Re-examining Aristotle's Categories as a Knowledge Organization System†

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Abstract: In his *Categories*, Aristotle details the kinds of being that exist, along with what can be understood and predicated of existing things. Most notably within this work, Aristotle advances a set of ten, top-level categories that can be used to classify all kinds of being. Even today, the influence of the *Categories* is felt in many domains, particularly in knowledge organization (KO). Here, Aristotle's *Categories* bear deep, long-standing connections with works examining categorization, subject analysis, and theory of classification. Though its relation to ontology might seem obvious, connections to KO perspectives on knowledge organization systems (KOSs) and ontological modeling are curiously lacking. The aim of this work is to offer a re-examination of the *Categories* as a KOS, particularly through the lens of the KO field's understandings of ontology. Utilizing Zeng's classification of KOSs as a theoretical framework, this study draws parallels between the first two sections of the *Categories* and the defining features of ontologies and offers an initial ontological model of this work. The results of this re-examination stand to offer a new view of a fundamental work in the KO canon, draw further connections between past and present perspectives in KO, and further contribute to the theoretical grounding of contemporary KOS research and practice.

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1.0 Introduction

The *Categories* is one of Aristotle's most well-known and widely discussed works. Forming a portion of the larger *Organon*, a collection of works devoted to logic and logical procedure, the *Categories* can be seen as an early example of philosophical ontology. In the *Categories*, Aristotle looks to propositions to detail the kinds of being that exist, along with what can be understood and predicated of existing things; it is ultimately an attempt to understand and articulate what is real (Guthrie 1981). Most notably within this work, Aristotle advances a set of ten, top-level categories that can be used to classify all kinds of being: substance, quantity, quality, relation, place, time, position, state, action, and affection. The text and this framework of categories have played a foundational role in logic and philosophy, influencing the works of Spinoza, Leibniz, Kant, and many more (Studtmann 2021). The influence of the *Categories* is also felt in many other domains, particularly in knowledge organization (KO). Here, examinations of Aristotle's *Categories* have brought to light deep connections with KO topics such as categorization, subject analysis, and theory of classification (Barite 2000). Though its relation to ontology as understood within KO might seem obvious, connections to KO perspectives on knowledge organization systems (KOSs) and ontological modeling are curiously lacking.

KOSs are systems designed to represent knowledge and information, typically through an arrangement of concepts, terms, and semantic relations (Mazzocchi 2018). Examples of KOSs include authority files, classifications, taxonomies,

and thesauri. Common to all KOSs are the goals of controlling terminology and eliminating ambiguity, as well as certain structural features such as terms, relationships, and properties (Zeng 2008). While all KOSs may be seen as attempts to represent what is real and of interest within a given domain of knowledge, one type of KOS is particularly robust and expressive in its attempts to model reality: ontology. This type of KOS uses classes, relationships, and properties to offer a highly structured, highly functional representation of what exists and what can be known. As such, it bears similarities to both the purpose and structure of Aristotle's ten categories.

The aim of this work is to explore these resemblances by offering a re-examination of the *Categories* as a KOS, particularly through the lens of the KO field's understandings of ontology. Utilizing Zeng's (2008) classification of KOSs as a theoretical framework, parallels will be drawn between the first two sections of the *Categories* and the features Zeng presents as indicative of ontologies. Through close reading of the *Categories* and comparison to Zeng's model, the present study will offer a reinterpretation of Aristotle's categories themselves as manifestations of a set classes, instances, properties, relationships, and values. The resulting re-examination stands to offer a new, KOS-centric interpretation of the *Categories*, while also drawing new connections between past and present perspectives in KO and further contributing to the theoretical grounding of contemporary KOS research and practice.

2.0 Background

Before proceeding into a re-examination of the *Categories*, some brief background must be first established. Here, clarifications on the meaning of ontology are presented, along with pertinent considerations and points of critique concerning the *Categories* and a review of relevant KO perspectives on the matter.

