What Researchers are Currently Saying about Ontologies: A Review of Recent Web of Science Articles†

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Abstract: Traditionally connected to philosophy, the term ontology is increasingly related to information systems areas. Some researchers consider the approaches of the two disciplinary contexts to be completely different. Others consider that, although different, they should talk to each other, as both seek to answer similar questions. With the extensive literature on this topic, we intend to contribute to the understanding of the use of the term ontology in current research and which references support this use. An exploratory study was developed with a mixed methodology and a sample collected from the Web of Science of articles published in 2018. The results show the current prevalence of computer science in studies related to ontology and also of Gruber's view suggesting ontology as kind of conceptualization, a dominant view in that field. Some researchers, particularly in the field of biomedicine, do not adhere to this dominant view but to another one that seems closer to ontological study in the philosophical context. The term ontology, in the context of information systems, appears to be consolidating with a meaning different from the original, presenting traces of the process of "metaphorization" in the transfer of the term between the two fields of study.

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1.0 Introduction

The ontological approach to describe reality—or put another way, the way we determine what is similar and what is different—is reflected in the organizational systems that we develop. Traditionally connected to philosophy, the term ontology has been increasingly related to information systems areas. In these two academic communities, there are researchers who consider the approaches as completely different; while in the former there is speculation about the structures of the world, the latter is focused on concrete problems of modeling domains of knowledge in computational artifacts (Poli and Obrst 2010). This understanding will not be oblivious to the use of the term ontology to designate a concrete artifact of computational engineering (Guizzardi 2007). Disagreeing with the separation between the two communities, Poli (2010a) considers that they should talk to each other, as both seek to answer similar questions.

Within the field of knowledge organization (KO), the analysis of studies on ontology has generated myriad opinions. On the one hand, Soergel (1999) suggests that studies on ontology would be some sort of bogus enterprise, as they concern classification, and classification is something that cannot be reinvented; for Gilchrist (2003), the use of the term ontology in other fields to name a type of classification structure is only an etymological issue. Currás (2004) believes the term ontology would result from well-known concepts from LIS applied to new technologies. In the same line as Soergel, Dahlberg (2014) states that it is a sort of reinvention of the wheel to take seriously new technological aspects of existing organizational processes, which introduces unfortunate designations—such as ontologies—to what is well-known as a knowledge organization system (KOS). On the other hand, there were visions that identify the similarity between ontology research and bibliographic classification, fostering cooperation, as for example Vickery (1997). Emphasizing the importance of the procedural aspect of ontology, as a study of what exists, Smiraglia (2014) considers this process one of the pillars in the development of any KOS.

All the discussion since the 1990s demonstrates how ontologies have become a core subject in the knowledge organization field, as one can see in the themes and subthemes of the ISKO international conferences over time. This interest seems to be natural, since people understand that ontologies as representational artifacts are grounded in classification principles, which are a seminal theme in LIS theories. Hjørland (2019) corroborates with this interest in explaining that there are a variety of classification systems in KO that can be seen as types of restricted ontologies. Several issues in classification, since ancient times, originated in metaphysical problems. Discussions and answers to the metaphysical problem of universals gave rise to several theories or lines of thought that have influenced the way we classify until today. The idea of concepts came from Kant and others as a sort of questioning regarding old Aristotelian theories. The role of LIS in applying and improving methods and theories of classification is widely known. However, in order to instruct computers to make inferences and classifications, formal ontologies are needed.

It is not the purpose of this study to comprehensively dissect the meaning of the term ontology, a subject that has been widely addressed in several studies. Good examples of works that clarify the meaning of the term ontology and make the connection between its use in the two disciplinary contexts, the philosophy area and those related to information systems, are Almeida (2013), Poli and Obrst (2010) and Smith (2003). Other similar works but with a perspective focused on the context of information systems are Almeida and Bax (2003), Gruber (2009), Guarino and Giaretta (1995) and Guarino et al. (2009). Examples of works where the emphasis is on the use of the term in the philosophical sense are Hennig (2008) and Poli (2010b). Another recurring approach is the search for a clarification of the uses of the term ontology in the KOS spectrum, e.g., Gruninger et al. (2008), Khazraee and Lin (2011), Kless et al. (2011) and Souza et al. (2012). Other studies present ontology as a process for knowledge organization, such as Poli (1996) and Smiraglia (2014). There are also works in which the term ontology arises associated with a new scientific area with designations such as "applied ontology" (Smith 2013) or "formal ontology" (Herre 2015). Finally, we highlight the comprehensive bibliometric study of ontology research that covers the period from 1900 to 2012. In this study, Zhu et al. (2015, 47) stress the importance of Thomas Gruber "for the establishment of the theory of ontology in scientific fields" and his "commonly accepted" definition of ontology.

With the extensive and relevant literature on the subject, of which we present only a small part, we consider a pertinent issue to question the impact on current ontology research. Thus, seeking to contribute to the understanding of this subject, we intend to verify on which authors and their respective works current researchers base their definitions of the term "ontology." Specifically, we aim to:

i) collect definitions of ontology presented in the most recent peer-reviewed articles published in 2018 from a sample taken from the Web of Science (WoS);
ii) identify the most cited authors and papers in these definitions; and,
iii) analyze the variations of meaning of those definitions.

In the next section, we describe the methodology used in the study to then summarize its results and complement the material collected with appendices presented at the end. In the fourth section, the central question of the study is explored in the discussion of the results. Finally, in the last section, we come forward with potential repercussions of the detected trend in current research.

2.0 Methodology

To reach the objectives, an exploratory study was developed combining a mixed methodology of monostrand conversion design with purposive sampling (Teddlie and Tashakkori 2009). For a sample selection, we searched the main collection of WoS using the expression "ontology OR ontologies," restricting it to the title field. Since the intention was to have a significant sample of the current year's production, the collection was performed in November 2018, using the filters "year=2018" and "document type=article."

The procedure described above resulted in 477 records considered for investigation as the study population. According to probabilistic techniques, given the size of the selected population, a sample of 214 articles would represent a confidence level of 95% and a margin of error of ±5%. Since we aimed to collect the most recent articles and not a random sample, the articles were sorted chronologically in descending order, and the first 214 were selected.

In the qualitative analysis, contingency analysis was initially used and, later, the categorical technique in the processing of the context units (Bardin 2011; Krippendorff 2004). Contingency analysis takes into account the distribution of elements and their association, as these aspects constitute a significant point for interpretation while they also provide context. The place or section of the text in which the subjects appear and their co-occurrence with other topics provide relevant indicators for interpretation, which may be associative, equivalent or opposite (Bardin 2011). So, the first step served to collect the definitions explained in the articles that make up the sample and, by analyzing the context in which the term ontology occurred, it simultaneously allowed the articles to be classified according to the context in which the term is addressed (philosophical or information systems contexts). In the second phase, we proceeded with clustering according to a propositional-semantic distinction, delineating categories according to the propositional forms presented and the semantic relationships between the unit's components (Krippendorff 2004). In articles with more than one definition, we used contextual elements to select which would represent the authors' opinion. In cases where these elements were not sufficient to clarify the meaning, we resorted to the typology of the definitions, considering as the most representative those without quotation, then indirect quotations and, finally, direct quotations.

Regarding the distribution by epistemological area, the five major categories of WoS were considered: "arts & humanities," "life sciences & biomedicine," "physical sciences," "social sciences" and "technology." These categories group the 153 research areas with which WoS articles are classified. In the case of articles included in more than one category, the category with the most areas assigned to the respective article was selected or, in case of equality, the one that leads the corresponding list.

3.0 Results

The number of articles (eighty-four) in which we found definitions for the term ontology corresponds to less than half of the sample. As a side note, all percentage values are shown rounded to units, so eighty-four correspond to 39% of 214 (see Figure 1). Of these eighty-four, only five articles do not present a contextual approach to information systems. These five articles represent a residual percentage (11%) of the number of works in the sample whose approach to the term ontology is related to their philosophical origin (47 = 100%). In contrast, in articles where the approach is made in the context of information systems, the difference is much smaller—definitions were found in seventy-nine (47%) of 167 (100%) articles with this approach.

In the distribution of the sample articles across the five broad categories of WoS (see Figure 2), we found a relationship between these very same categories and the contexts used in contingency analysis. The "arts & humanities" and "technology" categories present the extreme of this relationship. All articles in the sample classified in the former category address the term ontology in a philosophical context, while in the latter all papers present an approach in the context of information systems.

Regarding the research areas included in the WoS categories, we found that the three with the highest number of assignments are related to the computing field: "computer science," "engineering" and "mathematical & computational biology" (see Table 1).

