

ELEMENTS OF REPRESENTATION AT THE METAMODEL LEVEL FROM DIFFERENT PERSPECTIVES

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Abstract: Elements of representation at the metamodel level are inputs that can be consistently used in the construction of Knowledge Organization Systems (KOS) for specific domains, and whose adoption is linked to ontological and epistemological viewpoints, which are not always made explicit. In this context, the aim of this paper is to define, from multiple perspectives, the basic elements situated at the metamodel level and their theoretical assumptions. From a methodological standpoint, the study adopts a qualitative approach to the problem and, in terms of its objectives, is exploratory in nature. Regarding technical procedures, it is characterized as bibliographic research. As a result, a synthesis of metamodel-level elements discussed from various viewpoints is presented. It is concluded that understanding these elements, along with the ontological and epistemological perspectives that underpin them, is essential for the development of accurate and interoperable Knowledge Organization Systems.

Keywords: Metamodels; Conceptual models; Knowledge organization systems; Epistemological perspectives; Ontological perspectives.

Título: ELEMENTOS DE REPRESENTACIÓN A NIVEL DE METAMODELO DESDE DIFERENTES PERSPECTIVAS

Resumen: Los elementos de representación a nivel de metamodelo son insumos que pueden utilizarse de manera coherente en la construcción de Sistemas de Organización del Conocimiento (SOC) para dominios específicos, y cuya adopción está vinculada a perspectivas ontológicas y epistemológicas que no siempre se explicitan. En este contexto, el objetivo de este artículo es definir, desde múltiples perspectivas, los elementos básicos situados en el nivel de metamodelo y sus fundamentos teóricos. Desde el punto de vista metodológico, adopta un enfoque cualitativo del problema y, en cuanto a sus objetivos, tiene carácter exploratorio. En relación con los procedimientos técnicos, se caracteriza como una investigación bibliográfica. Como resultado, se presenta una síntesis de los elementos a nivel de metamodelo discutidos desde diversas perspectivas. Se concluye que comprender estos elementos, junto con las perspectivas ontológicas y epistemológicas que los sustentan, es esencial para el desarrollo de Sistemas de Organización del Conocimiento precisos e interoperables.

Palabras clave: Metamodelos; Modelos conceptuales; Sistemas de organización del conocimiento; Perspectivas ontológicas; Perspectivas epistemológicas.

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1. INTRODUCTION

Elements at the metamodel level underpins the development of knowledge organization systems (KOS) such as taxonomies, thesauri and ontologies. For this reason, understanding them unequivocally is a task that must precede even the knowledge of the target domain for which the KOS is intended. There is wide discussion in the literature about the metamodel-level elements dealt with here, sometimes reflecting different points of view, (Dahlberg, 1978a; Smith, 2010; Guizzardi, 2005), which can contribute to their ambiguous understanding, especially by those unfamiliar with the issues involved in dealing with ontologies. Furthermore, many of these elements have not always been used consistently in current KOS, which seems to highlight the need to broaden the discussion about them (Campos, 2025). For this reason, it is considered that this discussion is still pertinent and relevant, and leads us to the following question: how can the basic elements be understood at the metamodel level, to avoid their ambiguous understanding? In this context, the aim of this paper is to define, from various points of view, the basic elements that are at the level of metamodels and their theoretical assumptions.

The concept of metamodel used in this work is inspired by Kühne (2006), in the sense that it is a model of another model, acting at a higher level of abstraction than the models it describes, and that the relationship between the model and the metamodel is not transitive. In other words, although a metamodel describes a model, it does not directly describe the original scenario that the model represents. Thus, as the generalization relationship is transitive, entities at higher levels would be equivalent to those at lower levels and, therefore, any relationship between two entities that will be used to build a meta entity should not be transitive (Kühne, 2006, p. 377).

Furthermore, for our purposes, we consider that we are dealing with the most basic elements of a metamodel, referring to concepts found in related literature, particularly Philosophy, which provide the conceptual grounding for the development of KOS. It is not intended to provide an exhaustive and more comprehensive overview of possible elements at the metamodel level due to the wide scope of possibilities. For this reason, important elements such as attributes and relationships will be omitted from this work, due to the level of detail required to approach them from different points of view.

Moreover, considering these ongoing discussions on conceptual modeling and knowledge representation, this study builds on and contributes to existing research on the theoretical foundations of Knowledge Organization and conceptual analysis, engaging with established debates on ontological modeling and metamodel-level distinctions while extending them through a comparative, epistemologically explicit perspective.

2. METHODOLOGY

This study adopts a qualitative approach to the problem and is exploratory in nature. Regarding technical procedures, it is characterized as a bibliographic investigation. The bibliographic survey was carried out in the following sources of information: Capes Portal, Reference Database of Journal Articles in Information Science (Brapci) and Google Scholar. The selection of the Capes Journal Portal, Brapci, and Google Scholar is justified by the complementarity of these sources for the field of Knowledge Organization, combining multidisciplinary coverage, specialization in Information Science, and the expansion of access to relevant works that are not always indexed in controlled databases. The search terms used were: "formal ontology"; ontology AND epistemology; perspectives AND (ontological OR epistemological) AND "knowledge organization"; ontologies AND metamodels; (concept OR universal OR individual OR particular OR instance OR type OR aggregate OR class) AND ontology. The terms were used in Portuguese and English. Bardin's (2011) content analysis approach was used.