"Ontology" is a challenging term, and has only been made more so by its recent proliferation in usage among a number of disciplines. Though, at a broad level, the term has similar usage and meaning in the fields of both philosophy and KO, some important distinctions must be acknowledged. Here, we can turn to Almeida's (2013) exploration of the term for clarification. Within philosophy, ontology is seen as a sub-discipline of metaphysics (i.e., the study of reality), focused on being and the kinds of being that exist. Within information science, an ontology is a formal system viewed as part of the continuum of KOSs. Zeng (2008) provides some further explanation of ontology from a KO perspective: a formal, explicit specification of a shared understanding of a domain of knowledge, represented through the use of classes, complex relationships, properties, axioms, and rules. While both uses of the term refer to a representation of being, their respective meanings should not be conflated. Thus, for the purposes of the present work, we will take philosophical ontology to refer to the study of being, while ontology (used with no further qualification) will refer to the KO perspective on ontology (i.e., a kind of formal KOS).

In exploring the kinds of being that compose reality, the *Categories* may be seen as a classical work of philosophical ontology. While much work has examined, interpreted, drawn from, and refuted the *Categories*, it is important to note that questions persist about the intended comprehensiveness of Aristotle's system. Its coherence has frequently been challenged, with Guthrie (1981) noting there is evidence to suggest the list of categories was experimental, its makeup less important than the procedure Aristotle was attempting to illustrate. As a part of his *Organon*, the *Categories* were indeed intended to demonstrate a logical procedure. Specifically, Aristotle frames his discussion in terms of proposition and predication and, more broadly, what questions can be asked of something that exists and what forms the answers to these questions might take (Ackrill 1963). This introduces another area of debate concerning the *Categories* that must be kept in mind, namely, ontological versus linguistic interpretations. Ontological interpretations see the *Categories* squarely as a work of philosophical ontology. While Aristotle relies on certain linguistic cues, his categories concern the things these words and names signify; they are categories of things, not language (Almeida 2013). Linguistic interpretations, on the other hand, suggest that, whether intentionally or inadvertently, Aristotle is making categories of language and thus reflecting logical truths and a linguistic state of affairs rather than a metaphysical one (Benveniste 1971). Though both interpretations of the *Categories* may be useful for the present work, the re-examination offered here will assume the ontological interpretation. Logico-linguistic aspects will briefly be revisited in the closing of this work.

The *Categories* have also been a prominent source of discourse within the KO field. Here, attention has focused primarily on its connections to classification and facets. For instance, La Barre (2010) points to Aristotle's work as frequently invoked and debated in discussions of facet theory and facet analysis. Within classification literature, comparisons to Ranganathan's categories are long-standing. In an attempt to refute the supposed modernity of Ranganathan's system, Moss (1964) examined the similarities between the *Categories* and Ranganathan's work, noting the lingering influence of Aristotle. More recently, Aranalde (2009) also compared these two systems of categories, acknowledging that while they were created for different purposes they share an underlying ontological nature and empirical epistemology. Classification and facet theory are, however, not the only meaningful connections to be drawn

between the *Categories* and work in KO. In examining the contributions of philosophy to KO, Dahlberg (1992), mapped the ten categories to a system of entities, properties, activities, and dimensions, moving closer to an ontological interpretation. Beyond this, further connections to current understandings of ontology in the KO field have remained surprisingly underdeveloped in the literature.

3.0 Approach

To address this gap, the present study seeks to interpret the text of the *Categories* through a KOS lens, demonstrating specifically how Aristotle's work and framework of categories may be seen as an ontology. Some important notes about the scope of this study must be made, though. The text of the *Categories* is commonly divided into three parts. The first, the *Pre-Predicamenta*, establishes a set of ground rules for propositions and certain semantic relationships. The second, the *Predicamenta*, establishes the ten categories themselves, while the third section, the *Post-Predicamenta*, deals with certain types of oppositional relationships. While Aristotle's intention that these three parts be presented as a cohesive work is often questioned (Studtmann 2021), the first two sections bear enough congruence to be taken together. This paper's analysis will thus focus on the *Pre-Predicamenta* and *Predicamenta*. For simplicity's sake, consideration of Aristotle's additional ontological writings such as the *Physics* and *Metaphysics* will also be omitted. The limitations of taking this view of the *Categories* as a complete, self-contained system will be revisited below.

