Qualities, Quantities, and the Endurant-Perdurant Distinction in Top-Level Ontologies

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Abstract. The distinction between endurants and perdurants plays a prominent role in influential top-level ontologies in information science. But how are quantified qualities such as length and mass related to this distinction? In order to answer this question and see its consequences, one has to pay careful attention to the distinctions between: particulars and universals, persisting and instantaneous particulars, determinable and determinate universals. It is argued that robust top-level ontologies that classify particulars have to rely on other taxonomic principles than those who, like traditional science, classify universals.

1 Introduction

Both in some corners of philosophy [3] [7] [8] and in some discussions concerned with top-level ontologies in information science [1] [9], the distinction between endurants and perdurants plays a prominent role. In philosophy, this distinction is standardly introduced in order to discuss whether quality-bearers such as ordinary things, physical material particles, and persons should be regarded as persisting by enduring or by perduring, i.e., whether in their persistence through time they are strictly identical at every moment (endurants), or whether they persist by unfolding in time different parts of themselves (perdurants). However, those who are concerned with top-level ontologies cannot rest content with classifying quality-bearers. Qualities and their ways of persisting in time are of equal importance.

In classical physics, qualities such as length, mass, electric charge, and temperature have two features in common: (i) they are not only monadic qualities inhering in things, they are quantities, too; (ii) the variables that represent them are allowed to have values not only in time intervals but in absolutely instantaneous time points as well, i.e., such variables can represent non-persisting quantities.

This paper is an attempt to relate such monadic physical qualities to top-level ontologies. When not otherwise stated, the term quality means '*monadic* quality' and refers to universals, i.e., to entities that via their instances can be in many places at the same time.

2 Qualities and Quantities

The first question to be answered is the following:

(a) Should in a subsumption tree 'quantity y of quality x' be a taxon beside, beneath, or above 'quality x'?

Quantities such as those referred to by means of '3.01m' and '5.70kg' have to be kept distinct from pure numbers, and there would be no such quantities in the world if qualities did not contain a duality. Where there is an instance of a quality, there are always at one and the same time at least both a highest *determinable quality* such as length or mass and a lowest *determinate quality* such as those referred to by means of '3.01000…m' and '5.70000…kg', respectively.

The terms and the distinction are taken from a philosopher working about a hundred years ago, W.E. Johnson [5]. He introduced the distinction because he had realized that it differs from the genus-species distinction. Nowadays, something like it is mostly recognized under other names. The scientific standard nomenclature of "International Vocabulary of Basic and General Terms in Metrology (VIM)" contains a corresponding distinction under the terms *quantity dimension* and *quantity* [12]; operationalists who think that such quantities cannot refer to measurement-independent entities may turn the distinction into one between *measurement dimension* and *measurement result*; the conceptualist Peter Gärdenfors and many information scientists distinguish between *domains* and *points* in such domains [2]; and the group behind the ontology DOLCE [9] distinguishes between *quality types* and *quales*. We get the following table of correspondences:

W.E. Johnson:	**Determinable**	**Determinate**
VIM:	Quantity dimension	Quantity
Operationalists:	Measurement dimension	Measurement result
P. Gärdenfors:	Domain	Point in a domain
DOLCE:	Quality type	Quale

I have chosen to take departure from Johnson because his terminology is neither restricted to quantities (as VIM's is) nor tied to nominalist and conceptualist positions (as the terms of the operationalists and of Gärdenfors are).

We often use linguistic concepts such as 'thing' and 'long', as well as concepts for quantities, e.g., '3.01m', in order to speak about facts that exist independently of the concepts used. A true statement "This thing is 3.01 m long" designates by means of the concept '3.01m' a determinate quality of the determinable designated by 'long', i.e., *length*; both of which inhere in the thing referred to. However, it is not only quantity-talk that presupposes a distinction between determinable and determinate qualities. If we assert "The shape of this thing is circular", then we are using the distinction between a determinable quality, *shape*, and one of its determinates, *circularity*. Similarly, the statement "The colour of this thing is red" designates both a determinable, *colour*, and one of its determinates, *red*.