The "philosophy" area appears only in the eighth position, with nine assignments, and we found no definitions for the term ontology in any of these articles. The five articles, whose approach is related to the philosophical context,

	ontology approach in information systems context		ontology approach in philosophical context		sum	
articles where definitions were found	79	(94%)	5	(6%)	**84**	(100%)
	(47%)		(11%)		(39%)	
articles where definitions weren't found	88	(68%)	42	(32%)	**130**	(100%)
	(53%)		(89%)		(61%)	
sum	**167**	(78%)	**47**	(22%)	**214**	(100%)
	(100%)		(100%)		(100%)	

Figure 1. Sample distribution according to the results of contingency analysis.

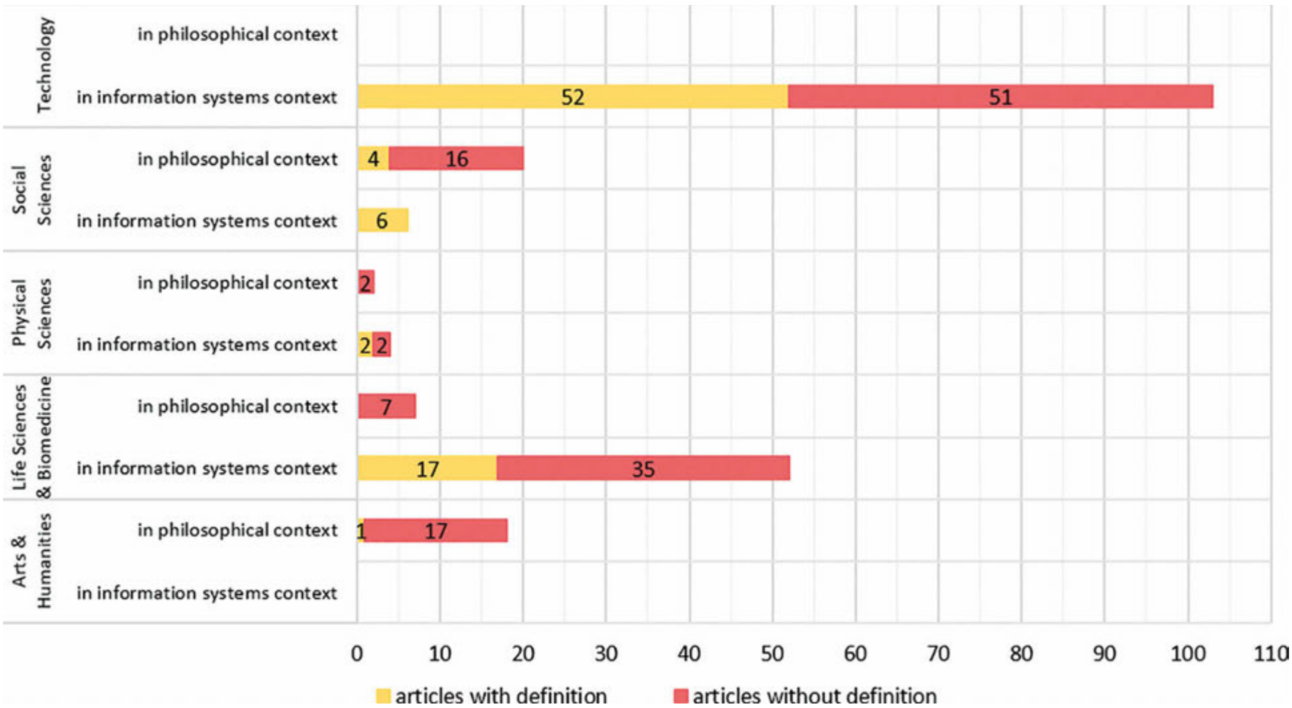

Figure 2. Sample distribution according to the five major categories of Web of Science.

in which definitions were found, are classified in the following areas: "cultural studies," "education & educational research," "ethnic studies," "history" and "sociology." In positions prior to the one occupied by the "philosophy" area, three areas related to medicine stand out: "biochemistry & molecular biology," "biotechnology & applied microbiology" and "medical informatics."

In the collection of authors and their works cited in the definitions (84 = 100%), we found that about one third (24 = 29%) of such authors had no reference to other works. However, given the co-authorship and the presentation of multiple references in various definitions, the number of authors (127) is higher than the total number of articles with definitions. Of this total number of authors only those who are cited more than once are presented in Table 2. In this table, we highlight the difference between the most cited, namely, Thomas R. Gruber with thirty-four mentions, and the second, V. Richard Benjamins and Rudi Studer with only eight. In addition, it is also noteworthy that, out of these seventeen authors, only Barry Smith is also the author of one of the 214 articles in the sample.

Analyzing the citations in terms of the number of different works by each author (see Table 2, column "no. works"), Gruber shares the top spot with Smith with four works each.[1] The second position, with three different works, is also shared by two authors: Nicola Guarino and Steffen Staab.[2]

no. articles	articles where definitions were		Web of Science research areas
	found	not found	
98	49	49	computer science
35	19	16	engineering
21	6	15	mathematical & computational biology
18	2	16	biochemistry & molecular biology
12	0	12	mathematics
11	2	9	biotechnology & applied microbiology
11	8	3	medical informatics
9	0	9	philosophy
7	0	7	science & technology - other topics
6	3	3	chemistry
6	3	3	education & educational research
6	3	3	environmental sciences & ecology
5	4	1	information science & library science
4	1	3	genetics & heredity
4	3	1	geography
4	1	3	social sciences - other topics
4	4	0	operations research & management science

Table 1. Web of Science research areas assigned to four or more sampled articles.

no. citations	authors	no. works	in co-authorship
34	Gruber, T.R.	4	1
8	Benjamins, V.R.	2	2
8	Studer, R.	2	2
6	Fensel, D.	1	1
5	Staab, S.	3	3
4	Guarino, N.	3	2
4	McGuinness, D.L.	2	2
4	Noy, N.F.	2	2
4	Smith, B.	4	2
3	Borst, W.N.	1	0
2	Chandrasekaran, J. & Josephson, J.R.	1	1 (a)
2	Maedche, A	2	1
2	Oberle, D.	1	1
2	Uschold, M. & Gruninger, M.	1	1 (a)
2	Wand, Y. & Weber, R.	2	2 (a)

Table 2. Authors with two or more citations in the collected definitions; (a) authors always cited together in sample articles.

In accounting for citations by work, Gruber once again stands out with the authorship of the two most cited works (see Table 3). This is expected given the numerical difference in citations that Gruber presents compared to all other authors. As in Table 2, Table 3 presents only the works with two or more citations from the total of sixty-one papers cited.

As a context for the analysis of the definitions taken in the sample (presented in appendices A, B and C) we also collect the definitions present in the works listed in Table 3 (see

ref.	no. citations	works	authors	edition year
A	20	A translation approach to portable ontology specifications	Gruber	1993
B	11	Toward principles for the design of ontologies used for knowledge sharing	Gruber	1993 / 1995 (a)
C	6	Knowledge Engineering: Principles and Methods	Studer; Benjamins & Fensel	1998
D	3	Ontology development 101: a guide to creating your first ontology	Noy & McGuinness	2001
E	3	Construction of engineering ontologies for knowledge sharing and reuse	Borst	1997
F	2	Ontologies: Principles, Methods and Applications	Uschold & Gruninger	1996
G	2	What are ontologies, and why do we need them?	Chandrasekaran; Josephson & Benjamins	1999
H	2	Handbook on ontologies	Staab; Studer	2009 (b)
I	2	What is an ontology?	Guarino; Oberle & Staab	2009 (b)

Table 3. Works with two or more citations in the collected definitions; (a) quotations from this paper refer to both versions of the article, the 1995 version is an amplified revision of a workshop paper presented in 1993; (b) The paper with the ref. I is a chapter from the work with the ref. H.

Table 4). The chronological presentation of Table 4 was selected to facilitate the perception of the link between the various works. It seems that the works following Gruber's articles incorporate his definition in a more or less explicit manner.

We identified the definitions given in texts with the refs. C and E are explicitly due to Gruber's work (texts with refs. A and B). In the definition provided in works due to ref. G, despite the fact that "representation vocabulary" is a notion relevant to defining ontologies, the "conceptualization" notion still receives more emphasis because for Gruber the conceptualization is the ontology itself. In turn, in the works with refs. D, H and I, the central element of the definitions is the "set of concepts." This, namely the "set of concepts," also appears in the definition of work with ref. F; however, it appears again as "a conceptualization."

As for the definitions collected from the sample, they were organized into three groups. appendix A depicts seventy-nine definitions, which we found in the articles approaching ontology in the context of information systems. In this appendix, we also pointed out twelve definitions that are framed with a reference to the philosophical origin of the term ontology. Appendix B reproduces the six definitions associated with that same origin but in articles whose approach is made in the context of information systems. Finally, we present in appendix C the five definitions of the term ontology found in articles whose approach is made in the context of its philosophical origin.

