise ilk felsefenin, yani ontolojinin konusudur. O halde, Aristoteles'e göre varlığı varlık olarak incelemek maddeden bağımsız ve hareketsiz olan tözlerin, yani formların incelenmesidir.

Husserl'in ontolojisini üç başlık altında toplamak mümkündür. Olgular alanında zamana ve mekana bağlı somut entiteler (öğeler/varlıklar), özler alanında genellenebilen, tümel ve değişmeyen ideal entiteler, mânâ alanında ise kapsamlar bulunmaktadır. Özler ontolojisi kendi içinde bölgesel ontoloji ve formal ontoloji

olmak üzere iki ayrılır. Bölgesel ontolojinin ideal entiteleri olgular alanının entitelerinin genelleştirilmesi ile elde edilir. Formal ontoloji ise "herhangi bir şey"in ideal biçimini çalışır. Dahası, formal ontoloji ile formal mantık birbirlerine paraleldirler. Bu üç farklı ontolojik alan birbirinin üzerine kurulur. Olgular ontolojisi idealar ontolojisine, idealar ontolojisi ise mânâ ontolojisine bağımlıdır. Üstelik, Husserl'in ontolojisi mantık, epistemoloji ve fenomenoloji ile girifttir.

Quine'a göre varlık biliminin incelediği tek şey vardır, o da her şeydir. Ancak, felsefe tarihi boyunca "her şey"in ne olduğu üzerinde anlaşılamadığı için bu kadar çok öğreti vardır diyen Quine, var olmayı ancak bir değişkenin değeri olmakla tanımlar. Dolayısıyla, metafiziksel ontolojik tartışmalardan uzak durarak, dili mantık olan bilimsel yaklaşım ile bir ontolojinin inşasının mümkün olacağını söyler, ve ardından ontolojik görelik öğretisini öner sürer. Bu öğretiye göre var olanlar bir değişkene atfedildikten sonra bir teori içinde doğrulanabildikleri sürece vardırlar. O halde, bilim insanları teorilerini ontolojik kabuller üzerine kurarlar, ve ontoloji bu bilimsel sonuçlardan kendini inşa eder.

Tezin amacına göre sadece felsefi ontolojilerin anlatılması yeterli olmayacaktır, dolayısıyla filozofları kategori sistemleri hakkında ayrıca bilgi vermek gereklidir. Kategoriler var olanların en yüksek cinslerini içeren envanterler olarak tanımlanacağı gibi, en yüksek tümeller olarak da isimlendirilebilirler. Filozofların ontolojik yaklaşımları farklılık gösterdiği gibi, kategori sistemlerinde de değişiklikler söz konusudur. Örneğin, Aristoteles için hiyerarşik bir kategorik yapı varken, Kant kategorilerini gruplandırır.

Aristoteles'te kategoriler algılanabilir olan varlıklara sorulan sorularla elde edilir. Bu nedenle tam bir kategori listesini filozof vermez. Dolayısıyla, kategoriler fiziğin konusuna giren varlıklar üzerine çalışırlar. Kategoriler'de verilen en yüksek cinsler şunlardır: töz, nitelik, nicelik, ilişki, yer, zaman, durum, iyelik, etkinlik, edilgenlik. Töz, diğer tüm kategorilerden ontolojik olarak önseldir. Kant'ta ise tözün herhangi bir önselliği yoktur. Çünkü, Kant'a göre kategoriler a priori kavramlardır ki, bu kavramlar sayesinde deney mümkün olur, böylece sentetik bilgiye ulaşılabilir. Dört ana başlık altında toplam 12 kategoriden bahsedilse de Kant'ın kategori sistemi de tamamlanmış değildir, zira Kant'ın listesindeki kategorilerin

