Local Qualities, Quality Fields, and Quality Patterns: A Preliminary Investigation

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Abstract

Abstract. When we describe the shape of certain entities, like a vase or a river, we refer to their qualities in different ways. A river has usually a definite length, but its width varies with the distance from the source, typically getting higher towards the end. Similarly, a vase has a definite height, but its width may vary, reflecting a certain pattern that often marks a particular style. So, at least for certain entities, quality kinds such as length, height and width don't behave in the same way: length or height just inhere to these objects with no need of further qualification, while width requires a spatial localization in order to be determined.

In this paper I would like to explore the way qualities of things behave with respect to the parts of such things. Building on the notion of individual quality introduced in the DOLCE ontology, I will introduce the new notions of local quality, quality field and quality pattern, stressing their cognitive role in many practical situations. I will argue that an expression like "the river's width" or "the depth of the sea" actually refers to a quality field, and not to an individual quality. Quality fields will be used to introduce the further notion of *quality pattern,* and to analyze the distinction between *variation* and *change.*

Keywords. Ontology, quality, local quality, global quality, property, field, pattern

1. Introduction

When we describe the shape of certain entities, like a vase or a river, we refer to their qualities in different ways. A river has (more or less) a definite length, but its width varies with the distance from the source, typically getting higher towards the end. Similarly, a vase has a definite height, but its width may vary, reflecting a certain pattern that often marks a particular style. So, at least for certain entities, quality kinds such as length, height and width don't behave in the same way: length or height just inhere to these objects with no need of further qualification, while width requires a spatial localization in order to be determined.

We shall say that length and height, in these examples, behave as *global qualities*, while width behaves as a *local quality.* A local quality of a certain object is a quality which actually inheres to a *part* of that object, but, despite this fact, is somehow considered, from the cognitive point of view, as a quality of the whole object: so, we rarely say "the width of this river stretch is 100 meters", but we prefer to say "the river's width is 100 meters *here*". Analogously, we say "the depth of the Adriatic Sea is much higher along the Croatian coast than along the Italian coast", referring to "the river's width" or "the sea's depth" as one single entity, although, so to speak, spread out in space. Indeed, in many simple cases, we describe the *qualitative shape* of a certain object in terms of the behavior of a local spatial quality along a certain dimension.

Of course, the distinction between global and local qualities is very general, and goes much beyond purely spatial qualities: consider for instance the mass or volume of a physical object vs. its density or its temperature, or the duration of a rain vs. its intensity. In all these cases, we observe different ways qualities of things behave with respect to the parts of such things. The main purpose of this paper is to explore this phenomenon, which I will call *mereological behavior of qualities* (or, more in general, of *properties,* as we shall see), providing a formal account of local qualities and analyzing its practical implications.

2. Inclusive and exclusive properties

Looking at the philosophical literature, the phenomenon we have described appears to be connected to a more general one, concerning the mereological behavior of properties. A classic distinction in this respect is that between homoeomerous and anomoeomerous properties, based on whether or not a property holding for a whole also holds for all its parts, and discussed in particular by Armstrong [1]. Ingvar Johansson [2] builds on this work in the light of the Johnson's distinction between determinates and determinables [3], focusing his attention to the case of determinate properties belonging to the same determinable, and to the ontological nature of patterns like for instance a distribution of colored areas on a surface [4]. This is, at least in my knowledge, one of the few works addressing in some detail the mereological behavior of what I call qualities[1] (i.e. colors, lengths, temperatures), and not just that of generic properties, so I think it is a good starting point in our analysis[2]. Johansson proposes the following distinction among determinates:

(1) A determinate property is *inclusive* if and only if each possible part of its instances instantiates some other property under the same determinable.

(2) A determinate property is *exclusive* if and only if each possible part of its instances instantiates this very same property (under the same determinable).

As an example of inclusive property, Johansson brings a volume-determinate: if an object has a volume of 100 cm^3, then all its (proper) parts must have a different volume. So every instance of an inclusive determinate necessarily includes other (different) determinates for its parts[3]. On the contrary, he notes that a color-determinate is exclusive: if an object is (*homogeneously*) red, different determinates (under the same determinable) are excluded.