As the framework for this analysis, Zeng's (2008) classification of KOSs will be utilized. In her overview of the various types of KOSs, Zeng presents a model plotting the range of KOSs in a progression along two axes: increasing structural complexity and increasing functionality (Zeng 2008, 161). Ontologies are positioned at the upper end of the spectrum, depicted as semantically rich KOSs, representing classes and instances of concepts, along with hierarchical and associative relationships, properties, rules, and axioms. The present analysis will draw comparisons between these features and features present in the *Categories*.

First, a few terminological clarifications must be presented. Terminology used for the various components and features of ontologies varies throughout the KOS literature. In the present work, class and instance will be used to refer to groups of entities and individual entities, respectively. Relationships will be used in referring to the various semantic connections (hierarchical, equivalence, associative) that exist between entities. Following Zeng's (2008) usage of the term, properties will be used to refer to the other attributes that classes and instances may possess; these may be thought of as metadata elements that are not entity-entity relationships. For any given instance, properties are satisfied by values. For example, the property "height" may have a value of 140 cm.

4.0 The *Categories* as ontology

At the start of the *Categories*, in what is referred to as the *Pre-Predicamenta*, Aristotle presents us with two dimensions along which all types of being can vary: said-of and present-in. In the first, something that is predicable of something else is said-of. For example, in the proposition "Aristotle is a human," the concept of "human" is predicable of an individual human. Aristotle, being predicable of nothing else, is therefore not said-of. Logical inheritance is also present here: humans are animals, and as a human, Aristotle is thus also a type of animal. Within KOSs, this kind of relationship can be seen as the generic hierarchical kind, establishing among concepts a class-subclass or class-instance relationship. By this token, anything said-of would be a class, while anything not said-of would be an instance.

In the second dimension, something is present-in when it is incapable of existing outside of a subject, while those that are not present-in may exist independently. For example, knowledge exists in the human mind, and thus it is present-in an individual. In contrast, horse is said-of an individual horse, but is never present-in a substance in the way knowledge is. As explained below, the substance category holds a special position in Aristotle's work, and may be the only concepts capable of independent existence (i.e., not present-in). All other kinds of being must be present-in and thus dependent on substances for their existence.

Combining these two dimensions, we arrive at four types of being. To illustrate, Aristotle goes on to explain that some things "are both predicable of a subject and present in a subject. Thus while knowledge is present in the human mind, it is predicable of grammar" (Aristotle 2000, 1). Here knowledge would appear to be a non-substance class that cannot exist independently, with grammar being a subclass of knowledge and, assumedly, one individual's grammatical knowledge being an instance. We can thus begin to see the presence of multiple classes and a range of hierarchical and associative relationships linking them, with any cross-categorical relationships being necessarily associative.

Taken all together, these four kinds of being can be placed in a matrix; this matrix, along with corresponding aspects of an ontology, may be seen in Table 1.

In the *Predicamenta*, Aristotle moves on to discuss the ten categories that enumerate all kinds of being. These categories and the examples given by Aristotle are summarized in Table 2. For further illumination, the corresponding questions answered by these categories, as offered by Moss (1964), are presented as well.

Interestingly, Aristotle presents the categories as ostensibly disjoint, and with no top-level category uniting them.

	Present-in	**Not present-in**
Said-of	classes (non-substance), properties, relationships ex. length, color	classes (secondary substance) ex. Person
Not said-of	instances (non- substance), values ex. 2 cubits, blue	instances (primary substance) ex. Aristotle

Table 1. The said-of/present-in matrix.

Category	**Examples *(Aristotle 2001)***	**Question *(Moss 1964)***
substance	man, the horse	what?
quantity	2 cubits long	how large?
quality	white, grammatical	what sort?
relation	double, half	related to what?
place	in the Lyceum	where?
time	yesterday, last year	when?
position	lying, sitting	in what attitude?
state	shod, armed	how circumstanced?
action	to lance, to cauterize	doing what?
affection	to be lanced, to be cauterized	what suffering?