From the analysis of the definitions associated with the information systems context, four categories emerged: i) a conceptualization; ii) a set of concepts; iii) a conceptual model; and, iv) a terminological artifact (see Table 5).

Comparing the four categories, noticeable is the percentage increase in relation to the total of each category of the number of definitions without reference to other works. The situation described relates to the fact that many of the definitions with direct or indirect citation refer to the works presented in Table 4 (particularly Gruber's two papers) and the categories mirror the definitions contained therein. Table 6 presents the distribution, by the four categories of analysis, of direct and indirect citations for the works presented in Table 3, according to the relationship mentioned above among the various definitions. From these relationships, we form four groups: the definitions of Gruber's works (ref. A and B), those explicitly constructed from these (ref. C and E), those that refer to "a conceptualization" less explicitly (ref. F and G) and those that underline the "set of concepts" (ref. D, H and I).

It should be noted that all works included in the "other works" column of Table 6 are cited only once. This highlights the prevalence of Gruber's definition, and others influenced by it, as a reference, particularly in the first category, where more than half of the definitions (62%) cite this author. In contrast, only one citation of category iv ("a terminological artifact"), refers to works included in Table 3. The author of this definition (ref. 097), while citing two works by Gruber, does not use Gruber's definition in his own definition of ontology. Another definition included in category iv deserves mention, the definition ref. 022 which, despite making a direct quote, exchanges the original "it describes the concepts" (Antoniou and Kehagias 2000, 623) for "it describes the constructs" (Gelbard et al. 2018, 2).

Crossing the categories of analysis with the broad areas of WoS shows that the category of analysis (i) "a conceptualization," does not include any definition taken from articles classified in the "life sciences & biomedicine" area contrasting with the "technology" area where the majority is distributed in the first two categories (see Table 7).

works	definitions
A: Gruber (1993) and B: Gruber (1995) (a)	An ontology is an explicit specification of a conceptualization. The term is borrowed from philosophy, where an ontology is a systematic account of Existence. For knowledge-based systems, what "exists" is exactly that which can be represented. When the knowledge of a domain is represented in a declarative formalism, the set of objects that can be represented is called the universe of discourse.
F: Uschold et al. (1996)	"Ontology" is the term used to refer to the shared understanding of some domain of interest which may be used as a unifying framework to solve the above problems in the above-described manner. An ontology necessarily entails or embodies some sort of world view with respect to a given domain. The world view is often conceived as a set of concepts (e.g. entities, attributes, processes), their definitions and their interrelationships; this is referred to as a conceptualisation.
E: Borst (1997)	In philosophy, the word ontology means a theory about the nature of being, or the kinds of existence ... For AI the main question is not what the nature of being is, but what an AI system has to reason about to be able to perform a useful task ... Most researchers generally agree on the definition of Gruber, but find it too broad ... We will therefore give a definition of ontologies that suits us the best and continue this section with explaining how to make a good ontology: An ontology is a formal specification of a shared conceptualization.
C: Studer et al. (1998)	Originally, the term "ontology" comes from philosophy—it goes as far back as Aristotle's attempt to classify the things in the world—where it is employed to describe the existence of beings in the world ... Many definitions of ontologies have been given in the last decade, but one that characterises best, in our opinion, the essence of an ontology is based on the related definitions in ([Borst, 1997; Gruber, 1993]): An ontology is a formal, explicit specification of a shared conceptualisation.
G: Chan- drasekaran et al. (1999)	In philosophy, ontology is the study of the kinds of things that exist ... In AI, the term ontology has largely come to mean one of two related things. First of all, ontology is a representation vocabulary, often specialized to some domain or subject matter. More precisely, it is not the vocabulary as such that qualifies as an ontology, but the conceptualizations that the terms in the vocabulary are intended to capture ... In its second sense, the term ontology is sometimes used to refer to a body of knowledge describing some domain, typically a commonsense knowledge domain, using a representation vocabulary.
D: Noy et al. (2001)	For the purposes of this guide an ontology is a formal explicit description of concepts in a domain of discourse (classes (sometimes called concepts)), properties of each concept describing various features and attributes of the concept (slots (sometimes called roles or properties)), and restrictions on slots (facets (sometimes called role restrictions)).
H: Staab et al. (2009) and I: Guarino et al. (2009) (b)	In the first case, we refer to a philosophical discipline, namely the branch of philosophy which deals with the nature and structure of "reality" ... In the second case, which reflects the most prevalent use in Computer Science, we refer to an ontology as a special kind of information object or computational artifact ... The backbone of an ontology consists of a generalization / specialization hierarchy of concepts, i.e., a taxonomy.

Table 4. Works with two or more citations in the collected definitions; (a) the definition in both works is the same; (b) quotations that cite the work H refer to the definition presented in the work I.

categories	ref. of definitions in appendix A	dir	ind	self	total
i) a conceptualization	006; 014; 016; 018; 027; 032; 033; 037; 061; 070; 075; 076; 081; 106; 061; 125; 131; 143; 152; 154; 178; 195; 210.	5 (22%)	16 (70%)	2 (8%)	23 (100%)
ii) a set of concepts	005; 007; 008; 020; 021; 044; 063; 066; 072; 089; 096; 102; 105; 107; 118; 129; 136; 137; 139; 151; 161; 172; 175; 177; 179; 182; 183; 197; 206; 212; 214.	1 (3%)	20 (65%)	10 (32%)	31 (100%)
iii) a conceptual model	004; 025; 068; 079; 080; 126; 132; 142; 180.	1 (11%)	3 (33%)	5 (56%)	9 (100%)
iv) a terminological artifact	015; 022; 023; 036; 047; 050; 069; 085; 097; 104; 122; 148; 157; 170; 193; 213.	1 (7%)	6 (38%)	9 (56%)	16 (100%)

Table 5. Categories resulting from the analysis of the definitions associated with the information systems context, respective definitions and types of quotations; ("dir"—count of definitions with direct quotation; "ind"—count of definitions with indirect quotation; "self"—count of definitions without citing other documents).

categories of analysis	A+B	C+E	F+G	D+H+I	other works	total
i) a conceptualization	15 (62%)	3 (11%)	0 (0%)	2 (8%)	5 (19%)	26 (100%)
ii) a set of concepts	5 (19%)	2 (7%)	2 (7%)	3 (11%)	15 (56%)	27 (100%)
iii) a conceptual model	2 (29%)	1 (14%)	0 (0%)	0 (0%)	4 (57%)	7 (100%)
iv) a terminological artifact	1 (10%)	0 (0%)	0 (0%)	0 (0%)	9 (90%)	10 (100%)

Table 6. Distributions of direct and indirect citations to works presented in Table 3 by the categories resulting from the analysis of the definitions associated with the information systems context; (the total reflects the sum of works cited associated to definitions in appendix A and not the sum of those definitions: "A+B"—sum of citations to Gruber (1993) and Gruber (1995); "C+E"—sum of citations to Studer et al. (1998) and Borst (1997); "F+G"—sum of citations to: Uschold et al. (1996) and Chandrasekaran et al. (1999); "D+H+I"—sum of citations to Noy et al. (2001), Staab et al. (2009) and Guarino et al. (2009).)

WoS major categories	categories of analysis				total
	i)	ii)	iii)	iv)	
Life Sciences & Biomedicine	0 (0%)	8 (47%)	1 (6%)	8 (47%)	17 (100%)
Physical Sciences	1 (33%)	2 (67%)	0 (0%)	0 (0%)	3 (100%)
Social Sciences	2 (33%)	2 (33%)	0 (0%)	2 (33%)	6 (100%)
Technology	21 (40%)	19 (36%)	8 (15%)	5 (9%)	53 (100%)

Table 7. Distributions of the definitions associated with the information systems context according to the major categories of Web of Science; (the WoS category "arts & humanities" was not presented, because it does not include definitions associated with the information systems context; categories of analysis: i) - a conceptualization; ii) - a set of concepts; iii) - a conceptual model; iv) - a terminological artifact).

It is worth noticing that two in five definitions in the WoS category "technology," included in our category of analysis (iv), come from the library and information science (LIS) area. Indeed, since the other two definitions of this area fall into the category of analysis (iii), the four definitions of LIS do not contribute to the majority mentioned above. The majority of definitions distribution by categories of analysis (i) and (ii) within the WoS major category "technology."

Finally, concerning the definitions associated with the philosophical context (presented in appendices B and C), they present a certain uniformity that can be summarized in the following statement: "ontology is the philosophical study of what exists in reality." Note that, as we mention it above, none of those definitions are included in articles classified, on WoS, in the "philosophy" area.