In my view, the homogeneity proviso in the latter example is illuminating, since it gives evidence of a peculiarity of some determinables (like color, density, or temperature): they are prone to have their determinates arbitrarily distributed in the region they are defined. They have therefore a *local behavior.* This makes it difficult to understand the meaning of simple statements like *this car is red*, or *the room's temperature is 20 °C,* so that, in many cases, the ascription of such determinates to an extended object is the result of an implicit convention (the car color is the body's color) or an average operation, and very rarely results from an homogeneous distribution.

To account for possible non-homogeneous distributions of determinates under the same determinable, Johansson introduces a variant to (2):

(3) A determinate property is *semi-exclusive* if and only if some possible part of its instances instantiates this very same property (under the same determinable).

So, if we admit that the red determinate is semi-exclusive, then an object can be globally red (as a result of some convention) if it just has one red part while being locally yellow somewhere else, or it may be also the case that it has multiple local colors with no definite global color. We can conjecture therefore that semi-exclusivity is a formal property which is associated with local behavior.

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[1] Note however that Johansson's notion of quality is different from mine, as will be clear in the following, since he adopts a realist ontology according to which qualities are conceived as universals, and include both substances and properties.

[2] To complete the picture, we should also consider the distinction between *extensive* and *intensive* properties, which has many variants in the literature. I will discuss it in the next section, since I believe that Johansson's work helps to understand it.

[3] For the sake of simplicity, I will assume there are no atoms in the domain, so every object has some proper parts.

Consider now the width of a river. Like for the color case, we can have a river stretch whose width is homogeneous, or another whose width is not definite, since it varies along the river flow. So width-determinates are semi-exclusive. However, differently from colors, we can't say that widths can distribute freely for all the parts of the river stretch, since the longitudinal parts are constrained to have a width lower than that of the river stretch. Indeed, besides being semi-exclusive, according to Johansson widths are also *semi-inclusive:*

(4) A determinate property is *semi-inclusive* if and only if some possible part of its instances instantiates some other property under the same determinable.

This means that, in practice, there is a *direction* (across the river flow) according to which each part contributes to the width of the whole, but there is another direction (along the flow) according to which there is no such contribution. As we shall see, this observation will be useful to define the notion of local quality. For the time being, however, we must say that semi-exclusivity, alone, is not enough to fully capture the intuition behind the notion of local behavior, mainly because, according to the definitions above, semi-inclusivity and semi-exclusivity are not disjoint.

3. Extensive and intensive properties

In physics and chemistry, an extensive property (like having a certain volume) is such that, if it holds for a whole, every single part necessarily contributes to this fact, while an intensive property (like having a certain temperature or color) is not necessarily affected by the parts of its instances. In his book, Johansson uses the terms 'extensive' and 'intensive' in a different sense, based on Kant's distinction between extensive and intensive *magnitudes*. He observers that for Kant 'extensive' is synonymous of 'inclusive', but 'intensive' means just *quantifiable,* so that it is not opposite to 'extensive'[4]. I don't think this understanding of 'intensive' is useful for our purposes, so I will stick to the previous (still informal) definition.

I will rather suggest the following definition:

(5) A determinate property is *extensive* if and only if it is necessarily semi-inclusive. A property is *intensive* otherwise.

Under this definition, an intensive property is just a property which does not impose any inclusivity constraints on its mereological behavior. All exclusive properties turn out to be intensive, as well as all semi-exclusive properties *which are not also semi-inclusive*[5]. An important aspect of this definition is its modal nature. A property is extensive or intensive depending on whether or not, because of its very nature, it forces the proper parts of its instances to be different. To me, this definition of intensivity finally captures our intuitions concerning the local behavior of a determinable: only intensive determinables (i.e., all of whose determinates are intensive) can admit arbitrary distributions within the parts of a given object.

As a final note, someone may observe that (5) is neutral with respect to an aspect usually considered as characteristic of extensive properties, namely additivity. Additivity however only concerns quantifiable properties, and I agree with Johanssson that the basic distinction we are aiming at should be more general. In particular,

[4] In other words, on one hand 'intensive' is understood as opposite to 'extensive', while on the other hand it is understood as 'capable of having an intension'.

[5] In addition, a property like *mean temperature of 20° C*, which is neither semi-exclusive nor semi-inclusive (since it can hold both when all the proper parts of its instances have the same temperature and when no proper part has the same temperature), turns out to be intensive.

