

# Understanding Ontological Levels

Claudio Masolo

Laboratory for Applied Ontology, ISTC-CNR

`masolo@loa-cnr.it`

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# 1 Spatial coincidence

A sculptor creates the statue of the infant Goliath by sculpting the lump of clay Lumpl.

- Lumpl, but not Goliath, would survive a squeezing while Goliath, but not Lumpl, would survive the loss of some parts.
- Goliath, by a continuous and complete renovation of the clay it is made of, could survive the destruction of all parts of Lumpl.
- Lumpl already existed before the sculptor bought it, while Goliath comes into existence only once the sculptor has completed her work.
- Goliath, but not Lumpl, has been created by an artist, it costs 2000 euros, it causes you to pay a ticket to see it.

## 2 Counting problem

In 2009, Alitalia carried a million passengers. If, in 2009, some persons flew Alitalia more than once then Alitalia served less than a million persons (similarly for roles in general).

- To count the passengers of an airline one cannot simply count the persons that flew it.
- Passengers but not persons have a flight number and specific rights and obligations.
- A person can fly different airlines or she can fly several times the same airline with different destinations or simply in different days.

### 3 Conflict properties paradox

Luc as passenger of Air France has the right of checking in online, while, as passenger of Alitalia, has the obligation of checking in at the airport.

- If passengers reduce to persons then one obtains a contradiction: Luc cannot have both the right of checking in online and the obligation of checking in at the airport (assuming a standard view on rights and obligations).

## 4 Abstraction hierarchies

- *Abstraction hierarchies* can be used to represent a complex systems at different levels of detail.
- High-level objects can be seen as the result of an abstraction process that starts from basic (often physical) objects.
  - ▶ Cells can be aggregated to compose organs with specific functions, i.e. cells are the 'physical implementations' of organs. (the same for the components of a complex system)
  - ▶ Relation between an one object and a *plurality* of objects.
- To plan a trip a road can be seen as a 2D object that abstracts from its 3D aspects.
  - ▶ Relation between two objects without spatial coincidence.

## 5 A solution: multiplicativism

- Lumpl *constitutes*, but it is different from, Goliath.
  - ▶ Constitution is a factive (asymmetric) relation that does not reduce to parthood or co-location; it just allows the *inheritance* of some properties, i.e. it provides a sort of *unity*.
- Luc-qua-passenger *inheres in*, but he is different from, Luc.
  - ▶ During its whole existence, a qua-entity inheres in the same *host* (the player of the role passenger in the example).
- My heart is an *aggregation* of, but it is different from, a plurality of cells.

## 6 A note on multiplicativism and existence

- Does Goliath *really* exist or it is the result of a *conceptual* construction that collects different amounts of clay on the basis of cognitive criteria that can be founded on shape, continuity, etc.?
- In philosophy the *ontological/conceptual* distinction is fundamental.
- On one hand, KR can avoid to commit to reductionism or anti-reductionism: if multiplicativism solves problems, independently of the nature of the entities introduced, it deserves attention.
- On the other hand, the general (and foundational) point of view of philosophers is a very important input to avoid ad-hoc solutions that are difficult to generalize, re-use, and share.
- ▶ I'm particularly interested in this second aspect.

## 7 Aims

- To develop a *formal* framework that allows to manage constitution, inherence, and abstraction (aggregation) in a *uniform* way.
- To set up this framework on the basis of general and *well-foundend primitives*.
- To highlight possible *alternative* frameworks, the comparison of which would improve our understanding of levels.
  - ▶ I do not formally explore these alternatives, I just point out some of them.



## 8 Entity stacking

- I will refine a multiplicative approach called *entity stacking* that is based on the notion of *existential dependence*:
  - ▶ Goliath depends on Lump1,
  - ▶ Luc-qua-passenger depends on Luc,
  - ▶ my heart depends on the on cells,but the opposite holds for none of the previous examples.
- This dependence can be generalized to kinds.
  - ▶ E.g. statues, to exist, require amounts of matter but amounts of matter can exist without any statue.