A cutoff of 80 items was established, considered feasible to be analyzed, in order of relevance, for each source used and for each language, in addition to the time frame of ten years. The limit ensures the analytical feasibility of the study and the depth of the qualitative analysis. In the pre-analysis stage, the floating reading technique was initially applied to guide the selection of texts resulting from the bibliographic survey, considering titles, abstracts and keywords. Where appropriate, the technique of exploring the references of the articles consulted was also used to further explore the bibliographic material considered relevant. Once the texts were selected, they were thoroughly examined in full, and the

findings were interpreted and systematically organized. From an epistemological standpoint, the study adopts an interpretative, non-hierarchical approach, understanding metamodel-level elements as theory-dependent. This perspective guided the selection and reading of the literature, focusing on how different epistemological positions shape the definition and use of these elements, without treating any single approach as normative.

3. ONTOLOGICAL AND EPISTEMOLOGICAL PERSPECTIVES AND THEIR ASPECTS

Ontologies are influenced by ontological and epistemological perspectives when looking at reality. Ontological perspectives such as realism, conceptualism and nominalism have been discussed in literature with a focus on understanding what exists, whether universals exist and what they are (Ferrater-Mora, 1977), as well as additional questions such as how many possible worlds there are (Lewis, 1986). Epistemological perspectives such as empiricism, rationalism, historicism and pragmatism, on the other hand, focus on the nature of knowledge of reality, covering issues such as the objectivity or subjectivity of this knowledge and whether it is fallible (Grenon & Smith, 2004). It is important to note that the ontological and epistemological perspectives are sometimes intertwined, and it is not easy to draw a clear boundary between them, making it more important to understand the aspects they address than to separate them by perspective. That said, the following is a basic, non-exhaustive overview of these aspects: (i) How many possible worlds there are; (ii) Assuming there are possible worlds, are they concrete or abstract; (iii) How many points of view there are about the world and whether or not they can be conflicting; (iv) Does reality exist in a mind-dependent way or not; (v) Do universals exist. Table I summarizes these aspects and the respective possible points of view.

General aspect	Point of view
How many possible worlds are there?	Just one (Psillos, 1999; Smith, 2010). More than one (Lewis, 1986; Plantinga, 1987).
If there is more than one possible world, are they concrete or abstract?	Concrete (David Lewis, 1986) Abstract (Plantinga, 1987).
How many points of view are there about the world?	Just one (Psillos, 1999). More than one as long as they don't conflict (Smith & Cuesters, 2010). More than one, conflicting or not (Lewis, 1986; Plantinga, 1987).
Does reality depend on the mind or not?	Reality is independent of the mind and is therefore objective (Smith, 2010). Reality is dependent on human cognition and is therefore subjective, although it has an existence outside the mind (Kant, 2001 ⁱ). Reality only exists in the mind (Berkeley, 2002 ⁱⁱ).
Where do Universals exist?	Both in objects and in the mind, according to Duns Scotus (De Boni, 2008; Lowe, 2002; Klima, 2022; Smith, 1997). Only in the human mind, being understood as concepts (Grossmann, 1960; Locke, 1975 ³). Only in particular objects, being dependent on them, i.e. only present in those objects (Armstrong, 1989). Independently of objects, as in Platonism (Zalta, 1983). They don't exist. Names are just labels to group similar things together. There are only particular things (Goodman & Quine, 1947).

Table I: Possible points of view for each general ontological aspect. Source: the author.

As for epistemological perspectives, there are also various ways of thinking about them (Hjørland, 2009, Steup; Neta, 2024), and various aspects involved, among them: (i) What is the nature of knowledge about reality; for example, is it objective, or approximately objective; (ii) How is knowledge about reality obtained; for example, from observations of things in the world, through reason, etc. (iii) What influences the acquisition of knowledge about reality; for example, historical, cultural and social contexts, pragmatic purposes, etc.; (iv) What can be said about knowledge from the point of view of its veracity; for example, whether it is fallible, or whether it is generally infallible. For reasons of scope, these questions (and other pertinent ones) will not be detailed, but are discussed in authors such as Rorty (1980), Sire (2004), Hjørland (2009), Kleineberg (2013), Ridi (2016), Machado et al. (2023), among others.

4. METAMODEL-LEVEL ELEMENTS

Elements at the metamodel level are fundamental to the formal structuring of knowledge representation systems. By addressing these elements, we seek to present abstract categories that support conceptual modeling, allowing for the semantic organization of diverse knowledge domains. These elements play a strategic role in building interoperable models. As a matter of scope, due to their greater complexity and need for detail, we have not dealt with relationships and attributes in this paper. We focus on discussing the following elements at the metamodel level: concept, universal, individual, particular, instance, type, aggregate and class. Throughout this discussion, we seek to illustrate their influence by establishing connections with the ontological and epistemological perspectives previously outlined.