The determinable-determinate distinction applies both to mind-independent qualities and to concepts for such qualities. There is, however, an important

difference [5]. Mostly, linguistic concepts feature a whole hierarchy of determinables and determinates, which makes the distinction relative, as in: 'colour' is a determinable for 'red', which is a determinable for 'light red', which is a determinable for 'very light red'. The same is true of concepts for quantities when the concepts in question are not regarded as being mathematically exact: 'length' is a determinable for '(approximately) 3m', which is a determinable for '(approximately) 3.0m', which is a determinable for '(approximately) 3.01m', which is a determinable for '(approximately) 3.010m', which is a determinable for '3.0100…(ad infinitum)m'. The last concept is a lowest possible conceptual determinate. In the mind-independent world, on the other hand, we seem to have only universals referred to by means of the highest conceptual determinables (such as 'length', 'mass', 'colour', and 'shape') and universals referred to by means of the lowest conceptual determinates possible (such as 'absolutely circular' and '3.0100…(ad infinitum)m'. All the concepts on intermediate levels seem to refer to disjunctions of the lowest determinate concept-independent qualities possible.

The relation between a determinable and its determinates is both in case of concepts and mind-independent universals one of subsumption. As the concept '3.0100m' is subsumed under the concept 'length', the length universal *3.0100…m* is subsumed under the universal *length*. This affords us the answer to question (a):

(a') The taxon 'quantity y of quality x' should be subsumed under 'quality x' and therefore be placed beneath, not beside or above the latter.

If neither quality universals or concepts, but the corresponding classes of particulars (i.e., instances of universals and extensions of concepts, respectively) are classified, then the subsumption relation '- subsumed under -' is mirrored by the relation '- subclass of -'. In many information science contexts there is no need to mention this distinction, but here it is.

3 Endurants and Perdurants

If top-level ontologies should take into account absolutely momentary quality instances, then the following two questions have to be answered:

(b) Are non-persisting quality instances enduring, perduring, or neither?
(c) Are persisting quality instances enduring, perduring, or neither?

How are the terms 'endurant' and 'perdurant' defined? An exclusive use of these nouns seems to reflect an exclusive interest in quality-bearers, and I will therefore use also the more general terms 'enduring particular' and 'perduring particular', respectively. These distinctions do not directly apply to concepts and universals, only to particulars falling under concepts and to instances of universals (see section 4). The statements below will be regarded as expressing the conceptual contents of the terms at hand and, therefore, as being by definition true; the terms 'temporal part' and 'wholly present' will be treated as primitive terms.

Enduring particulars:

E1. persist;
E2. necessarily lack proper temporal parts;
E3. are necessarily wholly present in each time interval at which they exist.

Perduring particulars:

P1. persist;
P2. necessarily have proper temporal parts;
P3. are necessarily *not* wholly present in each time interval at which they exist.

As long as an enduring particular persists, it retains its identity unchanged, even though, if it is a quality-bearer (endurant), it may exchange qualities and at different times have qualities which it cannot possibly have simultaneously. Thus an enduring person cannot at one and the same time be both 160 cm and 175 cm tall, but he may during his lifetime change from having the first height to having the second.

The statements E2 and E3 imply each other mutually. Since an enduring kind of entity can have no proper temporal parts, it has to be wholly present in any time interval of its persistence, however large and however small. Conversely, since an enduring entity is necessarily wholly present in any time interval of its persistence, it cannot possibly have proper temporal parts.

Processes are different and are perdurants. If everyday talk about ordinary material things and persons is to be taken literally (as I believe), then existing things and persons are endurants. If, on the other hand, the perdurance theory (four-dimensionalism [10]) is correct, then things and persons should, their appearances notwithstanding, be regarded as being only processes of a certain kind.

The statements P2 and P3 imply each other mutually. Since a perduring kind of entity necessarily has proper temporal parts, it cannot be wholly present in any time interval of its persistence. Conversely, since it is necessarily not wholly present in all its time intervals, it necessarily has at least one proper temporal part.

Question (b) is now easily answered. From the definitions of 'enduring particular' and 'perduring particular', which both require persistence, it follows:

(b') Non-persisting quality instances (determinates as well as determinables) are neither enduring nor perduring particulars.

This trivial truth implies that no top-level ontology can regard the pair of taxa 'enduring particular' and 'perduring particular' as being an exhaustive classification of spatiotemporal particulars. So, next: what about persisting qualities?

Lowest possible *determinates* contain by definition no complexity; in this respect they differ from lowest possible *species*, as Johnson pointed out. This means that their persisting instances can have neither spatial nor temporal proper parts, which, in turn, means that such instances are wholly present in all time intervals at which they persist. They conform to requirement E3 for enduring entities and are enduring particulars.