birleşmesinden başka a priori kavramların çıkması muhtemeldir. Kant'ın kategorileri şu şekildedir: Niceliğe göre: birlik (ölçü), çokluk (büyüklük), tümlük (bütün); Niteliğe göre: gerçeklik, olumsuzlama, sınırlandırma; İlişkiye göre: töz, neden, birliktelik; Kipliğe göre: olanak, varoluş, zorunluluk. Husserl'in kategorileri ise var olanın betimlenmesiyle elde edilir, yani kategoriler üç alanın en yüksek tümelleridir. Örneğin, olgular alanının bazı kategorileri gerçek bireyler, olaylar; özler alanından formal ontolojinin bazı kategorileri parça-bütün, sayı, küme-grup, ve bölge ontolojisinin bazı kategorileri doğa, bilim, kültür; mânâ alanının bazı kategorileri ise birey, yüklem olarak verilebilir. Ontolojik kabullenmelerin teoriler için elzem olduğunu savunan Quine'a göre ise, her kategori farklı biçimlerdeki nitelemeyi kapsar; farklı biçimlerde olmasının sebebi nicelemenin isteğe bağlı olarak ifade edilebilme özgürlüğündendir. Bu nedenle, ontoloji ve dolayısıyla kategoriler düşünürün ontolojik kabullenmelerine dayanırlar. İmdi, "var olmak bir değişkenin nicelendirilmiş değeri olmaktır" sloganı yine kategorilerin belirlenmesi için bir kriter olarak kullanır.

Bu çalışmanın ikinci konusu ise üst düzey ontolojiler üzerinedir. Ontoloji, felsefi alandaki anlamından uzaklaşarak, günümüzde disiplinlerarası bir bilim olarak karşımıza çıkmaktadır. İlk olarak yapay zeka çalışmalarındaki metinlerde karşılaşılan bu yeni bilimin tanımı şu şekildedir: ontoloji kavramsallaştırmanın biçimsel belirtilmesidir. Bu yaklaşım ontolojilerin belirli bir alanda sınıflandırılması olarak anlaşılmalıdır. Her alan için bir kavramsallaştırmanın yapıldığı, ve sınıflandırma içindeki ilişkilerin belirli bir amaç doğrultusunda oluşturulduğu düşünüldüğünde, sorunların çıkması muhtemeldir. Örneğin, bir alan için hazırlanan ontolojiyi farklı amaçlarda kullanmak mümkün olmayabilir, çünkü ontologlar, ontolojilerin kategorik yapılarını ihtiyaçlarına göre oluşturmuş ve kavramsallaştırmalarını yine bu ihtiyaç çerçevesinde yapmışlardır. Benzer şekilde, yeni bir entitenin belirli bir alana dahil edilmesi kategorik yapıyı bozmasa bile yeni entite ile diğer entiteler arasında yeni tür ilişkilerin kurulmasını zorunlu kılabilir. O halde, alan ontolojilerinin hem paylaşımı hem de tekrar kullanılabilirliklerini uygulamalarda sekteye uğrar. Kaldı ki, çağın getirdiği geniş malumatın kontrollü bir biçimde ele alınması, hatta bu malumat içinden ihtiyaç doğrultusunda çıkarım yapacak sistemlerin kullanılması elzemdir. Bu nedenle, herhangi bir alana bağlı

kalmayan, yani tüm gerçekliği kapsayacak, yeni bir ontolojik yapı gereklidir. Üst düzey ontoloji denilen alan bağımsız ontolojiler, gerçekliğe ait tüm entiteler ve bu entiteler arasındaki ilişkiler üzerine en genel kategorileri ve kavramları tanımlayarak ve belitselleştirerek teoriler kurarlar. Böylece tüm alanlara uygulanabilen ontolojiler geliştirilmiş olur.