4.1 Concept

There are different understandings of what a concept is. For reasons of scope, we will consider two perspectives: one that views the concept as a unit of knowledge, representing group consensus, and another that regards the concept as a unit of thought. From the perspective in which concepts are units of thought, in accordance with the definition of the ISO/R 1087:1969 - International Organization for Standardization (1969), the focus is on the cognitive aspects of a person's apprehension of a given reality. Although the existence of an objective reality is acknowledged, its perception is subjectively constructed and context-dependent. Such subjectivity manifests in how individuals communicate their understanding, consistent with a linguistic perspective. Corroborating this understanding, for Ogden and Richards (1946), whose work belongs to the field of semiotics and the philosophy of language, the concept is an idea in the mind of an individual, reflecting the subjectivity of that individual with everything that composes and influences it. The authors illustrate their point of view with a triangle (p. 11).

The top vertex (thought or reference) refers to the concept as an idea that a person has in mind. It is the mental representation of something intended to be communicated, and the meaning (or reference) is a product of social and cultural relations (Ogden; Richards, 1946). The left-hand vertex (symbol) is the word, image or sign used to represent the thought or referent. The righthand vertex (referent), in turn, concerns the real object or entity in the world that the symbol represents. It is what the thought or reference refers to, providing an "anchor" in reality. However, understanding what makes up this reality in which the referent is inserted depends on the individual's ontological perspective. Ogden and Richards (1946) argue that there is no direct link between the symbol and the object, indicating that the meaning is mediated by thought or reference, which is influenced by the sociocultural context of the person making the interpretation (e.g. race as a biological or cultural characteristic), by the level of granularity at which this interpretation takes place (e.g. whale, specifically, or mammal), or even by the role that the referent is seen in (e.g. king of England or the owner of Buckingham Palace). All this influences the interpretation of symbols, so the same referent can refer to different references. This point of view on the concept refers to the possibility of accepting several possible worlds, and several points of view on the world, since concepts are subjective. Furthermore, reality depends on the mind.

For Dahlberg (1978), within the field of information science and knowledge organization, a concept is also illustrated by a triangle, with the referent at the top, the (essential) characteristics of the referent at the left and the term denoting it at the right. What distinguishes it from the concept as a unit of thought is that it expresses the consensus of a group, and not the subjective thought that is in the mind of a single individual. According to the author, what matters for her theory are "scientific concepts", i.e. those that are made explicit by language, can be presented clearly, as far as possible, and consensually by experts in a field of knowledge and, therefore, differ from concepts that are acquired informally and

subjectively in the minds of individuals. In other words, for Dahlberg (1978a, p.11) concepts are the basic units of verifiable scientific knowledge.

Dahlberg's definition of concept is grounded in hypothetical realism (Dahlberg, 1978b), a position that acknowledges the absence of epistemological certainty regarding knowledge (Vollmer, 1984). From an ontological point of view, hypothetical realism presupposes the existence of a real world that is independent of perception and consciousness, is structured, and its structure corresponds to those of the world that we recognize and understand as cognizing subjects. Hypothetical realism admits various points of view in relation to a given reality, and the theories that are used to explain this reality are empirically testable. Therefore, as Vollmer (2017, p. 170) points out, it would not be possible to determine which theory is true, as they could all be confirmed by empirical tests, which would prevent the precise definition of the structure of the underlying reality.

However, unlike Vollmer, Dahlberg admits the possibility of objects whose existence does not necessarily occur in the real world, but which would be admissible in fictional worlds, such as unicorns (Dahlberg, 1978a, p.4). This statement by Dahlberg leads us to believe that she admits the existence of more than one possible world (although not ontologically independent), since there is no correspondent in the real world for entities such as unicorns and, for the author, concepts presuppose referents in the world. It is important to note that, for Lewis (1986), a possible world refers to the notion that events in the actual world could have unfolded differently, with each possible world being ontologically distinct. However, the concept can be interpreted differently, as Varzi (apud Ridi 2016, p. 6) suggests: "There is one world for each version and vision of it in the different scientific theories, in the works of different artists and novelists, in our perceptions as influenced by those works and theories (...)". We believe that Dahlberg's perspective aligns with this interpretive view of possible worlds. As such, we can see that, for her, the definitions attached to concepts are contextual and dependent on a given reality in a possible world in Varzi's sense. In addition, concepts can correspond to classes of things, as in conceptualism (Dahlberg, 1978b; Campos, 2025). In principle, depending on who draws up the KOS and the consensus of experts in a given context (which is established in a definition), since Dahlberg does not distinguish between concepts and universals, it would be possible to place concepts such as unicorns and entities that correspond to universals, such as animals, in the same hierarchy, since everything is considered a concept.

4.2 Universal

Universal (in general), in the objective meaning, is something that can be attributed to various things, such as the idea of humanity, which can be attributed to people. In the subjective meaning, universal refers to judgments about truth or falsity, such as what is beautiful or ugly. From an ontological point of view, it depends on the perspective: realism, conceptualism. Nominalism does not admit the existence of universals.