Johansson makes a very interesting example of a semi-inclusive determinable, namely *shape*, which is not additive but still would count as extensive under our definition.

4. Local qualities

Let us now shift from determinates and determinables to individual qualities and quality kinds. Independently from any deep metaphysical commitments, I think that this move is pragmatically useful not only to provide an analysis consistent with the DOLCE ontology [5], [6], but also to better clarify our intuitions concerning local qualities. In DOLCE we distinguish between *individual qualities*, which inhere to specific individuals, and *qualia*, which are abstract entities representing what exactly resembling individual qualities have in common. Qualia resulting from comparable individual qualities are organized in quality spaces. We refer to individual qualities with expressions such as *the color of my car,* while we refer to qualia with simple terms like *red.* So the color of my car is different from the color of your car, even if they have exactly the same shade of red, i.e., they have the same quale[6]. If I paint my car in blue, the term *the color of my car* still denotes the same quality, but its quale is now different. So, in general, the relationship between qualities and qualia is temporalized.

From now on, I shall simply use the term *quality* to refer to an individual quality. In DOLCE, qualities are organized in *quality kinds*, i.e. *maximal classes of comparable qualities*. *Color* and *volume* are examples of quality kinds. Their instances are individual colors or individual volumes. The objects to which such qualities inhere are instances, respectively, of the *has-color* and *has-volume* determinables. So there is a correspondence between determinables and quality kinds, but quality kinds are not determinables. Similarly, there is a correspondence between determinates and qualia, in the sense that the objects whose qualities have the same quale inhere are instances of the same determinate.

In terms of individual qualities and quality kinds, (1) can be reformulated as follows[7]:

(6) A quality *q* of kind *Q* with quale *ql* inhering to an object *x* is *inclusive* iff every proper part *y* of *x* has a quality *q'* of kind *Q* with quale *ql'* different from *ql.*

The definitions (2)-(4) above can be reformulated analogously, and will be omitted here for the sake of brevity. (5) however makes little sense at the level of individual qualities, and much more sense at the level of quality kinds, or, more in general, to classes of qualities belonging to the same kind:

(7) A quality kind (or a class o qualities belonging to the same kind) is *extensive* iff, necessarily, all its instances (i.e., its individual qualities) are semi-inclusive. It is *intensive* otherwise.

Let us now go back to our initial question: *what is a local quality?* A first conjecture we can make is that *a local quality is an instance of an intensive quality kind.* So, looking back at our original example, the color of each part of the vase, being an instance of an intensive quality kind (color), appears to be a local quality.

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[6] I must say I have no clear understanding about the best way to name the relationship existing between individual qualities and their qualia. In this paper I will simply use "has". Probably a more informative name would be "manifests as".

[7] For the sake of conciseness, I will abstract from time in these definitions, since time is not relevant to understand their rationale. Extending them to the temporal version is however a simple matter, taking into account that in DOLCE the part-of and the has-quale relation are temporalized when they concern endurants.

However, things are not so simple, since we want also to account for the local behavior of a river's width, and *width* is not an intensive quality kind, since it is semi-inclusive. Moreover, a fundamental question arises: *local to what?* Given a particular object, how can we tell what are *its* local qualities? For instance, think of our river example. Arguably, the river has many local widths, each inhering to a particular river stretch. But also each possible longitudinal part of the river has a width. Is that width a local quality *of the river,* or just of a strange part of it? From the cognitive point of view, I say it is not a local width of the river. Think of another example, perhaps more vivid: a vase with a handle. The vase has many local widths (at the top, at the bottom, in the middle…), as well as the handle has many local widths, but none of the local widths of the handle is a local width of the vase, despite the fact that the handle is a part of the vase.

To address this issue, let us first clarify that each local quality of an object inheres to some proper part of the object, *but not to the object itself.* So, when we say that a vase *has* many local widths, this is because of an *indirect* inherence relation, similar to the one holding in DOLCE between an event and the spatial location of its participants. The point now is that this indirect relation existing between the quality of a part and the whole doesn't hold for all parts: as we have seen, not every width of a part of the vase is a local width of the vase. I think there is a simple cognitive mechanism that explains this situation. When we consider a (non-inclusive) quality kind such as *width* as applied to a river, we implicitly introduce a set of *canonical parts* (namely those cut across the river flow, corresponding to river stretches) whose width counts as *a local width of the river*. Because of the way canonical parts are constructed, the class of all local widths of a river turns out to be intensive, despite the quality kind 'width' is not.