Üst düzey ontolojiler üzerine yapılacak inceleme öncesinde bazı teknik ifadelerin açıklanması gerekir. Üst düzey ontolojilerin oluşturulma amaçlarından birisi her çeşit alanda birlikte işlerliği (interoperability) desteklemektir. Birlikte işlerlik en basit tanımıyla veri alışverişidir. O halde ontolog, birlikte işlerliği hedefleyerek çeşitli araçlarla üst düzey ontolojisini tasarlar. Bu araçların amacı, gerçekleştirim dilleri (implementation languages) seviyesinde verileri başka bir ontolojiden getirirken ve/veya başka bir ontolojiye kaydederken anlamlılık kaybını en düşük seviyede tutmaktır. Yani OWL gerçekleştirim dilinden SUO-KIF gerçekleştirim diline yapılacak çevirileri desteklemesi ve anlamlılığın bütünlüğüne zarar vermemesi hedeflenir. Gerçekleştirim dili, dolayısıyla, bir ontolojiyi ifade eden formal bir dildir. Bazı ontolojiler kendi gerçekleştirim dillerine sahiptirler, örneğin CycL, Cyc üst düzey ontolojisinin gerçekleştirim dilidir; bazı ontolojiler diğer dillerin üzerine kurulurlar, örneğin SUO-KIF, KIF üzerine kurulmuş bir dildir; bazıları ise ontolojiler için oluşturulmuş dilleri kullanır, bu dillerden biri OWL (Web Ontology Language, Web Ontoloji Dili)'dur. Gerçekleştirim dilleri kimi zaman mantık sistemleri ile ifade edilirler, birinci basamak mantığı ya da yüksek basamak mantığı gibi. Diğer gerçekleştirim dillerine örnek olarak OWL Lite, OWL DL, OWL Full, DAML, DAML+OIL ve LOOM verilebilir.

Ontolojilerin oluşturulmasında kullanılan en temel teknik yapıların ardından, arka planında yatan diğer yapıların başında elbette kategoriler gelir. Kategorilerde en yüksek cins genellikle "şey" (thing), "nesne" (object) veya "entite" (entitiy) olarak kullanılır. "Şey" ve "nesne" fiziksel çağrışımlara sahip olduklarından "entite" kullanımı daha doğrudur, zira bu metnin okunması veya π sayısı da gerçekliğin içindedir, dolayısıyla birer entitelerdir. Kategoriler tüm entiteleri temsilleyemeyeceğinden, kavramsallaştırmaya başvurulur. O halde kavramlar bir kategori içinde sistemleştirilir. Kategoriler içindeki bir diğer yapı olan ilişkiler ise

gerçekleştirim dilleri aracılığı ile tanımlanır. En temel ilişki olan "–dır" (is_a), kategorinin üst seviyesindeki cinsler arasındaki taksonomiyi verir.

Bir üst düzey ontolojinin oluşum aşamasının en başında felsefi kabulleri vardır. Felsefi kabuller, ontolojik seçimlerin neler olduğuna işaret ederler. Gerçekliğin kavramsallaştırılmasında kullanılan iki tane ana ontolojik seçim vardır: çoğulcu-indirgemeci (multiplicativist-reductionist) ve betimsel-düzenleyici (descriptive- revisionary). Çoğulcu ontoloji (multiplicativist ontology) gerçekliği olabildiğince yansıtabilmek için çok sayıda basit kavramlar kullanarak azami ifadelendirmeyi hedeflerler. Çoğulcu ontolojinin karşıtı olan indirgemeci ontoloji (reductionist ontology) ise gerçekliği modellemek için asgari sayıda basit kavramlar kullanmayı amaçlar. Bu iki yaklaşım arasındaki ayrım, aynı zaman ve mekan içinde bir entitenin eş konumlandırılmasının olanaklılığındadır. Çoğulcu yaklaşım için eş konumlandırma mümkün iken, indirgemeci yaklaşımda olasılık dışıdır. Betimsel (descriptive) yaklaşımla hazırlanmış ontolojiler ise gerçeklik doğal dillerin yapısına uygun bir biçimde olabildiğince sınırlandırılmaksızın tüm entiteleri içerir. Bu yüzden bu ontolojilere gerçekçi ontolojiler (realist ontology) de denir. Düzenleyici (revisionary) yaklaşımla hazırlanmış ontolojiler ise gerçekliği olduğu gibi yansıtırlar. Gerçekliğin tam bir modellemesinin yapılabilmesi için felsefedeki ve bilimdeki tartışmalardan uzak dururlar. Bu iki yaklaşım arasındaki fark nesneler ve olaylar arasında bir fark gözetip gözetmemektedir. Betimsel ontolojilerde zaman içinde değişimi gözlenebilen entiteler, yani olaylar bulunurken, düzenleyici ontolojilerde tüm entiteler zaman ve mekanda yayıldığı için nesne-olay ayrımını yapmak gereksizdir. Görüleceği üzere, betimsel ontolojiler ile çoğulcu ontolojiler, ve düzenleyici ontolojiler ile indirgemeci ontolojiler arasında paralellikler vardır.