Universal in modern moderate realism, according to Almeida (2021, p. 110) are "abstractions of sets of entities with similar characteristics that exist in the world independently of the human mind, and that represent all entities of that type that exist, have existed or will exist", i.e. there are no temporal or spatial cut-offs (Smith et al., 2006; Spear, 2006). According to these authors, universals, in the context of contemporary moderate realism, are also called types or kinds, or even natural kinds (Smith, 2008).

The notion of universals is linked to the idea that there are basic categories of things that are common or shared by different objects. For example, two different objects that have the same color have something in common. This perspective is consistent with Lowe's (2002) position, a philosopher of analytic metaphysics, for whom universals can be properties (characteristics) or relationships (for example, being greater than) that can be instantiated in multiple objects or events. In this case, we consider "the universal as a common nature, a *fundamentum universalitatis*, or in other words as the ground or basis for our correct application of concepts such as oxygen or man and thus as the ultimate truth-maker for judgments of similarity" (Smith, 1997, p. 130). And again, "the universal is a *unum in multis*. It is not spread out in a physical sense among the things which instantiate it; it is real already in one object" (Smith, 1997, p. 130). Thus, for Smith, universals are concrete ontological entities that exist *in re*ⁱⁱⁱ, that is, in the objects themselves, independently of any human thought or abstraction and, as in moderate realism, are not transcendent entities as in Platonism (Calemi, 2016). This view is inspired by that of Aristotle's, where, in simplified terms, universals are essences or properties common to multiple particulars, which have their foundation in individual things, *in re* (Tôrres, 2008; Brower, 2016). As such, they depend on the existence of instances (Bealer, 1998, p.6).

Like concepts, universals refer to the existence of general "ideas" that reflect the common characteristics of a group of entities (Joseph, 2008), although, as we shall see, universals are not the same thing as concepts. To illustrate the point, Arp, Smith and Spear (2015, p. 18) point out that certain general terms used by science to describe specific individuals do not correspond to universals as such, as in the case of expressions such as "smoker in Leipzig" or "Finnish spy".

From the perspective of conceptualism, as interpreted through Locke's empiricist philosophy, universals are not independent of the mind, on the contrary: "general and universal belong not to the real existence of things; but are the inventions and creatures of understanding" (Locke, 1975, p.11^{iv}). Thus, according to Crane (2003, p. 252), who offers a conceptualist reading of Locke, the philosopher maintains that only particulars truly exist, and universal species do not occur naturally. Instead, they are created as abstract ideas (concepts), which positions Locke within the conceptualist tradition, since he does not treat universals as mere names (as in nominalism), but as mental constructs. In conceptualism, then, as articulated by Klima (2022) it is admitted that universals are defined as *post rem*^v, that is, they do not exist independently, but rather as concepts formed after the perception of things. In this perspective, universals are created to understand reality. In this sense, universals are mental inventions useful for classifying and communicating but they have no independent ontological existence (Saint-Andre, 2002).

4.3 Type

As we have seen, according to Smith et al. (2006), universals in realism are taken to be synonymous with type. Porello and Guizzardi (2017), however, make a distinction between types: those that are taken in the sense of rough sets and those that are taken as Kinds. In the case of rough sets, they allow for indeterminacy in classification. They are made up of three regions: the positive part (correct classification), the negative part (non-classification) and the indeterminate classification boundary. This makes it possible to deal with partiality, vagueness and uncertainty in the classification task. It is an understanding that has a parallel with Eleanor Rosch's (1978) prototypical theory of classification, in which the existence of a gradient of belonging to the type is considered, where there are individuals who are more typical exemplars than others.

Types such as Kinds correspond to the definition proposed by Welty and Guarino (2001, p. 66), who state that "a Type is a Sortal and a Rigid Sortal". In this view, types provide an identity condition for their instances—specifying what is required for an entity to be considered an instance of that type—and this identity condition remains valid throughout the entity's existence. So, in this case, for example, person would be a rigid sortal, a type, while symptoms or headache would not. Guizzardi et al. (2021) also point out that in the philosophy literature types are also called continuing or enduring things and that they contrast with entities such as enduring or occurring, such as events and processes, which are entities that unfold in time and are not considered types.

4.4 Individual, particular and instance

Intuitively, we can say that an individual is a unique entity in the world—such as your dentist or that specific bottle of wine someone received as a gift from a friend. This notion of individual corresponds to what Smith and Ceusters (2010, p. 142) defines as a particular: "[...] concrete individual entities (entities that exist in space and time and that exist only once"^{vi}). But there are other understandings of what is and what is not an individual (Inwagen^{vii}, 2024; Whitehead^{viii}, 1978). In this context, Branquinho, Murcho and Gomes (2005, p. 386) note that there are two approaches to the individual: one linked to the recognition of individuality, of an epistemological nature, and another related to the definition of what constitutes an individual, belonging to the field of metaphysics. Keeping this in mind, we turn to commentators on medieval philosophers who study Boethius and Duns Scotus, whose contributions to metaphysics and the notion of the individual help us better understand what an individual is.