## 9 Grounding

- Existential dependence is often defined as  $\Box(Ex \rightarrow Ey)$ .
- Existential dependence of  $x$  on  $y$  “amounts to the necessary truth of a material conditional whose antecedent is about  $x$  only and whose consequent is about  $y$  only; and given that any such material conditional fails to express any ‘real’ relation between the two objects, it is hard to see how prefixing it with a necessary operator could change anything in this connection” (Correia 2002, p58).
- Grounding: an object  $x$  is grounded on a (different) object  $y$  at  $t$  if the existence of  $y$  at  $t$  makes possible the existence of  $x$  at  $t$ , i.e.,  $x$  owes its existence at  $t$  to  $y$ ’s existence at  $t$ .
- Grounding introduces a *factual relation* among objects.

## 10 The notion of level

- Grounding can stack more than one object:
  - ▶ a pebble can be grounded on an amount of matter and it can ground a paperweight;
  - ▶ cells ground organs that ground bodies that ground persons that ground organizations, etc.
- Grounding is a 'vertical' relation between objects. To group objects in levels an 'horizontal' relation is necessary.
- General relation compatible with different views on levels:
  - ▶ levels depend only on laws of nature;
  - ▶ levels are the result of a conceptualization;
  - ▶ levels correspond to (natural) kinds of objects.

## 11 Being at the same level as

- I consider 'being at the same level as' as an additional primitive.
- Why not assuming a recursive definition in terms of grounding?
  - ▶ Not first-order axiomatizable.
  - ▶ Requires bottom-level objects to stop the recursion.
  - ▶ Given a bottom level, hierarchies of levels build on it are linear.
- Level hierarchies are assumed as non-linear by some authors.
  - ▶ Some comparisons do not make sense: are robots on a higher level than sea slugs? (Baker 2007))
  - ▶ Levels account for conceptual points of view on reality, the same object can be seen in different ways.

## 12 Parthood

- A *whole*, e.g. a table, can have persistence criteria and causal powers different from the ones of its *parts*, e.g. a top and four legs. To exist, the table requires the existence of the top and the legs. Is therefore parthood just a kind of constitution or aggregation?
- The relation between parthood and constitution/aggregation is a highly debated issue complicated by the fact that there is no consensus about the core properties of parthood.
- I differentiate *grounding* from *parthood* by assuming a purely *formal* parthood: mereology just aims at referring to 'pluralities' ('multitudes') of entities without committing to sets: *mereological sums* are 'nothing more' than their summands.

## 13 Time

- To express change through time I need to consider temporal indexes.
- I want to be neutral with respect to the structure of time, therefore I consider here a very weak theory of time: basically I will consider time just as a non-structured set of indexes called *times*.

## 14 Formal primitives

- A logic with two sorts, *time* and *object*, distinguished by a notational convention: variables on times are noted by  $t, t', t_i$ , etc.
- $E_t x$       “ $x$  exists at time  $t$ ”
- $x \prec_t y$       “ $x$  grounds  $y$  at  $t$ ”, “ $y$  owes its existence at  $t$  to  $x$ ”
- $x P_t y$       “ $x$  is part of  $y$  at  $t$ ”
- $x \equiv y$       “ $x$  is at the same level as  $y$ ”

## 15 Focus

- I will discuss only some axioms that I consider important.
- The details of the axiomatization can be founded in the paper.



## 16 Static notion of level

- ▶  $x \equiv y$      “ $x$  is at the same level as  $y$ ”
- Objects cannot change level through time, e.g. no object can survive a change in natural kind because no object can lose essential properties.
- *Dynamic* theories are interesting, require two temporal arguments, and are more complex from the formal point of view.

## 17 Down-linearity of grounding

**a20**  $y \prec_t x \wedge z \prec_t x \rightarrow y \prec_t z \vee y = z \vee z \prec_t y$

- To account for the following intuitions:
  - ▶ Goliath is intimately connected to Lumpl, it cannot be grounded on something else at the same level;
  - ▶ two objects with different grounding are different, i.e. the difference in grounding is enough to distinguish them.
- (a20) is too strong if grounding is a simple existential dependence:
  - ▶ one objects can depend on all its parts (all at the same level);
  - ▶ relational tropes can, in principle, depend on objects belonging to different levels (that do not depend one on the other).