Bu ontolojik seçimlere eklenebilecek başka felsefi kabullerden bahsetmek mümkündür. Etkincilik (actualism), bu alandaki anlamıyla, sadece gerçekten var olanı kabul ederken, olanakçılık (possibilism) olası alemleri ve/veya durumları da kabul eder. Bu yaklaşımlara eş olarak, şimdicilik (presentism) şu anda var olan gerçeklikler üzerinden bir ontoloji kurarken, sonsuzculuk (eternalism) ise tüm zamanları kapsayan bir ontoloji kurmayı hedefler. Dolaysıyla etkincilik ve şimdicilik arasında görülen benzerlik olanakçılık ve sonsuzculuk arasında da görülür.

Ontolojilerin oluşturulmasında en baştan dikkat edilmesi gereken bir başka temel yapı ise devam edenler (continuants) ve meydana gelenler (occurrents) ayrımının ontolojide belirlenip belirlenmeyeceğidir. Devam eden entitelerin zamansal parçaları yoktur, yani bunlar var oldukları zamanın tüm anlarında bir bütün olarak bulunurlar. Meydana gelen entiteler ise zaman içinde oluşurlar ve zaman aralıkları vardır. Birinci gruptaki entiteler nesneleri işaret ederler, örneğin kedi veya bu çalışma; ikinci gruptaki entiteler ise olayları işaret ederler, örneğin kedinin hayatı veya bu çalışmanın okunması. Devam eden entiteler ve meydana gelen entiteler ayrımına paralel olan diğer bir ayrım ise 3B ve 4B'dir ("B" boyutu ifade eder). 3B görüşüne göre entiteler var oldukları tüm zamanlarda bütün olarak vardırlar, 4B görüşünde ise entitelerin hem mekanda hem de zamanda uzanımları vardır. O halde 3B'yi devam eden entitelerle, 4B'yi meydana gelen entitelerle eşitlemek yerinde olacaktır.

Soyut entitelerin ve tümellerin ontolojiye dahil edilmesi ve tümel-tikel ayrımın neye göre yapılması gerektiği, yine ontolojilerin oluşturulma aşamasında karar verilmesi gereken felsefi duruşlardır. Soyut entiteler zaman ve mekandan bağımsızdırlar. Soyut entitelerin ve özellikle tümellerin ne olduklarının tanımlanması çok önemlidir, zira ontologların bu kavramlara bakış açılarına göre ontolojilerin yapılarında ciddi değişiklikler gözlemlenir.

Üst düzey ontolojiler bilimsel duruşlarından dolayı gerçekliğin sadece bilimsel tarafı ile ilgililerdir. Haliyle, felsefi olarak da indirgemeci bir yaklaşımlarının olduğunu söylemek gerekir. Bu nedenle pragmatik kaygılarla hazırlanıyor olmaları son derede doğaldır. Dolayısıyla, tüm üst düzey ontolojiler araççıdırlar.

Teknik ve felsefi yapıları anlatılan üst düzey ontolojilerin örneklendirilmesi için en önemli ve en tanınmış olanlar incelenecektir.