4.0 Discussion

In view of the differences in the number of actors in each field of investigation and the representation of these areas in WoS, the comparison of values between them should be understood in the context of the sample. Despite this limitation, we consider that the sample collected is a strong indicator of the current prevalence of the information technology area in studies related to ontology. This superiority *per se* would be sufficient to justify a difference between the number of definitions found in each context analyzed, but not as pronounced as that found (47% in the context of information systems and 11% in that associated with philosophical origin). Such an occurrence will be related to the novelty of the connection of the term ontology to digital information systems compared to the secular association with the philosophy area.

Another aspect that promotes the need to present an explicit definition of a term, besides its novelty, is its use in a different context. The use of the term ontology in disciplinary contexts other than philosophy is one such case. In the sample, the definitions for the term ontology were all found in articles outside its original disciplinary context, so the sample seems to mirror the situation described. In the new disciplinary context, by restricting the count to articles classified in the WoS "computer science" area, the equal number of articles with and without definition is a potential indicator of the assimilation of the term ontology by the respective community. One should expect that as the term becomes more commonly used in a new context, the presentation of a definition for it will decrease.

In the conceptual accommodation phase of a term in a new context, the use of sources of recognized authority attesting its meaning is expected. Gruber's articles (1993; 1995) seem to fulfil this role in research related to computational ontologies even because of his early association with it. This role is reflected not only in the corpus of analysis but also in the works of other authors that these articles cite. We find several references to him in the works cited.

Another possible indicator of Gruber's role as an "authority" is his citation in definitions proposed by others. Exemplary cases of this appropriation are the definitions ref. 178 and 210, which correspond to that of Studer et al. (1998), and ref. 076, which is the one presented by Borst (1997); all three are referenced in the respective sample articles with Gruber's work (1993). The case of definition ref. 210 is the most striking because it comes as a direct quote. Although the close connection between the two definitions (Studer's and Borst's) and Gruber's is conducive to confusion (see Table 4), greater rigor would be expected in the context of scientific writing.

There are, also, other occurrences that point to the apparent "status" achieved by Gruber's definition. The definition in the expanded version, "an ontology is a formal, explicit specification of a shared conceptualization" as stated by Studer et al. (1998, 184), is used in three works (ref. 006, 014 and 143) without the respective article being cited. In its place, are referenced three other works that define an ontology as: 1) "a special kind of information object or computational artifact" (Staab and Studer 2009, 2); 2) "an engineering artifact, constituted by a specific vocabulary used to describe a certain reality" (Maedche 2002, 665:11); and, 3) "a specification mechanism to enhance knowledge sharing and reuse across different applications" (P. Borst, Akkermans and Top 1997, 365).

Still, regarding Gruber's definition, it is important to mention a question that emerged from this study: the reduced number of clarifications found about what is meant by "conceptualization" (only three: ref. 089, 131 and 143). This is an issue that could constitute a study in its own right given the central role of the term "conceptualization" in the respective definitions and the evidence of situations similar to those mentioned above. The clarification found in the article with the definition ref. 089 attributes this clarification to Guarino et al. (2009) who, in turn, quote directly from Gruber (1993). Indeed, Guarino only suggested that the approach to conceptualization should be intensional, in contrast to Gruber's original perspective. Within this debate, the word "intensional" is used in the formal semantics context, where one can find the pair extensional-intensional. Extensional sentences make reference to sentences that depend only on local-facts for their truth-conditions, while intensional sentences are those that are not extensional (Portner 2005). In ontologies, the intensional part is called T-BOX, the terminological part, which refers to axioms about properties and relationships, for example, a human being is a person; the extensional part is called A-BOX, the assertional part, which refers to instances of classes, for example, Jonh loves Mary.

One area of research where the view of ontology as a conceptualization does not appear to have much adherence is "life sciences & biomedicine." A possible influence may come from Barry Smith's well-documented position on this (e.g., Klein and Smith 2010; Smith 2004; Smith 2006; Smith, Ceusters and Temmerman 2005) and his action as a member of the outreach working group of the Open Biological and Biomedical Ontology Foundry.

Regarding the area of library and information science, the small number of articles limits possible inferences (only five articles were accounted, see Table 1). In future research, we consider it relevant to verify whether this small number is a reflection of the low expressiveness of the area in relation to the ontological study in the context of information systems, as the sample seems to indicate. Almeida (2013) suggests that, although ontological study has been present in the area since the nineteenth century for the representation of subjects, the LIS literature will be at an early stage with regard to the role that its researchers can play in the modeling of computational ontologies. Another issue that the five LIS works in the sample raise concerns concerning their countries of origin, given the absence of the nation considered dominant in ontology research, namely, the USA (Zhu et al. 2015). These five works come from Brazil (two), Germany, India and Sweden.

As for the definitions presented for the term ontology in the philosophical context (depicted in appendix C), some considerations are in order. Although the authors of several and diverse fields that propose definitions to ontologies, these are authors that almost certainly have no research in the field of philosophy *per se*. This situation is a result of the appropriation of the term by computer science in the 1980s as described, for example, by Gruber (1992). Even in the philosophical field, it is considered almost impossible to reach a consensual definition for the term (Niiniluoto 2002) and even then, the ontological issues are in general referred to as hypotheses (for example, the problem of universals).

The appropriation of a term from one area of knowledge by another is common practice in the scientific community: "emerging technologies require new words and frequently borrow from other fields which may be contiguous or totally unrelated" (English 1998, 32). Some consider that such appropriation related with ontology began in the 1960s, when Mealy (1967, 525) in a paper about the nature and models for data suggested: "we could easily resurrect disputes in medieval philosophy at this point! The issue is ontology, or the question of what exists." The idea is that in knowing the nature of entities, in understanding the structure of the world provided by an ontology, one can transfer part of this structure for the computer. In doing this, one would model better than by using ad hoc approaches and solipsism. To that end, another early use of the term ontology in computer-aided information systems was the work of Hayes (1983), seeking to provide an adequate theory of the common-sense world (Smith and Casati 1994). Unlike this line of research, which retains the notion of philosophy's ontology, the use of the term ontology to designate a vocabulary expressed in a knowledge representation language seems to deviate from the metaphysical sense. This second use of the term appears to undergo a "metaphorizing" process. As stated by Rita Temmerman (1995, 125): "metaphorising is the result of encoding at the concept level. The resulting name or term for the concept can be understood in its new meaning without understanding the basis for the naming." In this process, the new meaning may deviate from the original, because it is built in a new framework of assumptions.

5.0 Conclusion

This study points to evidence that leads us to consider that the term ontology is being consolidated in the context of information systems with a different meaning from the original. The emphasis in most definitions is placed on the notions of: a) "a conceptualization;" or, b) "a set of concepts," moving away from the ontological study as a branch of philosophy. The philosophical study focuses between a purely formal point of view, too general to contain relevant information, and the cognitive point of view, laden with implicit information (Poli 2010b). It will be in this last pole that the ontologies, as conceptualizations, fit. In these, only the particular point of view of a community matters, as Gruber (2004, 5) states: "I find it critical to remember that every ontology is a treaty—a social agreement—among people with some common motive in sharing." To the extent that model correction seems less important than its usefulness: "we don't have to worry so much about whether they are right and getting on with the business of building them to do something useful" (Gruber 2004, 1).

Parallel to Gruber's understanding of ontology in information systems, some authors have presented definitions with a description that can be considered closer to their use in the context of philosophy. These definitions have in common a deviation from the cognitive load inherent in the term "concept," using other terms, such as "entities," to designate the elements to be represented in an ontology. Despite this possible link between the two research areas, the study points to the lack of interaction between them. Extrapolating the tendency, we could foresee that the meaning of the term ontology, and even possibly the study itself, in the context of information systems will have only a remotely historical connection with its counterpart in the field of philosophy. In this context, we consider the position of authors such as Poli or Smith, who regard ontological study as interdisciplinary, crucial for the continuation of a healthy and useful discussion between the two fields.

6.0 Final remarks

We consider that the panorama described in this exploratory study, despite its limitations, presents empirical data that contribute to the understanding of the lack of clarity regarding the meaning of the term ontology in the context of information systems. In particular, we have uncovered the use of the term ontology as a synonym for conceptualization and its consequent indistinction regarding other types of representational artifacts. An uncritical use of terminology makes communication difficult, leading to misunderstandings. Also, LIS cannot properly contribute with its expertise in classification, if terminological difference hampers the initiatives. Within this situation it is difficult to distinguish between the specificities of a reference ontology, coming from a scientific domain, in comparison to those of another system, also called ontology, designed to meet the generally idiosyncratic needs of a particular institution or particular interests. While in the latter it is the pragmatic aspects that fundamentally constrain it, in the former the primacy should be the scientific correction of the model. This study points out that, for the computing community in particular, this distinction does not seem to be very relevant. We also revelaed a scant citation of works by voices disagreeing with that position. We admit that additional in-depth studies are necessary to assess the consistency of the trend we detected, as well as a greater sample that allows better representation of research areas. It is worth mentioning that such an enlargement would apply in an extension of the temporal horizon of our search and, which would not be representative of a single year's production. In any case, we hope to have made a reflective contribution in a subject where a careful intervention can be the distinguishing mark of the KO and LIS areas.