In this context, according to Abbagnano (2007, p. 555), Boethius calls an individual what is indivisible or what cannot be predicated of other similar things, such as Socrates. Furthermore, in medieval logic it is "that which is said of a single thing, like Socrates and Plato" (Abbagnano, 2007, p.555). For the medieval philosopher Duns Scotus, it is "that which is numerically one, that which is not divisible into many things and is numerically distinct from any other", but, according to Abbagnano (2007, p. 555), Duns Scotus also presents the premises for a different concept of the individual, defined not by indivisibility, but by the complex singularity resulting from multiple determinations that make common nature something specific and unique. In other words, for Boethius (and in Scotus' initial conception), an individual is

seen from the perspective of being something indivisible and unique; in Scotus' second perspective (according to Abbagnano), by the sum of all its unique characteristics, providing an identity. For example, in the first conception we can consider a particular dog as a unique individual, which cannot be divided into other dogs, and is numerically distinct from any other dog. On the other hand, in Duns Scotus' second conception (according to Abbagnano) it is considered in terms of numerous characteristics that make it unique: its name, its physical size, its medical history, among others. All these characteristics combined make him unique, in the sense that even if there are other similar dogs, none will be exactly the same as that dog due to these numerous determinations that define him.

This second sense of Scot's individual is the one understood by Guizzardi and Zamborlini (2012, p. 288) when they propose in the UFO ontology a conception of the individual as a real entity with a unique identity. And it is related to the universal, because, for the authors, universals are understood as sets of characteristics that can manifest themselves in different individuals (Guizzardi & Zamborlini, 2012, p. 288).

Even without going into this issue in depth, it is important to understand that there are many facets that can be involved in understanding these basic concepts and that, therefore, when we take one position, we must be aware that there are others, as this presupposes a particular ontological worldview. For example, according to Ingwagen (2024, p. 29), we can't consider things like a "hole in a piece of cheese (as opposed to the cheese that "lines" the hole)" as individuals: according to Ingwagen (2024, p. 29) "a thing is not an individual thing if it is a mere collection of things"ix. Also, for Ingwagen, holes are not to be considered as ontological entities. This position differs from that of Guizzardi (2005), who considers that both parasitic substances such as stains, edges and protuberances, as well as so-called negative objects such as holes and empty spaces, are considered objects, and that the relationship between these parasitic entities and the objects to which they belong is that of an inseparable part, and not merely of inherence: "For instance, we say that a hole in a piece of cheese is an inseparable part of the cheese, as opposed to one of its moments. Objects can also have parasitic substantials as essential parts" (Guizzardi, 2005, p. 216). So, for Ingwagen, holes are not independent individuals and are not objects; they are just aspects or characteristics of the things to which they belong, while for Guizzardi holes are inseparable parts of a whole, but still considered objects.

In the context of realism, as discussed by Klemke (1960), an analytic philosopher dedicated to the metaphysics of identity and universals, when the term individual is used to refer to things that exist by instantiating a certain type, we can understand individual as being a, exemplifying the universal it is instantiating. However, this is not always the case, as an instance of a universal can be considered as a quality that an individual possesses and not as an individual itself (Klemke, 1960). For example, redness is an instance of the universal red that the apple possesses. Redness is not an individual entity but a quality that depends on a particular object (the apple). Apple A, a specific apple that can be picked up and held, is a particular instance of the universal apple, and it is also an individual, because it has a concrete and specific identity that distinguishes it as a unique entity in the world. Thus, assuming the existence of universals, the term 'particular' is generally used in opposition to universal, in the sense that particulars instantiate universals (Lowe, 2002).

In realism, on the other hand, an instance of a universal is not synonymous with an individual. Instead, an individual characterizes or exemplifies a universal. This is because, as McGill (1934) discusses, in certain contexts, an instance of a universal can be a particular, such as a concrete entity, or even another universal, when dealing with hierarchical levels of abstraction. However, there are other views on what a particular is (Campbell, 1981; Simons, 1994).

A counterpoint to the realist view is Trope Theory, defended by Keith Campbell and D. C. Williams (Campbell, 1981). In this perspective, a particular can be understood as a unique combination of properties (tropes) that occur together, where tropes are regarded as the fundamental constituents of particulars, formed by groupings of tropes that share the same space (Campbell, 1981, p. 479). For example, an apple is not a "thing" that has color, shape and taste - it is the concrete gathering of tropes such as "redness", "roundness", "sweetness" etc. This means that particulars are understood as bundles of tropes: an object is not an individual that possesses properties, but a unique grouping of tropes.

It should be noted that Campbell (1981) does not deny that it is possible to group together similar properties (such as all the redness of apples), but these groupings are conceptual, not ontological. In other words, there is no universal "redness"; there are many redness tropes that are similar, but not identical, and that have autonomous existence. This approach offers an alternative to the realism of universals.