## 18 Generic dependence between levels

**a22**  $x \equiv y \wedge u \prec_t x \wedge \mathbf{E}_{t'} y \rightarrow \exists v (v \equiv u \wedge v \prec_{t'} y)$

- Entities belonging to higher levels depend on lower level entities.
- (a22) partially characterizes the notion of level.

## 19 One-level objects

$$\mathbf{d14} \quad 1\mathbf{L}x \triangleq \forall yt(y\mathbf{P}_tx \rightarrow y \equiv x)$$

$$\mathbf{a30} \quad x \equiv y \rightarrow 1\mathbf{L}x \wedge 1\mathbf{L}y$$

$$\mathbf{a31} \quad x \prec_t y \rightarrow 1\mathbf{L}x \wedge 1\mathbf{L}y$$

- (a30) and (a31) assure that  $\equiv$  and  $\prec$  apply to objects with parts belonging to different levels.
- Is it not clear to me what  $\equiv$  and  $\prec$  mean for multi-level objects, some options exist.
- (a30) and (a31) do not exclude the existence of multi-level objects (in particular parthood is not defined only on one-level objects).

## 20 Partial grounding

**d15**  $x \prec_t y \triangleq \exists z(x P_t z \wedge z \prec_t y)$  (partial grounding)

**t15**  $z \prec_t y \wedge y \prec_t x \rightarrow z \prec_t x$

**t20**  $\neg x \prec_t x$

**t24**  $\exists a(x P P_t a \wedge a \prec_t y) \rightarrow \exists z(z \equiv x \wedge z \prec_t y \wedge \neg z O_t x)$

- (t24) is similar to weak supplementation of parthood.
- Partial grounding satisfies properties very similar to the ones assumed for *minimal mereology* (Casati&Varzi 1999).
- In my understanding, this explains why some authors use parthood to represent constitution or partial grounding. However some links between  $\prec$  and  $P$  or  $\equiv$  are not considered in any mereology.

## 21 Constitution

- At a given level and time, the grounding of an object is unique, therefore *constitution* can be directly represented by grounding.
- Constitution implies spatial co-location. Here I have not addressed this aspect but I think it is not difficult to extend the theory to take into account space.
- Who prefers a notion of partial constitution can use partial grounding.
- Note however that in my theory partial grounding and parthood are two different relations:

$$\mathbf{t14} \quad x \triangleleft_t y \rightarrow \neg y P_t x$$

## 22 Inherence

- While constituted objects can change their constituents across time, qua entities inhere in the same object during their whole existence.
- In addition inherence is generally assumed to satisfy the *non-migration principle*: a qua-entity inheres in a unique object ( $t^{**}$ ).

$$\mathbf{d19} \quad x \oplus_t y \triangleq x \prec_t y \wedge \neg \exists z (x \prec_t z \wedge z \prec_t y) \quad (\text{direct grounding})$$

$$\mathbf{d20} \quad x \text{IN} y \triangleq \forall t (\mathbf{E}_t x \rightarrow y \oplus_t x) \quad (\text{inherence})$$

$$\mathbf{t^{**}} \quad x \text{IN} y \wedge x \text{IN} z \rightarrow y = z$$

## 23 Granularity

- The distinction between parthood and grounding allows to address *granularity* by considering *atoms* (objects without proper parts) that are grounded on non-atomic objects.
- I considered just a very trivial theory of granularity.
- The following assumptions can quite easily be characterized in terms of the presented theory:
  - ▶ objects are ultimately (mereologically) composed by atoms;
  - ▶ higher levels are coarser than lower ones (i.e. atoms are grounded on non-atoms;
  - ▶ higher atoms *partition* lower ones (i.e. any lower level atom partially grounds one and only one high level atom).