Similarly, when we apply 'width' to a vase, we consider as canonical parts those concerning the internal cavity, excluding the handle. Finally, when we apply 'color' to a car, we only consider the external parts of the body as canonical parts, while when we apply it to the vase we may consider as canonical all the (external) parts of the vase, including those of the handle.

In sum, we can conclude that local qualities are instances of *quality classes,* constructed ad hoc with the cognitive mechanism described above as a specialization of non-inclusive quality kinds. In general, such classes are not *rigid,* using OntoClean's terminology: the color of a part of the vase will keep its identity when the part is removed, although it will not be a local color of the vase any more. Local qualities don't form a new ontological category. Locality, for qualities, is just a special way to describe a whole (especially its *shape*) with reference to the qualities of its parts.

5. Quality fields and quality patterns

Consider now all local qualities of a certain kind that a certain object has, at a given time. For instance, think of all the local depths of the Adriatic Sea. I say that the mereological sum of these local qualities is a *quality field.* While a single local depth does not inhere to the whole Adriatic Sea, the whole depth field does, it inheres to it. Quality fields form therefore a new ontological category in the vast class of dependent entities. We are able to define them thanks to the introduction of the notion of local quality.

Once we introduce quality fields, we can give an exact denotation to expressions like "the river's width" or "the depth of the sea" which don't usually refer to an individual quality, unless we conventionally pick up a specific individual quality (say the maximal depth). I will say that these expressions denote a quality field. Indeed, on the basis of our previous analysis, we can safely assume that an expression of the form

"the Q of X" denotes a quality field if Q is not an extensive quality kind, unless a special convention is introduced for certain kinds of X.

Let us bring time into account, using the notion of quality field to analyse the distinction between *variation* and *change.* Synchronically, at a specific time, we can observe *variations* in the Adriatic Sea's depth field when shifting our focus of attention from one part (e.g., the depth of the Italian side) to an other (e.g., the depth of the Croatian side). The whole quality field can also genuinely *change* in time, keeping its identity, when some of its individual qualities change their qualia. This is what happened in the last 2000 years, since the depth of the Italian coast is much lower than it used to be in the Roman age.

Consider now the Adriatic Sea's depth field at the Roman age. It exhibits an individual spatial *pattern*, which is different from the pattern we can observe today. Such pattern reflects *the specific qualia distribution* of the individual qualities forming the depth field at that time. I define a individual pattern as an emerging entity *constituted* by (a part of) a quality field. It differs from a quality field since the actual qualia distribution is an essential property of the pattern, and is not essential to the quality field (whose qualia distribution can change in time). So individual patterns are frozen, they don't change, although they can exhibit variations. Note that I am insisting using the term *individual* pattern to make it clear they are not abstract entities: two things may have exactly resembling, although distinct, individual patterns. In this case, I say that they will have the same *shape,* but this is another story.

Let us finally shift the attention to perdurants. They can have both global and local qualities, inhering to each temporal part. The duration of a rain is a global quality, while its intensity is a quality field. When we say "the rain intensity is high now" we are referring to the whole intensity field, whose value happens to be low in the present time interval, exactly like the width of the river happens to be high in a certain place. So, the introduction of local qualities and fields can help understanding apparent "changes" in events and processes, like those described in [7], without the need of introducing a new entity which is the subject of such change: a speed variation during a run or an increase in the river flow will be simply considered as a variation of a local quality (the run speed or the water flow) along the temporal dimension. This move may also eliminate (at least for these examples) the need to introduce so-called *relators* [8] in addition to events exemplifying a binary relation like *marriage*: a change in the peacefulness of the marriage will be simply described as a variation of a local quality of the marriage itself, with no need to introduce a separate relating entity.

In conclusion, the introduction of local qualities, fields and patterns seems to be a simple and powerful extension to the Dolce's notion of quality, which allows us to formally account for the way we deal with spatial and temporal quality distributions. This is still not enough to fully account for the different *shapes* such distributions may exhibit, but I believe it contributes to understand what shapes are.

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