BFO (Basic Formal Ontology, Temel Formal Ontoloji) özellikle bilimsel alanlarda kullanılmak üzere oluşturulmuş bir üst düzey ontolojidir. Gerçekleştirim dilleri birinci basamak mantığı ve OWL-DL olan BFO'nun inşasının altında yatan felsefi kabuller şunlardır: betimsel, çoğunlukçu yaklaşım, etkincilik ve meydana gelenler-devam edenler ayrımı. BFO en yüksek cins olarak "Entite"yi belirler ve "Entite" BFO'nun en önemli özelliği olan modüler yapısını oluşturan SPAN alt-

ontolojisine ve SNAP alt-ontolojisine ayrılır. SNAP-ontolojisini meydana gelen entiteler, SPAN-ontolojisini ise devam eden entiteler oluşturur. Dolayısıyla, BFO 3B ve 4B ayrımını bünyesinde bulundurur. BFO tümellerin tanımı yapmayı alan ontologlarına bırakır, ancak soyut entiteleri kategorilerinde sınıflandırmak mümkün değildir. Son olarak, BFO olanakçılığa izin vermez. Bu üst düzey ontoloji özellikle tıp alanlarında ve ticaret uygulamalarında kullanılır.

DOLCE (Descriptive Ontology for Linguistics and Cognitive Engineering; Dilbilim ve Bilişsel Mühendislik için Betimsel Ontoloji) farklı ihtiyaç ve tercihlere hizmet etmek ve birlikte işlerliliği tesis etmek için birbirlerine bağlanmış üst düzey ontolojilerin kütüphanesi olarak geliştirilmiştir. KIF içeren birinci basamak mantığı, OWL, DAML+OIL, LOOM ve RDFS'te kodlanan DOLCE'nin tasarımcıları şu felsefi kabullerin üzerine bu üst düzey ontolojiyi kurmuşlardır: devam edenler ve meydana gelenler ayrımı, betimsel, olanakçılık ve sonsuzluk yaklaşımları, sadece tikellerin kabulü. DOLCE'nin "Entite" kökünden çıkan kategoriler ya ontolojik ya kavramsaldır. Bu gizli ayrımdan sonra ontolojik olanlar devam edenler ve meydana gelenler ayrımını, kavramsal olanlar ise nicelik ve soyut ayrımını verirler. Bu üst düzey ontolojinin 3B ve 4B bakış açısına sahip olduğu aşikardır, tümellere ise sistemde yer yoktur. Modüler bir yapıya sahip olmayan DOLCE, dilbilimden tekstile bir çok alanda uygulanmaktadır.

SUMO (Suggested Upper Merged Ontology; Önerilen Üst Düzey Birleştirilmiş Ontoloji) erişime açık olan ontolojilerin birleştirilmesiyle, tek, anlaşılabilir ve düzenle oluşturulmuş bir üst düzey ontolojiyi hedefleyen bir projenin ürünüdür. Bir çok disiplinden bir araya gelmiş olan bilim insanları kendi disiplinlerinin bakış açılarını bu projeye yansıtarak, gerçekliğin en muhtemel biçimde kategorik bir yapıda inşa etmişlerdir. Kendine ait bir gerçekleştirim diline (SUO-KIF) sahip olmanın yanı sıra, SUMO, OWL'da da kodlanmıştır. Kategorik yapısının en üstünde bulunan "Entite", "Fiziksel" entiteler ve "Soyut" entiteler olarak ikiye ayrılır. SUMO bir çok üst düzey ontolojinin bir araya getirilmesinden oluştuğu için gerçekliği tüm derecelerini olabildiğince yansıtır, bu da onun betimsel bir ontoloji olduğunu gösterir. Diğer taraftan, analistler SUMO'nun çoğulcu mu yoksa indirgemeci mi olduğu konusunda bir fikir birliğine ulaşamamışlardır. Uzlaşmanın olmadığı diğer konular ise SUMO'nun etkinci mi olanakçı mı, ve tümellerin

ontolojide olup olmadığıdır. Modüler yapısı SUMO'nun geniş çapta uygulanabilirliğini sağlamıştır. Öyle ki, dünya hükümetinden, otomobillere, biyolojik virüslerden spor dallarına kadar bir çok alanda kullanılmıştır.