Notes

1. Gruber's works, besides the two presented in Table 2, are: (Gruber 2009; Gruber and Olsen 1994); and Smith's works are: (Arp, Smith and Spear 2015; Munn and Smith 2008; Smith 2003).
2. Staab's work, besides the two presented in Table 2, is: (Maedche and Staab 2001); and Guarino's works, besides the one presented in Table 2, are: (Guarino 1998; Guarino and Giaretta 1995).

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Appendices

We present the definitions found in the sample in appendices A, B and C and in D the references of the respective articles. In transcribing the definitions with citation (direct or indirect), the original numerical references were replaced by the author-date style. On the column "WoS cat." in appendices A, B and C, we present the Web of Science major category where the respective article was classified. In the "type" column we identified definitions that do not refer to other work with the designation "self," those citing other documents are identified with "dir," in the case of direct quotations, and with "ind," when quotation is indirect. In appendix A, the designations "self," "ind" and "dir," may have the suffix "_ro" when the definition is framed with a reference to the origin of the term ontology (which may not be included in the transcribed excerpt) or "_pd" when the authors also define the term in that context of origin (those definitions are in appendix B).

Appendix A:
Definitions of the term ontology associated with information systems found in articles whose approach is made in the context of these systems.

Ref.	Definition	Type	WoS Cat.
004	One method of conceptualising data is as an ontology—a knowledge model that formalises variables, properties, and relationships such that they can be used for problem solving.	self	Life Sciences & Biomedicine
005	Swartout and Tate (1999) define ontology as a basic structure or framework around which a knowledge-base can be built. Formally, the ontology of a particular domain covers its terminology (domain vocabulary), all essential concepts and their instances (individuals) in the domain.	ind	Technology
006	From a computer science point of view and in the context of knowledge acquisition, an ontology could be defined as "a formal, explicit specification of a shared conceptualisation" (Staab et al., 2009).	dir	Technology
007	Ontology is a formal representation of a set of domain concepts and their relationships.	self	Technology
008	An ontology can be used to describe concepts, attributes, and restrictions within a particular domain [Noy & McGuinness, 2001].	ind	Technology
014	Ontologies are formal, explicit specifications of a shared conceptualization to represent domain knowledge, [Maedche, 2012] which are widely applied recently to represent knowledge in the Semantic Web.	ind	Technology
015	Applied ontologies consist of a set of clearly defined entities (which may, however, each have multiple labels), structured hierarchically, and interconnected by defined relations.	self	Life Sciences & Biomedicine
016	Ontology engineering is a powerful tool for computer-based information modeling and management that aims to conceptualize the physical world in a formal and explicit manner (Gruber, 1993).	ind	Technology
018	Ontology is defined as a formal representation of knowledge pertaining to a particular domain [Gruber, 1993; Noy & McGuinness, 2001] .... Ontologies are crucial to enable the vision of semantic web. They provide a common and shared understanding of concepts in a specific domain, allow reuse of domain knowledge, and make the data interoperable.	ind	Technology
020	Ontology is a formal model that represents a target domain which is generally constituted by a hierarchy of concepts that are interrelated by defined relations [McGuinness & Van Harmelen,	ind _pd	Technology

Ref.	Definition	Type	WoS Cat.
	2004].		
021	[A]n ontology is an explicit formal specification of the terms in the domain and relations among them [Gruber, 1993] expressed in machine-readable language; therefore, they can be processed automatically.... Classes (i.e., concepts), subclasses, and predicates between concepts represent an ontology.	ind	Life Sciences & Biomedicine
022	According to Antoniou and Kehagias (2000, p. 623), "An ontology defines the terminology of a domain: it describes the constructs that constitute the domain, and the relationships between those constructs."	dir	Technology
023	[B]iomedical ontologies are sets of terms and relations that represent biomedical entities and how they connect with one another.	self	Life Sciences & Biomedicine
025	As a conceptual model, ontology storage and management the information, has been widely concerned in the field of information retrieval.	self _ro	Technology
027	"Ontology is defined as an explicit specification of a conceptualization" (Gruber, 1993).	dir	Technology
032	The definition of ontology has many variants, which can be generalized under a machine-readable, structured representation of information .... the business domain ontology is intended to specify the conceptualization of a particular real-world business domain.	self	Technology
033	[O]ntology is a conceptualization with explicit specification in unanimity filed knowledge, it has been used popularly in modeling and retrieval of knowledge engineering for product lifecycle management.	self	Technology
036	One way of modeling data is designing ontologies and using them to maximize the benefit of accessing and extracting valuable implicit and explicit knowledge from structured and unstructured data.	self	Life Sciences & Biomedicine
037	The scientific meaning derives from Information Science, where "ontology" refers to a shared conceptualisation of a domain, presented as an organised technical vocabulary for that domain [Gruber, 1993].	ind _pd	Social Sciences
044	Traditionally a philosophical concept, ontology has been adopted by computer science and information science as a new way of defining meaning and relationships within data [Feilmayr & Wöß, 2016; Gruber, 1995].Ontologies are composed of three parts: a set of vocabulary representing various concepts, definitions for the vocabulary set, and defined relationships between the concepts.	ind _ro	Life Sciences & Biomedicine
047	Ontologies are models of reality, and are expressed through entities and their relationships.	self	Life Sciences & Biomedicine
050	Ontologies are information artifacts that present two basic characteristics: they are vocabularies shared in a certain community, and they have formal semantics based on axioms, expressed in some logic language. [Horrocks, 2008].	ind	Life Sciences & Biomedicine
061	Ontology is defined as an explicit specification of a conceptualization, and is consisted of concepts, relations, axioms which describe a certain domain [Gruber, 1993].	ind	Technology
063	An ontology is a unanimous agreement on shared concepts.	self _ro	Social Sciences
066	Simply, an ontology is a machine-readable artifact that encodes a logical representation of a domain space using vocabularies, and their semantic meanings..... In general, knowledge in an ontology is represented as triple which is information presented in subject>predicate>object. Essentially, the subject>predicate>object are concepts.	self_pd	Life Sciences & Biomedicine
068	Ontology has been widely applied ... as a model for storing and representing knowledge. Owing to it is an effective concept semantic model and a powerful analysis tool.	self _ro	Technology
069	Formally, an ontology is "a representational artifact, comprising a taxonomy as proper part, whose representations are intended to designate some combinations of universals, defined classes and certain relations between them" [Smith et al., 2006].	dir	Life Sciences & Biomedicine
070	Ontology is defined as an explicit and shared conceptualization of a given domain that provides explicit logical assertions about three types of things, classes, instances, and properties, and offers the means to capture and convert human knowledge into a computer-understandable and explicit format. [Gruber, 1993; Richards & Simoff, 2001].	ind	Technology
072	The term ontology refers to "a representation and definition of the categories, properties, and relations of the concepts, data, and entities that substantiate one, many, or all domains." [Gruber, 2009].	dir	Life Sciences & Biomedicine