Determinables, on the other hand, may seem to have a complexity, but this is a false impression. Of course, the unity of a determinable and a determinate is complex; it contains two aspects. But the determinable regarded in itself is exactly the same quite independently of which of its determinates it is united with. Think of patterns [4], for instance, a colour pattern. Since the determinable colour is wholly present in

all different colour determinates, it cannot be said to contain the colour complexity of the pattern. The answer to question (c) is:

(c') Persisting quality instances (determinates as well as determinables) are enduring particulars.

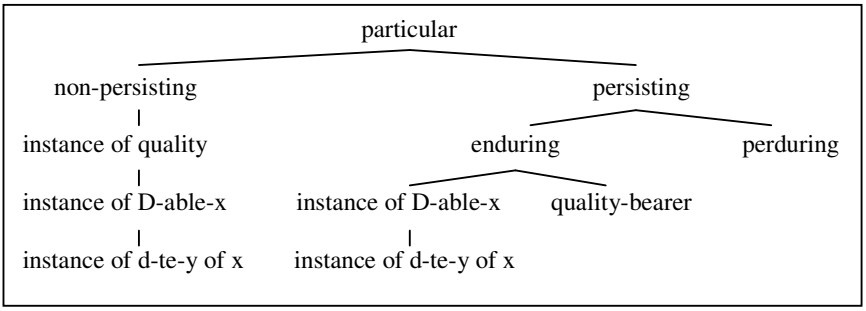
This truth implies that top-level ontologies that classify particulars ought to distinguish between two kinds of enduring particulars: enduring quality-bearers (endurants) and enduring quality instances, respectively.

4 Implications for Top-Level Ontologies

Ordinary natural-scientific taxonomies such as the classic ones in biology and chemistry are primarily classifications of natural kinds, i.e., kinds of *universals in the category of substance*. The corresponding *particulars* are then derivatively classified. Direct classifications of particulars are usually merely nominal and done only for practical purposes. For instance, if sixteen persons are going for a trip in four cars, they can be divided into four sub-groups in a purely nominal way without any considerations of what properties they might be bearers of. However, the classification of entities into enduring and perduring ones is neither a *direct classification of universals*, since universals do not as such persist, nor a merely *nominal classification of particulars*, since it has content as made clear by the statements E1to E3 and P1to P3. What kind of classification is it then?

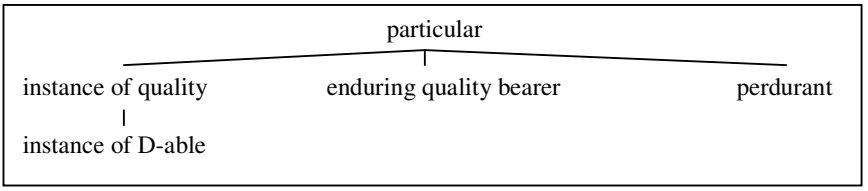
Different particulars can have different relations to time. Every existing particular can be classified as to whether it is (i) non-persisting, (ii) persisting by enduring, or (iii) persisting by perduring. This is the reason why the distinction between enduring and perduring particulars is not merely nominal despite the fact that it takes into account neither qualities nor natural kinds.

A top-level ontology for particulars that wants to take quality instances into account ought to start as follows ('D-able' is short for determinable and 'd-te' for determinate):



This taxonomy, however, may well be claimed to contain a flaw. The last two rows of this pure subclass tree contain so-called *multiple inheritances*. Both the taxa 'instance of D-able-x' and 'instance of d-te-y of x' come twice, and have to come

twice since there are qualities that exist both in time intervals and in time points. True, no one has proposed this classification, but there is a similar one, DOLCE [9]. If for the sake of simple comparison: (i) DOLCE's taxon 'abstract particular' is deleted, (ii) its term 'quality' is replaced by the equivalent 'instance of quality', (iii) its distinction between temporal, physical, and abstract qualities is disregarded, (iv) its term 'quality type' is replaced by the equivalent 'instance of determinable', and its term 'endurant' is replaced by 'enduring quality bearer', then DOLCE looks as follows and can be directly compared to the taxonomy above.



This taxonomy has no multiple inheritances, but it has two other flaws. The distinction between non-persisting and persisting particulars is left out of account, and it gives the impression that instances of qualities cannot be enduring. However, if these shortcomings are corrected, then we are back in the first hierarchy with its multiple inheritances. What to do? Let us try to start with universals instead of particulars, and see what difference this can make.

Universals can be classified not only directly as universals, but also indirectly via features that primarily belong to their instances, namely their relation to time [6]. Since all instances of a universal are alike, and nothing can at one and the same time persist both by enduring and by perduring, it follows that:

I. If instances of a certain universal can perdure, this universal cannot possibly have enduring instances, and vice versa.