In turn, in realism, as interpreted by Johansson (2004), an instance is a particular manifestation of a universal quality in a specific context (such as redness in an apple). In this sense, it is the concrete manifestation of this universal within a particular object. Instance, therefore, is the way in which this universal is realized or occurs in a specific thing. In the context of realism, the idea that universals exist in things (*in re*) implies recognizing that there are instances of qualities.

These instances, although particular, embody a universal aspect, which makes it possible to deal with both universals and their specific occurrences in objects (Johansson, 2004, p. 13). McGill (1934, p. 245), in turn, when discussing ontological categories within the context of analytic metaphysics, observes that although the relation that characterizes a universal in relation to the corresponding individual is never transitive, the relation of instantiation usually is. From the above, what an instance is can be explained in terms of the existence of something in reality as being unique and corresponding to a universal.

An instance may be understood as a particular manifestation of a universal in a given entity, ontologically dependent on another. We can understand it in the sense of an individual, when this exists independently. Finally, we can understand it as being a given universal, when it exemplifies it still as a universal rather than a particular one. (as in the case of "being green" as being an instance of "being a color").

However, there is yet another way of conceiving instances, which is observed in some OWL ontologies developed with a pragmatic computational purpose, where instance is understood as a member or element of a class in OWL, as Smith and colleagues observe: "In OWL, 'instance' means 'element' or 'member' of a class (where 'class' means 'general concept, category or classification') [...] that belongs to the class extension of owl:Class" (Smith et al., 2006, p. 57).

This type of pragmatic approach can be seen in the well-known ontology development methodology 101 by Noy and McGuinness (2001). In this approach, representing a concept as a class or an individual varies according to the intended use of the ontology and the lower level of granularity of the representation, i.e. the more specific concepts, in a clear divergence from the notions of genus-species and type-instance, with regard to these notions in the literature of philosophy (Armstrong, 1989; Lowe, 2002) and renowned authors of Formal Ontology, such as Nicola Guarino, Barry Smith and Giancarlo Guizzardi.

4.5 Aggregate and class

Aggregates and classes are not the same as universals in the classical sense, because they can be cut out, i.e. they don't necessarily consist of individuals who share the same essence over time and in all places. Joseph (2008), in her interpretation of concepts from the scholastic tradition, understands an aggregate as any gathering of individuals who form a whole. This set may consist of elements of different natures, such as a horse, a stone, and a tree, or elements of the same nature, such as the women who lived in the 20th century. In the latter case, it is a group of individuals belonging to the same species, but representing only a fraction of it, being distinguished by their existence in a specific historical period. In other words, for Joseph, the aggregate is seen as a particular set of individuals who may or may not belong to the same species, but who, regardless of this, do not include all the entities that possess that nature.

Smith (2010, p. 9) has a similar view to Joseph's, but with some different details. He defines aggregates (object aggregate) as material entities made up of a plurality of objects that function as continuous parts, and the aggregate can be defined according to its parts (including the roles of its elements), as members that form a whole, such as an orchestra, or by some delimiting aspect, such as the restaurants in a city, in which case the delimitation would be spatial. However, aggregates should not be confused with species, since aggregates are a cut-out, a group, while species include all the respective individuals in spacetime, considering the common essence that defines them (Joseph, 2008).

For Smith (2010) an entity "a" is an aggregate of objects if, and only if, we can divide it completely into parts that do not overlap (disjoint), and each part is a distinct object. Also, from the author's perspective, aggregates can be considered as collections, more specifically, as collections formed by continuous individual entities, such as, for example, the supermarket items in a bag, the cells that make up a body or the group of human beings existing at a given time (Bittner, Donnelly & Smith, 2004, p. 3).

As can be seen in the example of the shopping bag, aggregates do not necessarily share a common property and can be made up of items of a different nature. However, Smith sees a difference between collections and aggregates: while

the aggregate may have different members at different time intervals, this is no longer the case with collections. On the other hand, collections share common aspects with aggregates (Bittner, Donnelly & Smith, 2004; Arp, Smith & Spear, 2015; Smith, 2010; Smith et al., 2015). Thus, the notion of aggregate gives rise to various types of specialization, which can be derived from aspects such as extensionality, temporality, different forms of partitioning, etc.

On the other hand, classes, according to Joseph (2008, p. 42) are groupings^x that bring together individuals who have essential characteristics in common. Essence, according to the author, is "that which makes an entity what it is and without which it would not be the kind of entity it is". Another pertinent definition is that of (Spear, 2006, p. 18), who defines class as a collection of particulars to which a given term applies, so that all the elements in the collection are subsumed under that term, and any particular instantiating it necessarily belongs to the collection. It should be noted that although every universal has a corresponding class, the opposite is not always true (Spear, 2006, p. 18), i.e. there may be classes whose extension does not correspond to a universal. In the case of classes that correspond to universals we have that: "(C) Collection of X's =def. collection of particulars of type X." (Smith & Ceusters, 2010, p.143).

In this line of thought, for Smith et al. (2006, p. 60) classes are collections^{xi} of particulars that share common characteristics, highlighting that there is a distinction between class and universal: a class brings together only the particulars to which a general term applies, but when this term refers to a universal, the corresponding class - called the extension of the universal - includes all the particulars that, at that moment, instantiate it.