Ref.	Definition	Type	WoS Cat.
075	Ontologies are defined as formal, explicit specifications of shared conceptualisations. [Gruber, 1993].	ind	Technology
076	An ontology is a formal specification of a shared conceptualization. [Gruber, 1993].	ind	Technology
079	Ontology is defined in informatics as an attempt for comprehensive and detailed formalization of a given area of knowledge via a conceptual scheme.	self _ro	Technology
080	Ontologies provide conceptual models to represent and share knowledge.	self	Technology
081	The term ontology is used in the literature of computer science to refer to an explicit specification of a shared conceptualization in a machine readable format. [Gruber, 1993; Guarino & Giaretta, 1995; Studer; Benjamins & Fensel, 1998].	ind	Technology
085	Ontologies help integrate disparate or unorganized data to produce meaning, sort of "like a thesaurus, a finite set of terms, organized as a hierarchy that can be used to provide a value for an element.	self	Social Sciences
089	ISO 1087-1:2000 defines "concept" as a "unit of knowledge created by a unique combination of characteristics." In general, ontologies thus can be seen as collections of knowledge for some specific domain of discourse.	self	Technology
096	An ontology describes domain knowledge or domain space that represents and connects concepts of the domain.... The resulting software artifact can then be integrated with other software components to provide extended capabilities, perform tasks, and enable machine reasoning.	self	Life Sciences & Biomedicine
097	An ontology is a computational representation of a domain of knowledge based upon a controlled, standardized vocabulary for describing entities and the semantic relationships between them. [David & Tim, 2012; Gruber, 1993; Gruber & Olsen, 1994; Guarino, 1998]	ind	Life Sciences & Biomedicine
102	[A]n ontology is an explicit formal specification of the concepts (also referred to as classes) in a domain and the relations among them. [Uschold & Gruninger, 1996]	ind	Technology
104	An ontology can be defined as a set of hierarchically ordered terms to represent a specific domain. [original in portuguese, free translation of authors]	self	Technology
105	"An ontology is a formal explicit description of concepts in a domain of discourse (classes (sometimes called concepts)), properties of each concept describing various features and attributes of the concept (slots (sometimes called roles or properties)), and restrictions on slots (facets (sometimes called restrictions))." [Noy & McGuinness, 2001].	dir	Technology
106	In computer science, ontologies can be defined as "explicit specification of a shared conceptualization." [Gruber, 1993].	dir	Physical Sciences
107	It is a specialised representation artefact, designed to usefully mediate between an artificial network of labelled concepts and the perceptions and classifications of the people who work with it.	self	Physical Sciences
113	An ontology is an explicit specification of a conceptualization. [Edgington et al., 2004; Gruber, 1994].	ind	Technology
118	In computer and information sciences, ontologies serve as explicit representations of the concepts and relationships relevant to some area of interest (Gruber, 1995).	ind	Social Sciences
122	Ontology is a description of knowledge about a domain of interest, the core of which is machine processable specification with a formally defined meaning.	self	Technology
125	Ontology is defined as an explicit specification of a shared conceptualization representing knowledge through concepts, relationships, and individuals. [Gruber, 1993].	ind	Technology
126	In terms of information technology, ontologies summarize various types of formal conceptual systems that allow an explicit and thus machine-processable assignment of meaning to jointly defined linguistic concepts. [Gruber, 1993; Studer; Benjamins & Fensel, 1998]. [original in german, free translation of authors].	ind	Technology
129	Ontology is a formal representation of a domain of knowledge in terms of concepts and relationships to data (attributes) and other concepts. [Gruber, 1993].	ind	Technology
131	An ontology is a formal, explicit specification of a shared conceptualization. [Studer; Benjamins & Fensel, 1998].	ind	Social Sciences
132	Using ontology as a foundation for conceptual modeling builds on the assumption that ontology can help to better understand how the world is constituted (Gruber, 1995; Wand et al., 1999; Wand and Weber, 2006).	ind _pd	Technology

Ref.	Definition	Type	WoS Cat.
136	[O]ntologies (i.e., formal descriptions of domains [Gruber, 1993] using characterizing concepts, individuals, properties, and relations) remains a non-trivial task.	ind	Technology
137	Ontology is a tool for representing knowledge and reasoning that serves the organization of a set of concepts in a specific field, as well as the relations between these concepts [Agirre et al., 2000; Faatz & Steinmetz, 2002; Parekh; Gwo & Finin, 2004].	ind	Technology
139	Derived from philosophy, in computer science, we refer to an ontology as a special kind of information object or computational artifact [Guarino; Oberle & Staab, 2009; Studer, Benjamins & Fense, 1998].... These ontologies contains concepts and relationships that are meant to describe or record the facts about the real world.	ind _ro	Technology
142	Ontology-based data management aims at managing data through the lens of an ontology, that is, a conceptual representation of the domain of interest in the underlying information system.	self	Technology
143	As it has already been stated, an ontology is a formal explicit specification of a shared conceptualization of a domain [Borst; Akkermans & Top, 1997].	ind	Technology
148	In informatics, "ontology" refers to these formalized descriptions of the being, of existing entities (Smith, 2003).	ind	Social Sciences
151	In order to be able to automate engineering activities, a formalization of domain knowledge is essential. This formalization can be used to model system aspects in sense of properties and relations.... Basically, all parameters, components, and material types are modeled as concepts and individuals in the ontology.	self	Technology
152	Each ontology is the formal specification of the shared conceptualization of a domain of study (Gruber, 1995).	ind	Technology
154	Similarly for standardization in description of cloud services, it is required to use a semantic knowledge representation strategy called ontology that points to a perception of the domain of interest. It incorporates a set of concepts those include entities, attributes and their inter-relationships are altogether referred to as a conceptualization [Gruber. 1995].	ind	Technology
157	A very versatile knowledge management approach is the use of ontologies, information models consisting of formally defined hierarchies of entity types describing some domain of interest, coupled with well-defined relations between types and axioms expressing fundamental domain knowledge.	self	Technology
161	Ontology is one of the semantic web technologies to represent, exchange and reuse domain concepts, relations between concepts, and rules.... Domain ontology is a form of representation of concepts, relations and rules in a specific domain so that information in the domain can be well stored, searched and shared.	self	Technology
170	An ontology is a knowledge-based structured system, which consists of a rich, standardized vocabulary to describe entities and the semantic relationships between them.	self	Life Sciences & Biomedicine
172	Since an ontology is a formal fixation of the agreements made by a group of specialists in a certain domain about a system of concepts they use, as well as their properties and axioms, each ontology system makes sense only for the group of people who accept these agreements (the social nature of ontologies). [Beniaminov, 2008]	ind	Technology
175	Ontologies can be seen as structured vocabularies that explain the relations among their terms (or classes). They are formed by concepts and relations that can be combined to form more complex class expressions.	self	Technology
177	Researchers in information systems and knowledge-based systems have expanded the definition so that the term ontology refers to, not only the vocabulary itself, but also the concepts the vocabulary is intended to express [Chandrasekaran; Josephson & Benjamins, 1999].	ind _pd	Technology
178	Gruber [1993] defines an ontology as a formal explicit specification of a shared conceptualization.	ind	Technology
179	According to Borst [1997], ontology can be defined as a formal and explicit specification of a set of concepts in a shared form.	ind	Technology
180	Consequently, an ontology represents the conceptual model of the specific domain of interest, describing it in a declarative fashion [Sonntag, 2010].	ind _pd	Technology
182	An ontology is defined as a specification of concepts and relationships between the concepts that can exist in a given setting [Gallardo et al., 2011].	ind	Technology
183	Ontology, as a shared concept, is a mechanism that describes concepts and their system relationships [Elhdad; Chilamkurti & Torabi, 2013; Verstichel et al., 2011].	ind	Technology

Ref.	Definition	Type	WoS Cat.
193	An ontology can be understood as a logical representation of a domain model [Jones; Bench-Capon & Visser, 1998].	ind	Technology
195	An ontology is a formal and explicit specification of a shared conceptualization [Studer; Benjamins & Fensel, 1998], i.e. it provides a formal, structured representation of knowledge, with the advantage of it being reusable and shareable.	ind	Technology
197	A proper ontology, however, is defined as a formal representation of knowledge in a certain reality (i.e., a certain domain of knowledge), in a way that different people—and, notably, computers—can understand the concepts it contains and learn about the reality that is being represented [Arp; Smith & Spear, 2015; Rubin; Shah & Noy, 2007].	ind	Life Sciences & Biomedicine
206	The development of a formal system (i.e., ontology) .... Ontologies are used in biology as a way to classify terms, how they relate to broader concepts, and their interrelationships.... Formally, concepts are generally called "classes."	self	Life Sciences & Biomedicine
210	According to Gruber (1993), "Ontologies are effectively formal and explicit specifications in the form of concepts and relations of shared conceptualizations."	dir	Technology
212	In computer science, an ontology is a taxonomic description of the concepts in an application domain and the relationships among them [Musen, 1998].	ind	Life Sciences & Biomedicine
213	In Information Science, ontologies indicate models to represent ontological and epistemological assumptions that are relevant to the understanding of research and its computational treatment (Campos & Campos, 2014). [original in portuguese, free translation of authors]	ind	Technology
214	Ontologies can be described as structured vocabularies that explain the relations among their terms (or classes). They are formed by concepts and relations that can be combined to form more complex class expressions.	self	Physical Sciences

Appendix B:
Definitions of the term ontology associated with its philosophical origin found in articles whose approach is made in the context of information systems.

Ref.	Definition	Type	WoS Cat.
020	Philosophically, it is to inquire into being as it is being or into being in so much as they exist.	self	Technology
037	In Philosophy, the term "Ontology" refers to a discipline investigating what exists most fundamentally in the real world [Heil, 2003; Varzi, 2011], and hence reflects the most fundamental units of thought for theorising about the nature of reality.	ind	Social Sciences
066	The word ontology has its roots in metaphysical philosophy, extending back to Aristotle's Categories, as a "nature of being."	(a)	Life Sciences & Biomedicine
132	In philosophy, ontology is defined as the study of being, of what there is (Bricker, 2016)	ind	Technology
177	In philosophy, the study of ontology deals with the nature of reality – exploring the similarities, differences and relationships between the types of entities that exist [Davidson, 2013].	ind	Technology
180	The word ontology has borrowed initially from philosophy within less than twenty years, and it means the philosophical study of nature of existence.	self	Technology
(a) Although the definition refers to Aristotle's, it is not formalized in the bibliographic references presented in the respective article.			