Table 2. The ten categories.

As a top-level class is required of an ontology, one may, for convenience's sake, assume "being" as the implied top-level class here, as seen in Aranalde's (2009) interpretation.

Substances, being the only category of things that may exist independently, hold an important position within Aristotle's model, and are further divided into primary substances and secondary substances. Primary substances are the individuals we can directly apprehend, such as Aristotle or one specific oak tree. Secondary substances are the species to which primary substances belong, that is, the abstract groups of persons or trees. It is thus fairly easy to see secondary substances as classes, and primary substances as the instances of these classes.

In fact, in envisioning the categories as an ontology it may be tempting to simply position each category as a class under being, but evidence within the text suggests that the types of being Aristotle is describing may not all neatly align with entities in an ontology. Take, for instance, the place category. Beyond several examples, Aristotle has little to say regarding this category, declaring it to be self-explanatory. Focusing on his example, "in the Lyceum," we can understand the Lyceum to be a specific, concrete thing we can directly apprehend. As such, the Lyceum must in fact be a primary substance. The kind of being that Aristotle is indicating here (i.e., place-being) could instead be seen as the "in" connector. For a statement such as, "Aristotle is in the Lyceum" then, place functions as an associative relationship between two substance instances. Similarly, other locational relationships such as under or beyond must belong to this place category of relationships.

Given this and the fact that substances may be the only independently existing category, it may be tempting to head in the opposite direction and view all non-substance categories as sets of relationships, connecting substance to substance, or properties, connecting a substance to a value. This would certainly allow a more elegant solution to the challenging relation category. In the strictest of interpretations here, Aristotle is referring to things being related, not the relationship itself (Studtmann 2021). Frustratingly, any member of any category would then appear to be capable of being a relation as well. This raises the prospect of non-disjoint classes, which is acceptable in ontological modeling and would also seem to be permissible according to Aristotle's remarks in certain passages within the *Categories*. Still, a more practical solution may be to interpret the relation category as a set of comparative, associative relationships, wherein classes or instances from any other categories could serve as domain and range.

A similar solution would work for quantity. As Ackrill (1963) points out, the genus-species model seems inappro-

priate for this category. Aristotle describes quantities as being lines, surfaces, solids, and such, and would seem to be indicating dimensions of measurement rather than distinct numerical values. Thus, in an ontology, quantity might function as a set of properties, such as "hasLength" or "hasSurfaceArea," with substances serving as the domain, and values, such as 2 cubits, serving as the range.

Yet there is also evidence that other, non-substance categories are in fact entities and should be represented through classes and instances. Aristotle has much more to say concerning the quality category compared to most others, though his example concerning knowledge is particularly telling. A specific point of grammatical knowledge is present-in a person and cannot be said-of anything else. Grammar would thus serve as an abstract class for which this point of knowledge is an instance. This instantial hierarchical relationship is indicative of class-instance relationships in an ontology. Color is treated similarly within the *Categories*, with the specific white on a specific horse serving as an instance of the more abstract group of "white." Interestingly then, any instance of a quality class would have to bear an associative relationship to a primary substance in order to truly exist; this also implies the presence of a specific set of associative relationships linking substance and quality instances.

In truth, a mixture of classes, relationships, and properties may be the most effective means of interpreting the categories as an ontology. Of the remaining categories, time, position, and state may function similarly to quantity in that they connect substances to specific values, rendering them sets of properties. Action and affection are effectively a pair, describing certain events from an active or passive point of view. If "teaches" is an action, then "is taught" serves as the corresponding affection. It may then be simplest to interpret action and affection as a single set of inversely related associative relationships.

We are thus able to represent all ten categories within an ontology, though in varying ways. Table 3 shows an overview of the ontological interpretation of the categories as presented above.

To further illustrate this interpretation of the *Categories*, the ontology editing software Protégé was used to create an initial OWL ontology taking into account the decisions laid out above. Figure 1 shows a sample visualization of this ontology, utilizing some of the example components offered in Table 3.