Arp, Smith and Spear (2015, p. 19) note that when a universal has a maximal class^{xii} as its extension, these classes are called "natural classes" and correspond to a universal. Thus, natural classes should not be confused with conventional classes. For example: "The class of all human individuals with less than an inch of hair on their heads^{xiii} picks out a class of individuals in reality, but it is not a natural class, and so there is little reason to think of this class as corresponding to a universal." (Arp, Smith & Spear, 2015, p. 19). It should be noted that, in Smith's sense, the term class refers to ordinary classes rather than natural classes.

Smith (2008, p. 94) notes that there are classes defined by human beings that are used to talk about things that are not yet fully understood, or to express human points of view about certain things. For example, terms such as "obesity" and "hypertension" refer to real entities based on classes defined based on human consensus understandings, rather than universal ones, and can vary according to medical consensus.

It should be noted that this (common) understanding of class is different from that used in descriptive logic (DL), which is widely used in ontology editors such as Protégé OWL. In DL, a class is defined as a set in the mathematical sense (Guizzardi, 2005), i.e. there is no obligation for the elements to be of the same nature.

In this context, the author provides a detailed discussion of the problems that arise from considering classes in this sense when developing ontologies. For this reason, Smith and Ceusters (2010, p. 18) argue that they prefer to use the term "collection" rather than "class", in order to avoid ontology developers drawing the wrong conclusions based on the doctrines associated with the use of the word "class" in DL contexts^{xiv}. Finally, it should also be noted that class is not synonymous with aggregate, since an aggregate does not necessarily require all its members to have the same essence (Joseph, 2008).

4.6 Synthesis of the metamodel-level elements considered

To make it easier to understand the concepts discussed, Table II presents a synthesis of the main aspects covered in section 4. This table serves as a guide to differentiate between concepts, universals, categories, particulars, individuals, instances, types, aggregates and classes, illustrating that there is more than one way of understanding these elements (remembering that the synthesis presented here is not exhaustive), so it is important to make a choice explicit. However, it is important to note that the correspondences established between notions such as class, type and universal are theory-dependent and hold only within the ontological and epistemological frameworks discussed, without implying their equivalence across different philosophical traditions.

Meta-level element	Description
Concept (in Dahlberg's sense)	Unit of knowledge linked to a referent in the world, in a view of hypothetical realism, and where the existence of several possible worlds is admitted (in Varzi's sense). Concepts are considered based on essential characteristics established by expert consensus, which, depending on the domain, to some extent opens up space for concepts to be defined pragmatically. Thus, it admits elements for which there are no corresponding instances in the real world, such as, for example, unicorn. In addition, concepts that correspond to classes of things can be accepted, as in conceptualism (Dahlberg, 1978b; Campos, 2025).
Concept (in the sense of Ogden and Richards)	An idea, in the mind of an individual, reflecting the subjectivity of that individual with everything that composes and influences it. For this reason, it can be considered a unit of thought (Ogden & Richards, 1946; Campos, 2025).
Universal (in general)	In the objective meaning it is something that can be attributed to various things, such as the idea of humanity, which can be attributed to people. In the subjective meaning, the universal refers to judgments about truth or falsity, such as what is beautiful or ugly (Abbagnano, 2007). From a logical point of view, it can be predicated of many things; that is, it can be said of multiple entities (Abbagnano, 2007).
Universal in moderate realism	According to Almeida (2021, p. 110) "Abstractions of sets of entities with similar characteristics that exist in the world independently of the human mind, and that represent all entities of that type that exist, have existed or will exist", in other words, temporal or spatial cut-offs are not allowed (Smith et al., 2006; Spear, 2006). Universals necessarily have instances (Bealer, 1998). Universals are properties or essences that are shared by two or more particulars, but which only exist concretely in individual things (Tôrres, 2008; Brower, 2016).
Universal in conceptualism	Abstractions of reality, but as fruits of the mind created to understand reality. In this sense, universals are mental inventions useful for classifying and communicating and have no independent ontological existence (Saint-Andre, 2002).
Individual in general	An entity that exists and has a unique and continuous identity (Guizzardi & Zamborlini, 2012).
Individual for Boethius and in a first sense by Duns Scotus	According to Abagnano (2007), for Boethius it is that which is indivisible or that which cannot be predicated of other similar things, such as Socrates. In other words, it is indivisible and unique, such as a dog "X" which is numerically distinct from any other dog.
Individual for Duns Scotus (in its second sense)	According to Abagnano (2007), for Duns Scotus, an individual is a unique entity but considered in terms of numerous characteristics that make it unique and not just in terms of being indivisible. For example, considering a specific dog, its name, physical size, medical history, etc. all these characteristics combined make it a unique entity, in the sense that even if there are other similar dogs, none will be the same as that dog due to these countless determinations that define it.
Particular in the realist view	An entity that exists concretely and specifically in space and time (Smith & Ceusters, 2004). From an ontological point of view, a particular instantiates a universal. It is not necessarily an individual. For example: shadows and historical events are particular, but they are not individuals, because they do not have a single, continuous identity (Strawson, 2003).