Appendix C:
Definitions of the term ontology associated with the context of its philosophical origin found in articles whose approach is made in that same context.

Ref.	Definition	Type	WoS Cat.
046	[T]he theory of existence, or more narrowly, of what really exists, as opposed to that which appears to exist but does not.	self	Social Sciences
060	[O]ntology has historically been used in the field of philosophy to designate a concern with the existence of things and the essence of being.	self	Social Sciences
149	[T]hus consider ontology as a methodological problem rather than as a specific branch of a philosophical investigation setting up the axiomatic principles of beings or of so-called historical stages.	self	Arts & Humanities
150	Kohn [2015] defines ontology as "the study of reality."	dir	Social Sciences
205	Ontologies describe our categorization of the kinds of entities in the world—grouping them categorically by fundamental properties or characteristics.	self	Social Sciences

Appendix D:
Sample articles where we find definitions formatted as found in WoS.

Ref.	Article
004	Wheeler, TS. et al.. Feasibility and usability of an ontology-based mobile intervention for patients with hypertension. INTERNATIONAL JOURNAL OF MEDICAL INFORMATICS, 119. NOV 2018.
005	Jelokhani-Niaraki, M.. Knowledge sharing in Web-based collaborative multicriteria spatial decision analysis: An ontology-based multi-agent approach. COMPUTERS ENVIRONMENT AND URBAN SYSTEMS, 72. NOV 2018.
006	Chen, YQ. et al.. An ontology-based spatial data harmonisation for urban analytics. COMPUTERS ENVIRONMENT AND URBAN SYSTEMS, 72. NOV 2018.
007	Han, J. et al.. A computational tool for creative idea generation based on analogical reasoning and ontology. AI EDAM-ARTIFICIAL INTELLIGENCE FOR ENGINEERING DESIGN ANALYSIS AND MANUFACTURING, 32(4). NOV 2018.
008	Shiang, CW. et al.. Ontology reuse for multiagent system development through pattern classification. SOFTWARE-PRACTICE & EXPERIENCE, 48(11). NOV 2018.
014	Si, HY. et al.. Structured peer-to-peer-based publication and sharing of ontologies to automatically process SPARQL query on a semantic sensor network. INTERNATIONAL JOURNAL OF DISTRIBUTED SENSOR NETWORKS, 14(10). OCT 8 2018.
015	Larsen, RR. et al.. From Affective Science to Psychiatric Disorder: Ontology as a Semantic Bridge. FRONTIERS IN PSYCHIATRY, 9(487). OCT 8 2018.
016	Zhou, L. et al.. An ontology framework towards decentralized information management for eco-industrial parks. COMPUTERS & CHEMICAL ENGINEERING, 118. OCT 4 2018.
018	Alobaidi, M. et al.. Automated ontology generation framework powered by linked biomedical ontologies for disease-drug domain. COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE, 165. OCT 2018.
020	Hussain, M. et al.. Towards ontology-based multilingual URL filtering: a big data problem. JOURNAL OF SUPERCOMPUTING, 74(10). OCT 2018.
021	Traverso, A. et al.. The radiation oncology ontology (ROO): Publishing linked data in radiation oncology using semantic web and ontology techniques. MEDICAL PHYSICS, 45(10). OCT 2018.
022	Gelbard, R. et al.. Sentiment analysis in organizational work: Towards an ontology of people analytics. EXPERT SYSTEMS, 35(5). OCT 2018.
023	Kang, Y. et al.. Disease Specific Ontology of Adverse Events: Ontology extension and adaptation for Chronic Kidney Disease. COMPUTERS IN BIOLOGY AND MEDICINE, 101. OCT 1 2018.
025	Gao, W. et al.. Partial multi-dividing ontology learning algorithm. INFORMATION SCIENCES, 467. OCT 2018.
027	Bharambe, U. et al.. Adaptive Pareto-based approach for geo-ontology matching. COMPUTERS & GEOSCIENCES, 119. OCT 2018.

Ref.	Article
032	Biletskiy, Y. et al.. Building a business domain meta-ontology for information pre-processing. INFORMATION PROCESSING LETTERS, 138. OCT 2018.
033	Liang, JS.. An ontology-oriented knowledge methodology for process planning in additive layer manufacturing. ROBOTICS AND COMPUTER-INTEGRATED MANUFACTURING, 53. OCT 2018.
036	Alobaidi, M. et al.. Linked open data-based framework for automatic biomedical ontology generation. BMC BIOINFORMATICS, 19(319). SEP 10 2018.
037	Rousseau, D. et al.. Systemic Semantics: A Systems Approach to Building Ontologies and Concept Maps. SYSTEMS, 6(3). SEP 2018.
044	Takahashi, L. et al.. Redesigning the Materials and Catalysts Database Construction Process Using Ontologies. JOURNAL OF CHEMICAL INFORMATION AND MODELING, 58(9). SEP 2018.
046	Martin, J.. Ontology matters: a commentary on contribution to cultural historical activity. CULTURAL STUDIES OF SCIENCE EDUCATION, 13(3). SEP 2018.
047	Heimonen, J. et al.. Ontology Development for Patient Education Documents Using a Professional- and Patient-Oriented Delphi Method. CIN-COMPUTERS INFORMATICS NURSING, 36(9). SEP 2018.
050	Gibaud, B. et al.. Toward a standard ontology of surgical process models. INTERNATIONAL JOURNAL OF COMPUTER ASSISTED RADIOLOGY AND SURGERY, 13(9). SEP 2018.
060	Argentieri, MA.. Embodiment and Ontologies of Inequality in Medicine: Towards an Integrative Understanding of Disease and Health Disparities. BODY & SOCIETY, 24(3). SEP 2018.
061	Qiu, J. et al.. A hybrid-based method for Chinese domain lightweight ontology construction. INTERNATIONAL JOURNAL OF MACHINE LEARNING AND CYBERNETICS, 9(9). SEP 2018.
063	Zhu, XH. et al.. An Interoperable Model for the Intelligent Content Object Based on a Knowledge Ontology and the SCORM Specification. JOURNAL OF EDUCATIONAL COMPUTING RESEARCH, 56(5). SEP 2018.
066	Amith, M. et al.. Representing vaccine misinformation using ontologies. JOURNAL OF BIOMEDICAL SEMANTICS, 9(22). AUG 31 2018.
068	Tang, JL. et al.. Ontology Optimization Algorithm for Similarity Measuring and Ontology Mapping Using Adjoint Graph Framework. ENGINEERING LETTERS, 26(3). AUG 28 2018.
069	Kolyvakis, P. et al.. Biomedical ontology alignment: an approach based on representation learning. JOURNAL OF BIOMEDICAL SEMANTICS, 9(21). AUG 15 2018.
070	Zhong, BT. et al.. Ontology-based framework for building environmental monitoring and compliance checking under BIM environment. BUILDING AND ENVIRONMENT, 141. AUG 15 2018.
072	Shen, Y. et al.. EAPB: entropy-aware path-based metric for ontology quality. JOURNAL OF BIOMEDICAL SEMANTICS, 9(20). AUG 10 2018.
075	van Damme, P. et al.. From lexical regularities to axiomatic patterns for the quality assurance of biomedical terminologies and ontologies. JOURNAL OF BIOMEDICAL INFORMATICS, 84. AUG 2018.
076	Pozveh, ZH. et al.. FNLP-ONT: A feasible ontology for improving NLP tasks in Persian. EXPERT SYSTEMS, 35(4). AUG 2018.
079	Orozova, D. et al.. Ontology Concept in Courses on Students. TEM JOURNAL-TECHNOLOGY EDUCATION MANAGEMENT INFORMATICS, 7(3). AUG 2018.
080	Annane, A. et al.. Building an effective and efficient background knowledge resource to enhance ontology matching. JOURNAL OF WEB SEMANTICS, 51. AUG 2018.
081	Ansari, F. et al.. A problem-solving ontology for human-centered cyber physical production systems. CIRP JOURNAL OF MANUFACTURING SCIENCE AND TECHNOLOGY, 22. AUG 2018.
085	Iliadis, A.. Algorithms, ontology, and social progress. GLOBAL MEDIA AND COMMUNICATION, 14(2). AUG 2018.
089	Luttenberger, N. et al.. Standard International Trade Classification From Spreadsheet to OWL-2 Ontology. BUSINESS & INFORMATION SYSTEMS ENGINEERING, 60(4). AUG 2018.
096	Lin, R. et al.. Visualized Emotion Ontology: a model for representing visual cues of emotions. BMC MEDICAL INFORMATICS AND DECISION MAKING, 18(64). JUL 23 2018.