Cyc, 30 yıllık bir yatırım ve gelişmenin ürünü olup, yukarıda bahsedilen üst düzey ontolojilerden farklı olarak lisanslı bir üründür. Cyc'in ismi sadece "ansiklopedi" kelimesinin vurgulu hecesinden gelmez (İngilizce: encyclopedia), aynı zamanda ansiklopedik bir özelliğe sahip olması hedeflenerek hazırlanmıştır: dünyanın en geniş ve en tam genel bilgi tabanı ve uslamlama motoru. Tüm insan bilgisini yansıtmayı amaçlayan Cyc, haliyle betimsel ve çoğulcu bir ontolojidir. Soyut entiteleri ve tümelleri de içerir. En üst kategori olarak "Şey"i belirleyen Cyc üç kola ayrılır: "Matematiksel veya Hesaba Dayalı Şey", "Kısmi Algılanamaz" ve "Birey". Kategorinin daha alt seviyelerde oluşan döngüler tutarsızlıklara meydan veriyor olsa da, ontologlar bu yapının Cyc'in olasılıkçı bir ontoloji olmasına bağlıyorlar. Cyc hem devam eden entitelere hem de meydana gelen entitelere yer verir, ancak sadece 3B anlayışını benimser. Tüm insan bilgisini kapsamayı hedefleyerek hazırlanmış bu üst düzey ontoloji bir çok alanda kullanılmaktadır; ağ risk analizlerinden terörizm ile ilgili bilgilerin sunumuna kadar.

Diğer üst düzey ontolojiler ise şunlardır: CIDOC CRM, COSMO, gist, GFO, IDEAS, MarineTLO, OCHRE, PROTON, Sowa'nın üst düzey ontolojisi, UFO, UMBEL ve YAMATO'dur.

Bu çalışmanın son bölümü üst düzey ontolojilere felsefi bir yaklaşıma tahsis edilmiştir. Bu yeni bilimin kurucu öğeleri yukarıda incelenen ontolojilerdeki durumlarına göre incelenecek, ve bu öğeler temelinde yukarıda ontolojileri ve kategorik sistemleri anlatılan filozofların bakış açılarına göre de bu üst düzey ontolojiler irdelenecektir.

İlk yapıcı öğe olan kategorilerdir, yani gerçekliğe ait tüm entitelerin sınıflandırılmasıdır. Aristoteles'in kategorileri "varlık", Husserl'inki "entite" olarak başlarken, Kant kategorik bir hiyerarşi sunmadığı için algı nesneleri üzerinden bir listeleme yapar. Quine, ontolojik kabullenmeler üzerine kategorik bir sistemden bahsettiğinden, kategorik yapı kurucusunun kabullenmeleri üzerine gelişir. Cyc hariç, ki onun en yüksek cinsi "Şey"dir, diğer üst düzey ontolojiler "Entite"yi en