5.0 Discussion

Many of the features of KOSs as described by Zeng (2008) can be found within the *Categories*. Though it can indeed be rendered as an ontology, the process is more challenging and the results less elegant than one might first hope. In particular, actually mapping the ten categories themselves to ontology components is much more difficult than framing the initial said-of/present-in matrix in ontological terms. Still, the results above offer one example of how a work of classical, philosophical ontology may be interpreted through a modern, KOS lens. The process of re-examining the *Categories* revealed undeniable connections to KOS perspectives and practices. Hierarchical relationships, logical inheritance, and associative relationships may all easily be

Category	**Ontology Component**	**Examples**
(being)	top-level component	
substance (primary)	substance instances	Aristotle, the Lyceum
substance (secondary)	substance classes	Persons, Buildings
quantity	quantity properties and values	hasLength, "3 cubits"
quality	quality classes and instances	Knowledge, Color, "white"
relation	relation relationships	isGreaterThan, tallerThan
place	place relationships	in, under
time	time properties and values	occurred, "2021"
position	position properties and values	hasPosition, "lying"
state	state properties and values	hasState, "armed"
action	action/affection relationships	teaches
affection	action/affection relationships	isTaughtBy

Table 3. The categories as ontology components.

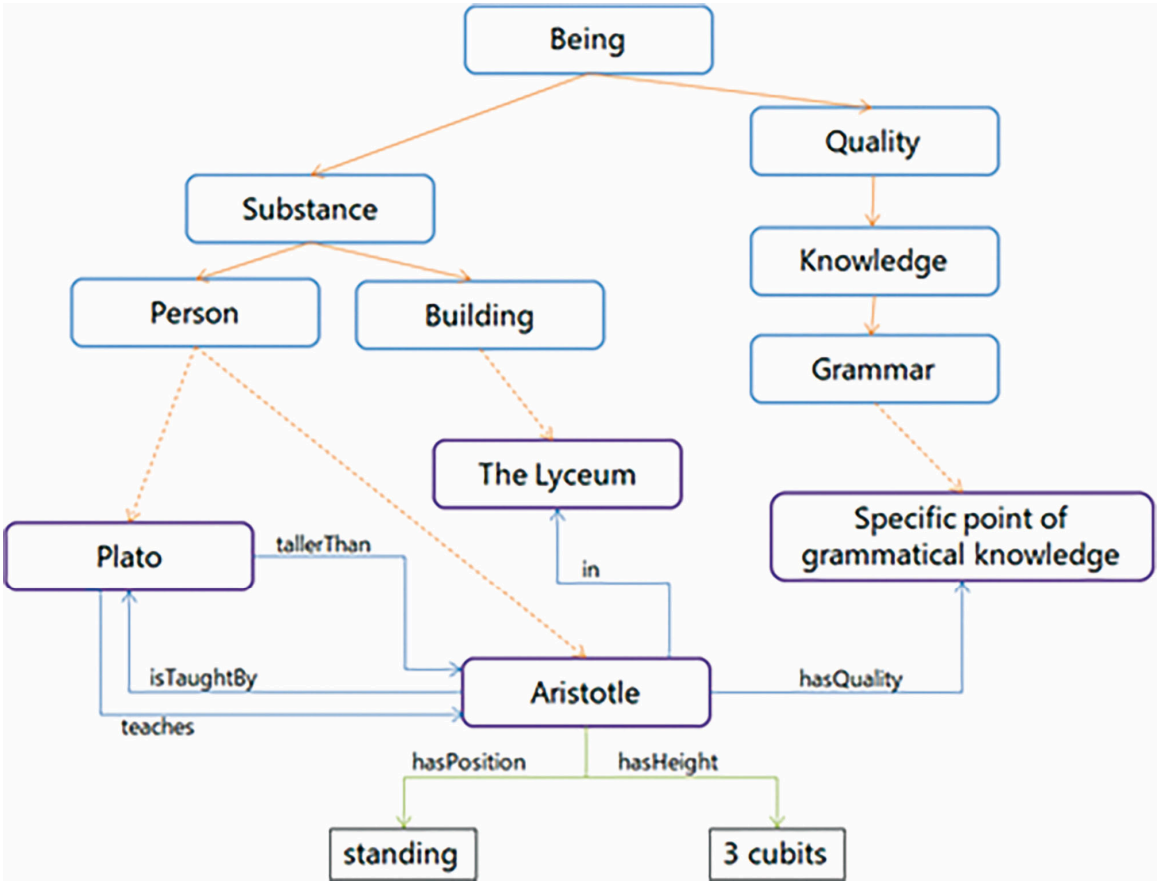

Figure 1. The categories as ontology components.

found within the *Categories*, and are characteristic of many KOSs including taxonomies, thesauri, and ontologies (Zeng 2008). Though the results of the ontological modeling here may not be perfect, the process itself provides further insight and raises important considerations concerning KOS practice.

The challenges encountered in the present study show some of the limitations of taking the *Categories* as a self-contained, ontological system. Certain categories receive relatively little consideration within the text, while Aristotle's metaphysical presumptions would be further articulated elsewhere within his writings, including in his *Physics*, *Metaphysics*, and *Prior Analytics*. Even the *Post-Predicamenta* of the *Categories* contains additional material that could have been useful here; for instance, its exploration of oppositional relationships may provide some axioms and logic, key aspects of Zeng's (2008) depiction of ontologies that were omitted from the present study. Still, it is likely that one consistent, cohesive ontology could not be distilled from such a large collection of Aristotle's works. Furthermore, the present study's ontological model is offered not as a solution to the *Categories*, but as an illustration of the connections between philosophical ontology and KOS study and practice. Just as there is the danger of imposing a systematic formality on