Meta-level element	Description
Particular in the view of Campbell's Trope Theory	Unique set of particular properties (tropes) that occur together (Campbell, 1981). They do not instantiate universals.
Instance in Formal Ontology	In general, an example of something unique in each reality. It can be a particular, when it exemplifies the manifestation of a universal being dependent on another particular; it can be an individual, when, existing independently, it exemplifies the manifestation of a universal; it can be a given universal, when it exemplifies it still as a universal, and not as a particular (Johansson, 2004; McGill, 1934).
Instance in pragmatic approaches to OWL	Member or element of a class (here taken in the sense of class in OWL) (Smith <i>et al.</i> , 2006).
Type	The same as universal, in realism, from the perspective of Smith and Ceusters (2010). The same as Kind in the Aristotelian square, from the perspective of Welty and Guarino (2001). The same as approximate set, in one of the perspectives of Porello and Guizzardi (2017).
Aggregate, according to Joseph in her interpretation of concepts from the scholastic tradition	A whole formed from the gathering of several things that have some common aspect, whether they are of the same nature, and which, when it gathers things of the same nature, does not encompass all the members that have that nature (Joseph, 2008). It is the same as a collection for Smith (Bittner, Donnely & Smith, 2004).
Aggregate in Smith's sense	Collections that can be divided completely into non-overlapping parts, where each part is a distinct object, and which can have different members at different time intervals. It leaves room for various types of specialization, which can be derived from aspects such as extensionality, temporality, different forms of partitioning etc. (Smith, 2010).
Class in Smith's sense	Sets of particulars that share characteristics in common, of the same nature, without their extension coinciding with that of a universal. This is the understanding of common class and not natural class, which for the author is the same as universal (Smith <i>et al.</i> , 2006).
Class in descriptive logic	A set in mathematical sense (Guizzardi, 2005), i.e. there is no obligation for the elements to be of the same nature. In this case, it adopts the same meaning as aggregate in scholastics.

Table II: Synthesis of elements at metamodel level: from concept to class. **Source:** the author.

As can be seen, elements at the metamodel level have different meanings, and an unambiguous understanding of these elements is fundamental for the development of KOS, with significant impacts on the interoperability, precision and understanding of the conceptual models that use them. For example, from a realist perspective, properties can be understood as universals, we are assuming that properties can be instantiated for two different particulars, exemplifying exactly a single universal, and so you can compare the properties of two particulars and, depending on how it is, consider them to be the same. On the other hand, if we consider properties as tropes, in Campbell's (1981) view, then no two properties will be the same, no matter how similar they are, just as no two individuals are the same. Another example is the assumption adopted for the individual. As pointed out earlier, depending on what is considered an individual, a hole in a piece of cheese may not be considered one.

5. FINAL CONSIDERATIONS

This paper has presented an analysis from various perspectives of the elements at the metamodel level, highlighting the influence of ontological and epistemological perspectives on the understanding of these elements, which is

fundamental for the development of accurate and interoperable KOS. Using a qualitative and exploratory approach, it was possible to summarize the main aspects that influence the definition and use of these elements. The results obtained illustrate that clarity in the definition of metamodel elements and the consideration of different ontological and epistemological perspectives are essential to avoid ambiguities and guarantee the accuracy of KOS. Furthermore, the discussion of concepts, universals, types, individuals, particulars, instances, aggregates and classes revealed the complexity involved in representing knowledge and the importance of making explicit the theoretical choices that underpin this representation. Future work could address attributes and relationships as elements at the metamodel level, from different points of view, as was done with the other elements dealt with here.

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8. NOTES

- i Translated reprint of his 1787 work (second version of his 1781 work).
- ii Reprint of the original work of 1710.³ Reprint of the original work of 1690.
- iii Latin *in re* or *in rebus* "in things"
- iv Referring to volume III
- v Latin for "after things"
- vi It exists only once, i.e. it is not repeated. For example, my dog is a unique individual who does not repeat himself. There is no other dog like him.
- vii In this work, the author gives detailed consideration to the aspects that make up individuality.
- viii Alfred Whitehead (1978) considers that individuals are temporal events and not fixed material entities.
- ix The author makes this claim based on the fact that a collection can have different members at different times, despite being the same collection, as in the case of the British Army.
- x Grouping here means that it is a cut-out of the extension of a universal.
- xi Here, from the context, we interpret that the authors, like Spear, use the term collection in the lay sense, of a group of things, and not in the sense of collection in contrast to grouping.
- xii Maximum class here is understood as all and only those particulars that instantiate a universal at a given time.
- xiii The authors understand that it can be useful to have such classes in ontologies and call them "defined classes". They add that "Universals, their extensions, and defined classes are all important for ontological purposes. However [...], it is essential that they be carefully distinguished" (Arp, Smith & Spear, 2015, p. 21).
- xiv According to Smith (2008), Descriptive Logic allows us to reason about concepts and their instances in reality, however, it is originally based on First Order Logic, which focuses only on individual entities, according to the nominalist perspective.