yüksek cins olarak kategorilerinin tepesine yerleştirirler. Aristoteles, kategorilerini diğer kitaplarına yardımcı bir araç olarak hazırladığından ve ontolojisi gereği kategoriler, gerçekliğin sadece bir kısmını ifade ettiğinden üst düzey ontolojilere sadece fiziksel nesnelerin soyut entiteler arasındaki ilişkiyi vermek ve kategorik bir baz oluşturmak için kullanılır. Kant'ın kategorileri üst düzey ontolojilerde pek kullanılmaz, zira bu sistemin uygulanabilirliği zordur. Quine'nın kategorik bakış açısı ise alan ontolojilerinde işe yarar. Husserl ise gerçekliği tüm açılardan ele aldığı ve ontolojisi mantığı ile içiçe olduğu için kategorik sistemde en çok faydalanılacak filozoftur. BFO, Aristotelesçi bir yapıdan esinlenirken, kategorik sisteminin oluşumunda Husserl'in parça-bütün, tümel-tikel gibi ontolojik yapılarını kullanmıştır. DOLCE'nin "Entite"yi ontolojik ve kavramsal olarak zımni ayrımı Husserlci bir yaklaşımı çağrıştırmaktadır. SUMO ise daha çok Aristotelesçi bir kategorik sistem üzerine kurulmuşa benzemektedir çünkü ilk ayrım fiziksel ve soyut entiteler üzerinden olmuştur. Kategorik sisteminin içinde döngüler bulunduran Cyc için bir benzetme yapmak mümkün değildir.

Bilimsel yapısından dolayı, ontolojilerin tikelleri içermelerinden daha doğal bir şey yoktur, ancak söz konusu tümellerin ontoloji içinde yansıtılmasıysa bu noktada ontologların açık bir biçimde tutumlarını belirtmeleri gerekir. Tümeller entitelerin örneklendirilmesi olarak ele alınabilir. Ayrıca realist yaklaşımda olduğu gibi bağımsız olarak var olabilirler, ya da tam tersi, kavramcılık yaklaşımında olduğu gibi bağımlı varlıklar olabilirler. Tümeller adcılık yaklaşımda ise şeylerin sınıflandırılması olarak tanımlanır. Aristoteles'in tümellere yaklaşımı kavramsal yaklaşıma yakındır. Adcı filozoflar olan Kant ve Quine'a göre ise tümeller nesneleri kategorize ederler. Husserl bu iki filozofa karşı çıkarak tümellerin akıl ile anlaşılabileceğini savunur ve Aristotelesçi bir duruşla tümellerin varlıklarını kabul eder. Tüm üst düzey ontolojiler tümelleri entitelerin örneklendirilmesi olarak ele alırlar. DOLCE ve SUMO'nun tikel ontolojileri olduğu için, Cyc'in ise adcı bakış açısıyla tümelleri tanımladığı için Kantçı ve Quinecı oldukları söylenebilir. BFO, tümellerin tanımı alan ontologlarına bıraktığı için adcı olduğu söylenebilir, ancak tümel ve tikel ayrımının son derece keskin olması Husserlci bir tutumu savunduğunu da gösterir.

Tikellerde olduğu gibi somut entiteler elbette ontolojilerde olacaktır, ancak tümellerde olduğu gibi soyut entitelerin nasıl ele alındığının ontologlarca dokümantasyonlarda belirtilmesi yine son derece elzemdir. Zaman ve mekandan bağımsız olan soyut entiteler bu çalışmada değinilen tüm filozofların -en azından söz konusu matematiksel nesneler olduğunda- ontolojilerinde yer almaktadır. İnceleme dahilinde olan üst düzey ontolojiler arasından BFO soyut entitelere yer vermeyen tek ontolojidir.

Devam eden entiteler ve meydana gelen entiteler üst düzey ontolojiler için çok önemlidirler. Bu çalışmada tartışılan tüm ontolojiler bünyelerinde hem devam eden entiteleri hem de meydana gelen entiteleri barındırırlar. Aristoteles ve Kant için bu entitelerin tartışılması mümkün değildir, zira doktrinlerinde bu tarz entitelerden bahsediyor olsalar bile, bu kavramları Husserl ve Quine açısından incelemek daha doğru olacaktır. Husserl olgular alanında devam edenler ve meydana gelenler ayrımı kategorik bir biçimde yapmıştır. Quine ise 4B modelini kabul etmesine rağmen, nesne ve olay ayrımını reddetmiştir. Bu nedenle, SPAN ve SNAP alt ontolojilerine sahip BFO'nun Husserlci anlayışa ile oluşturulduğu aşikardır. Yine de, bu noktada felsefi yorumlardan kaçınmakta fayda vardır, çünkü günümüzün ontolojilerine ait olan bu kavramları her ontolog bir şekilde kendi bakış açısına göre tanımlamışlardır.