From the definition of the concept of 'perduring particular', statement II below can be derived.

II. If instances of a certain universal can perdure, this universal cannot possibly have non-persisting instances.

Explanation: in a time point there can be no proper temporal parts; and since every perduring kind of particular necessarily has such parts, universals with perduring instances cannot possibly exist in merely a single point of time. As the concept of 'perduring' has been defined, a concept such as that of 'instantaneous perduring' makes no sense.

III. If instances of a certain universal can endure, this universal can also have non-persisting instances, and, conversely, if a certain universal can have non-persisting instances, it can have enduring instances, too.

Explanation: since every enduring kind of particular is wholly present in any time interval of its persistence, such a kind of particular may in principle even be infinitesimally small and exist in merely a time point. Conversely, any kind of particular that can exist in a single point of time may of course also exist in all the points that constitute a time interval.

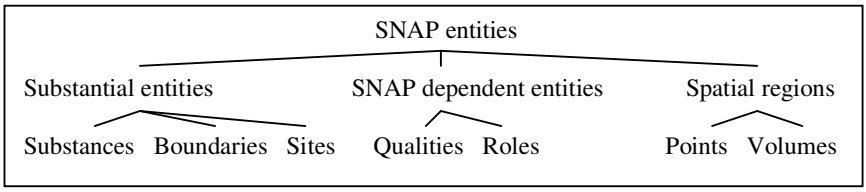
Taken together, I, II, and III imply the following dualism:

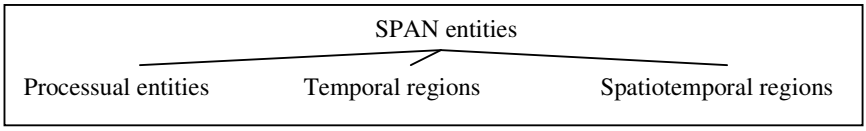
IV. Each universal is *either* such that its instances necessarily are perduring particulars *or* it is such that it can have both enduring and non-persisting instances.

Adopting terminology (and several views) from Grenon and Smith [1], I will call universals that can have both enduring and non-persisting instances *SNAP-universals* and universals whose instances necessarily are perduring *SPAN-universals*. Association clues: SNAP-universals can be caught in SNAPshots (since they have no proper temporal parts), but SPAN-universals require timeSPAN videos (since they have such parts).

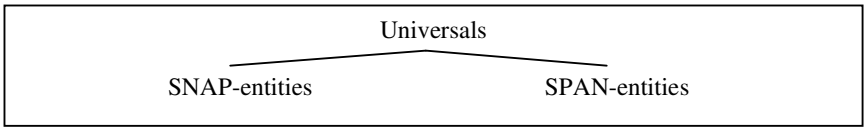
The classification of universals into SNAP- and SPAN-universals is of quite another character than the traditional scientific classifications of universals into subsumption trees. In the latter, universals are classified only as universals, and there is no explicit reference whatsoever to their instances. There are though in some sciences, as stressed by Smith in several talks and in [11], classificatory dualisms that correspond to the SNAP-SPAN distinction. In medicine, one finds the distinction between anatomy (SNAP) and physiology (SPAN), and in economy there are the distinctions between stocks and flows and between commodities and services.

Within the realm of SNAP-universals on the one hand, and within the realm of SPAN-universals on the other hand, one can in the usual way classify universals directly as universals. That is, 'SNAP-universal' can be taken as an ordinary top taxon in a traditional classification of universals, and so can 'SPAN-universal'. Smith's bi-ontological approach has given rise to the following bipartite top-level ontology [1] (for simplicity's sake, some taxa on the third level have been excluded):





What is then wrong with bringing these two ontologies together in one ontology that starts as follows?



The answer to the question should be obvious in the light of the views put forward. In an ontology such as this, all subsumption relations should be of the same character, but here they are not. From the most determinate universals possible up to the level of SNAP- and SPAN-universals, universals are classified only from the point of view of their non-spatiotemporal universality, but in the two top subsumptions universals are classified from the point of view of temporal features of their spatiotemporal instances. Using such a mix of classificatory principles is not good taxonomy.

Conclusions:

1. Top-level ontologies for particulars can start with only one top-taxon, particulars, but they have to accept multiple inheritances.
2. Top-level ontologies for universals need not accept multiple inheritances, but they have to start with two top-taxa.

What to choose? In my opinion, classifying universals ought to be the default position, but this issue is not to be dealt with here. It requires a discussion of its own.

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