Ref.	Article
097	Zhang, HS. et al.. An ontology-guided semantic data integration framework to support integrative data analysis of cancer survival. BMC MEDICAL INFORMATICS AND DECISION MAKING, 18(41). JUL 23 2018.
102	Roldan, ML. et al.. An Ontology-based Approach for Sharing, Integrating, and Retrieving Architectural Knowledge. ELECTRONIC NOTES IN THEORETICAL COMPUTER SCIENCE, 339. JUL 11 2018.
104	Freitas, V. et al.. Ontologia para representação de tempo no contexto de indicadores de desempenho. PERSPECTIVAS EM CIENCIA DA INFORMACAO, 23(3). JUL-SEP 2018.
105	Zheng, L. et al.. Complex overlapping concepts: An effective auditing methodology for families of similarly structured BioPortal ontologies. JOURNAL OF BIOMEDICAL INFORMATICS, 83. JUL 2018.
106	Louge, T. et al.. ASON: An OWL-S based ontology for astrophysical services. ASTRONOMY AND COMPUTING, 24. JUL 2018.
107	Woznowski, PR. et al.. Activities of Daily Living Ontology for Ubiquitous Systems: Development and Evaluation. SENSORS, 18(7). JUL 2018.
113	Moor, A de.. A Community Network Ontology for Participatory Collaboration Mapping: Towards Collective Impact. INFORMATION, 9(7). JUL 2018.
118	Dobreski, B. et al.. Ontology Informed Design to Advance Developers' Informal Online Learning. EDUCATIONAL TECHNOLOGY & SOCIETY, 21(3). JUL 2018.
122	Sankari, SSU. et al.. Ontology-Enabled Generation of Simulation Software for a Complex Dynamic System. JOURNAL OF AEROSPACE INFORMATION SYSTEMS, 15(7). JUL 2018.
125	Lima, R. et al.. OntoILPER: an ontology- and inductive logic programming-based system to extract entities and relations from text. KNOWLEDGE AND INFORMATION SYSTEMS, 56(1). JUL 2018.
126	Munnich, S.. Ontologien als semantische Zündstufe für die digitale Musikwissenschaft?. BIBLIOTHEK FORSCHUNG UND PRAXIS, 42(2). JUL 2018.
129	Roldan-Garcia, MD. et al.. Towards an ontology-driven clinical experience sharing ecosystem: Demonstration with liver cases. EXPERT SYSTEMS WITH APPLICATIONS, 101. JUL 1 2018.
131	Akinyemi, A. et al.. An ontology-based data integration framework for construction information management. PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS-MANAGEMENT PROCUREMENT AND LAW, 171(3). JUN 2018.
132	Eriksson, O. et al.. Institutional ontology for conceptual modeling. JOURNAL OF INFORMATION TECHNOLOGY, 33(2). JUN 2018.
136	Ruijgrok, P. et al.. ONTONAVSHOP: AN ONTOLOGY-BASED APPROACH FOR WEB-SHOP NAVIGATION. JOURNAL OF WEB ENGINEERING, 17(3-4). JUN 2018.
137	Ksiksi, A. et al.. Using Association Rules to Enrich Arabic Ontology. ENGINEERING TECHNOLOGY & APPLIED SCIENCE RESEARCH, 8(3). JUN 2018.
139	Arribas, B.. ONTOLOGY OF THE CURRENT NEWS: TECHNICAL AND NEW TECHNOLOGIES: BETWEEN CONTROL AND EMANCIPATION. ARIEL-REVISTA DE FILOSOFIA, (21). JUN 2018.
142	Lenzerini, M.. Managing Data Through the Lens of an Ontology. AI MAGAZINE, 39(2). SUM 2018.
143	Gulic, M. et al.. Automatically Specifying a Parallel Composition of Matchers in Ontology Matching Process by Using Genetic Algorithm. INFORMATION, 9(6). JUN 2018.
148	Kramer, B.. Online music recommendation platforms as representations of ontologies of musical taste. COMMUNICATIONS-EUROPEAN JOURNAL OF COMMUNICATION RESEARCH, 43(2). JUN 2018.
149	Mucen, B.. THE ONTOLOGY OF CAPITAL: ON THE SHARED METHODOLOGICAL LIMITS OF MODERNIZATION THEORY AND ITS CRITICS. HISTORY AND THEORY, 57(2). JUN 2018.
150	Garcia-Weyandt, CM.. Mothers of Corn: Wixarika women, verbal performances, and ontology. ALTERNATIVE-AN INTERNATIONAL JOURNAL OF INDIGENOUS PEOPLES, 14(2). JUN 2018.
151	Engel, G. et al.. Ontology-Assisted Engineering of Cyber-Physical Production Systems in the Field of Process Technology. IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, 14(6). JUN 2018.

Ref.	Article
152	Wang, CB. et al.. Ontology-driven data integration and visualization for exploring regional geologic time and paleontological information. COMPUTERS & GEOSCIENCES, 115. JUN 2018.
154	Parhi, M. et al.. A multi-agent-based framework for cloud service discovery and selection using ontology. SERVICE ORIENTED COMPUTING AND APPLICATIONS, 12(2). JUN 2018.
157	Hagedorn, TJ. et al.. A Knowledge-Based Method for Innovative Design for Additive Manufacturing Supported by Modular Ontologies. JOURNAL OF COMPUTING AND INFORMATION SCIENCE IN ENGINEERING, 18(2). JUN 2018.
161	Ma, ZL. et al.. Ontology- and freeware-based platform for rapid development of BIM applications with reasoning support. AUTOMATION IN CONSTRUCTION, 90. JUN 2018.
170	Gong, XF. et al.. A new method to measure the semantic similarity from query phenotypic abnormalities to diseases based on the human phenotype ontology. BMC BIOINFORMATICS, 19(162). MAY 8 2018.
172	Beniaminov, EM.. Ontology Libraries on the Web: Status and Prospects. AUTOMATIC DOCUMENTATION AND MATHEMATICAL LINGUISTICS, 52(3). MAY 2018.
175	Salguero, AG. et al.. Ontology-based feature generation to improve accuracy of activity recognition in smart environments. COMPUTERS & ELECTRICAL ENGINEERING, 68. MAY 2018.
177	McDaniel, M. et al.. Assessing the quality of domain ontologies: Metrics and an automated ranking system. DATA & KNOWLEDGE ENGINEERING, 115. MAY 2018.
178	Yago, H. et al.. ON-SMMILE: Ontology Network-based Student Model for MultIple Learning Environments. DATA & KNOWLEDGE ENGINEERING, 115. MAY 2018.
179	Maran, V. et al.. Domain content querying using ontology-based context-awareness in information systems. DATA & KNOWLEDGE ENGINEERING, 115. MAY 2018.
180	Mustafa, A. et al.. Integration of Heterogeneous Requirements using Ontologies. INTERNATIONAL JOURNAL OF ADVANCED COMPUTER SCIENCE AND APPLICATIONS, 9(5). MAY 2018.
182	Guo, H. et al.. Ontology-Based Domain Analysis for Model Driven Pervasive Game Development. INFORMATION, 9(5). MAY 2018.
183	Xu, FX. et al.. Developing an Ontology-Based Rollover Monitoring and Decision Support System for Engineering Vehicles. INFORMATION, 9(5). MAY 2018.
193	Schoenfisch, J. et al.. Root cause analysis in IT infrastructures using ontologies and abduction in Markov Logic Networks. INFORMATION SYSTEMS, 74(SI). MAY 2018.
195	Paredes-Valverde, MA. et al.. An ontology-based approach with which to assign human resources to software projects. SCIENCE OF COMPUTER PROGRAMMING, 156. MAY 1 2018.
197	Vitali, F. et al.. ONS: an ontology for a standardized description of interventions and observational studies in nutrition. GENES AND NUTRITION, 13(12). APR 30 2018.
205	Hoehn, JR. et al.. Students' flexible use of ontologies and the value of tentative reasoning: Examples of conceptual understanding in three canonical topics of quantum mechanics. PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH, 14(1). APR 11 2018.
206	Baker, N. et al.. Building a developmental toxicity ontology. BIRTH DEFECTS RESEARCH, 110(6). APR 3 2018.
210	Sathiya, B. et al.. Automatic Ontology Learning from Multiple Knowledge Sources of Text. INTERNATIONAL JOURNAL OF INTELLIGENT INFORMATION TECHNOLOGIES, 14(2). APR-JUN 2018.
212	Merlo, G. et al.. Development and Validation of a Functional Behavioural Assessment Ontology to Support Behavioural Health Interventions. JMIR MEDICAL INFORMATICS, 6(2). APR-JUN 2018.
213	Coneglian, CS. et al.. Materialização da Web Semântica: um modelo de construção dinâmica de consultas baseados em mapeamento de ontologias. PERSPECTIVAS EM CIENCIA DA INFORMACAO, 23(2). APR-JUN 2018.
214	Salguero, AG. et al.. Using Ontologies for the Online Recognition of Activities of Daily Living. SENSORS, 18(4). APR 2018.