the *Categories* that it was never intended to have, there are also dangers in KOS work in looking to overimpose an order that may not exist. This is true in the modeling of any domain of knowledge; admittedly, some decisions must be made for practicality, convenience, and elegance. Unlike in the present study, however, most KOS design is conducted for a specific community. Meeting the perspectives and needs of this community should always guide the necessary decisions around simplifying reality into a model.

The ontological/linguistic debate surrounding the *Categories*, as well as larger issues concerning the relationship between language and reality, also offer further insight into KOS practice. A purely ontological interpretation of the *Categories* was followed here and, in doing so, Aristotle's assumptions concerning the clear, direct relationship between language and reality were upheld. Just as Aristotle uses language as evidence for reality, we also turn to language as evidence in building and maintaining KOSs. For example, best practices concerning taxonomy development guide the taxonomist to collect words from a body of discourse, and then discern nouns that can exist independently from adjectives

and adverbs that cannot (Hlava 2014, 65). This reliance on language as evidence of reality is necessary, but exposes KOS practice to some of the same critiques and questions posed to philosophical ontology. For example, in his examination of the *Categories*, Benveniste (1971) offers a comparison of Greek to the Ewe language, showing there to be no comparable, singular term representing the concept of "being." Through this exercise, Benveniste illustrates how language may bind our ontological interpretations at a deeper, conceptual level, a lesson that must be kept in mind as we work to develop KOSs for a diverse, global audience.

6.0 Conclusion

The re-examination presented here shows that the *Categories* can be interpreted as an ontology within the framework of Zeng's (2008) KOS classification. This interpretation is not meant as a solution to the alluring perplexity of the *Categories*, but rather as an exercise in drawing connections between philosophical ontology and modern KOS understanding and practice, and in further illuminating the theoretical foundations of the KO field. In doing so, the present study does not negate previously made connections between the *Categories* and classification and facet theory, but adds to the literature on how philosophical ontology has shaped a range of KO practices. In suggesting how critiques of philosophical ontology may be employed in examinations of ontologies and other KOSs, this study also opens up new areas of assessment for these systems. Moving forward, there are opportunities for new examinations of KOSs and KOS practice employing these critiques, as well as additional analyses of works of philosophical ontology through a KOS lens.

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