Son olarak, olası alemlerin ontolojilerin yapısında bulunup bulunmadığına bakmak gerekir. Çoklu alemlere olanak sağlayan modaliteler filozofların öğretilerine göre ve formal dillerin modaliteye olanak sağlamasına göre çeşitlilik gösterirler. Olasılık, var olma, zorunluluk, inanç modaliteye örnek olarak verilebilir. Aristoteles, Kant ve Husserl modaliteye öğretilerinde yer verirken, Quine bu yaklaşımı karikatürize ederek reddeder. Bu yapı da bilimsel olarak ontolojilere dahil edilir, ancak filozoflar öğretileri çerçevesinde konuyu ele aldıkları için yapılacak herhangi bir yorum konunun dışına çıkar. Zira konuyu Aristoteles açısından ele alırsak, ilineksel olarak tesadüfe metafiziğinde yer verir, ancak formal dillerle kavramsallaştırılan tesadüf çok daha farklı bir bakış ile üst düzey ontolojilere yansıyacaktır. Bu durumda iki sistemde de tesadüfün olması ontolojinin Aristotelesçi olduğuna işaret etmez.

Felsefi ontolojiler ile üst düzey ontolojiler arasındaki en temel fark ikincisinin pragmatik olmasıdır. Bu nedenle iki tür ontolojinin inşasında çok farklı yaklaşımlar vardır. Felsefi ontolojiler makine dilleri veya müşteri istekleri gibi sınırlardan uzak olduklarından üst düzey ontolojilere göre daha yaratıcı, özgün ve üretkendirler. Bu nedenle, felsefeden ayrılıp kendi özerkliğine kavuşan ontoloji, tüm pragmatik yaklaşımlarında, felsefenin sağladığı bütünsel bakışı ve özgürlüğü bünyesinde tutmalıdır. Kötü kavramsallaştırmalar, tanımlamalar, eksik veya dikkate alınmamış durumlar ontolojilerin içinde sorunlar doğurmaktadır. Bu sorunlara formal dillerden veya kavramsallaştırılmış çalışmalardan gitmek yeterli değildir. Bu nedenle, bilimlerin kurucusu Aristoteles'in de işaret ettiği gibi, tanım yapmak ancak felsefenin işidir. Felsefi disiplinle zenginleşen dimağların teknik ve kavramsal sorunlara daha üretken cevaplar sunacağı, ya da soruları ile bu sorunları açarak ontoloji çalışanlara yeni bakış açıları, dolayısıyla farklı çözümler bulduracakları umulur. Brentano'nun felsefe tarihi teorisine geri dönülecek olunursa, ontolojinin teorik gelişmelerin kucağında olduğu görülür, ki bu da ontologların felsefeyi kullanarak ontoloji bilimini zenginleştireceklerine işaret eder. Yine Brentano'nun bakışından şunu söylemek de mümkündür: ontolojinin bilimsel yönünün metodolojilerle zenginleştirildiği bir evredeyiz. Disiplinlerarası özelliği ön plana çıkan ontolojiler, farklı bilim dallarındaki bilim insanları ile ontolojinin kendine has metodolojileriyle uygulanabilirlik noktasına ulaşmak üzere gelişiyorlar.

APPENDIX B. TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ■

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : Satıoğlu
Adı : Dilek
Bölümü : Felsefe

TEZİN ADI (İngilizce) : A Philosophical Approach to Upper-Level Ontologies

TEZİN TÜRÜ : Yüksek Lisans ■ Doktora ☐

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. ■
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
3. Tezimden bir (1) yıl süreyle fotokopi alınamaz. ■

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: